Hellenic Society for Systemic Studies
Full Member of IFSR

From Systemic Thinking to Systems Design & Systems Practice

June 24-27, 2009
Xanthi, Greece
http://hss05.pme.duth.gr

Co-Organisers
Democritus University of Thrace
Department of Production & Management Engineering
Kimmeria Campus
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Topic:

Business

Potentialities of small business structures in machine-building industry for inventions of knowledge

*Diana Antonova, Svilen Kunev*

An inter-industry analysis with emphasis on agriculture *(ABSTRACT ONLY)*

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Consumers’ online buying behaviour in the context of different product types

*Elissavet Keisidou, Lazaros Sarigiannidis, Dimitrios Maditinos*
Potentialities of Small Business Structures in Machine-building Industry for Inventions of Knowledge

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Abstract:
The paper discusses the potentialities of small structures for generation of knowledge, its practical application and contribution in the processes of knowledge diffusion, together with the difficulties that small structures encounter during the realization of their innovative activity. Results from a study conducted in 2008 among 200 active non-financial SMEs from the Bulgarian machine-building sector are discussed, conclusions and recommendations are formulated.

Keywords:
Inventions; innovation activity; factors, influencing innovations; technological transfer; diffusion of innovations.

1. Introduction
Innovation is mainly connected with three basic features: scientific and technical novelty, production (practical) applicability and trade utilization. While science and technical aspect accentuate primarily on the degree of novelty, for business the potential for practical application and gaining of positive financial results are more important. Many ideas cannot be accomplished and do not have successful market penetration. That makes companies to focus their attention on two main directions:

- materialization of the specific idea (invention) or development in new products, materials, technologies, organization, markets;
commercialization, transforming of the idea and the innovation into income source.[1]

Small and medium enterprises (SME) have a number of favorable advantages for innovations: they create new jobs; they show stronger flexibility in crisis situations and have adaptive internal organizational structure. SMEs can answer the changes in market juncture in a fast and adequate manner, they can adopt innovations and they are favorable place for development of entrepreneurial skills and business culture. [2] Small structures are the units necessary for ‘optimization of the entire innovation process”.[3]

The paper discusses the potentialities of small structures for generation of knowledge, its practical application and contribution in the processes of knowledge diffusion, together with the difficulties that small structures encounter during the realization of their innovative activity. This helps to reveal the companies’ inner potential for acceleration of technological transfer and diffusion of innovations, for achieving of economic growth and increasing of competitiveness not only for single entities, but also for the economy as a whole.

In that row of thoughts, the insufficient empirical information provoke the conducting of a study in the Bulgarian machine-building sector. SMEs in that sector compose about 7.8% of all SMEs in Bulgaria, they are distinguished for their relatively high innovation activity and exercising of good innovation practices. The main goal of the study is to determine:

- the degree of innovation activity among SMEs in machine-building sector;
- the main directions of that innovation activity and the means for its implementation;
- the factors which influence innovations;
- the achieved results;
- the major problems which SMEs face.

The research work is focused on the active non-financial SMEs from the Bulgarian machine-building sector. The investigated period is 2007-08, and the study is conducted from June to September 2008 among 200 companies. The results show that innovation efforts of the companies are directed to a small degree to process or mixed type innovations. On the contrary, empirical results from EU show that process innovations have superiority over product innovations.
2. **Innovational activity**

During 2007-08 one fourth of SMEs in machine-building industry demonstrated innovational activity. Companies who implemented innovational products (17.7%) are almost twice more than those, who put efforts in processes, and a small part of respondents (9.2%) indicate that marketing innovations are among their innovational priorities. Decisions for change are provoked by the following main reasons:

- Compliance with legislation requirements and standards;
- Usual pattern for business behavior;
- Seasonable reaction to market changes and necessities

About ¼ of the respondents have developed or implemented new or seriously modified products. Considerable attention is focused on new products for the enterprise, who are addressed to a local segment. With increasing the market share and the degree of novelty the share of innovative companies decreases. Only one of 24 firms has allocated its activities to products actually new for the international market. The micro enterprises, who stress on “survival through retaining current position with the help of well-known products”, are those with the lowest activity. While micro and medium units don’t have particular focus on product innovations, small companies are oriented to changes connected with introducing of new and modified production methods. On the other hand, the share of middle-sized companies who have put into practice new supply methods for the Bulgarian market, exceed 6 times the share of micro companies.

The level of activity for implementing organizational innovations is higher, which could be explained with increased use of computer technologies and the introduction of parallel innovations in contacts with business partners, while a small part of respondents have initiated changes in managerial systems and methods. A small part of the respondents declare that they tried to foster the creative abilities of employees, the generation of new ideas for innovational development and their implementation afterwards by organizational changes.

The companies who have implemented more than one project can be grouped as follows:

- Medium business structures – changes in managerial methods and systems and in the relations with other enterprises (5.12%);
- Small production units – changes in work organization and in the relations with other enterprises (2.25%);
Micro enterprises - changes in managerial methods and systems and in work organization (2.12%)

Marketing innovations have the lowest share and are implemented mainly in companies with employees over 9 people. All groups focus their efforts in modifying product design and packing than in innovations in the methods of selling. Motives for such types of changes are: necessity or logical consequence from implementing of other types of innovations; legislation, imposing certain actions in the company; requests from particular segments; pursuit of the cheapest variant of innovational change.

The main conclusion about the innovational activity of Bulgarian machine-building SMEs is that their share grows up with the increasing of the size of the companies and in activities with high degree of technological operations and considerable size of added value. These results are confirmed by surveys of “Vitosha Resarch 2006” and “Innovations.BG 2007”. On the contrary, empirical data of EU show prevalence of process innovations over product ones.

3. Main directions of innovational activity and methods for its implementation

For small and medium enterprises is more likely cooperation in the area of innovations than independent undertaking of innovatory activities. The joint work has is to a great extent market orientation than innovational-technological character. There is a weak link between enterprises and public organizational structure.

Regardless of the type of innovations, cooperation with another enterprise or with enterprise and scientific organization is the most preferred way of joint work. This is the basic form for combining the efforts of companies who have implemented at least two types of innovations. An underestimating of possibility for joint innovative actions with higher schools is observed. Enterprises perceive universities only as a place for education and not as research centers. A certain recovery in the confidence in scientific centers is also observed. In general, subsidiary companies had not used services of other partner in innovational activity. The interviewed managers declare positive attitude to cooperation in innovations, but they are to some extent reserved, because they are not so aware of the methods for realizing of joint innovation activity and do not have sufficient information for potential partners and supporting organizations.

The conclusion is that with increasing the company’s size the possibility for conducting a joint innovational project also rises, and the presence of an international shareholders in the enterprise’s capital favors the choice of an international partner.
4. Protection of intellectual property and human factor

One of the most serious problems of SMEs is protection of intellectual property. Almost symbolic is the share of machine-building companies who have used methods for protection of intellectual property (0.87% of innovative business units). In 90% of the cases these are SMEs. The structure of registered industrial models is: design decisions (0.54%) and trade marks (2.34%). As a whole, in over 78% of the cases protection of their innovative solutions have done economic units with number of employees over 50 people. The conclusions of “Innovations.BG 2007” and “Vitosha Research 2006” are similar. Due to relatively easy coping and the lack of sufficient knowledge and information in that field, major part of managers decide not to renovate or patent.

In machine-building sector the number of people, occupied with innovative activity is the biggest within the group of medium enterprises – average from 4 to 7 people. Small companies have from 2 to 4 people, and micro units – up to 2 people.

The presence of Scientific and research department is typical for business structures of a larger size. Within the observed group each eight medium enterprise and 10.55% of small units have such a department. That indicator, analyzed from another viewpoint shows that almost half of the medium companies (49.2%) and 34% of small business units do not have scientific and research teams in their organizational structure.

Important measurement of innovative activity is investing in human resources, which are necessary for working on innovational projects (72% of respondents). Approximately half of the medium sized and 1/3 of small enterprises have allocated resources for training, but even among those company accumulating of serious effects is not observed. Some managers perceive investments in human factor – irrespective of their direction – as connected with innovational activity and its results. In that sense, they are included in the investigated group not so reasonable and their presence changes in the investment pattern in a positive way which is not an objective result.

There is a large-scale non-resistance of personnel to alterations but that is not enough, because of lack of active position and motivation for initiating and participation in innovational projects.

5. Factors favoring innovations

The most important factors playing favorable role for innovations in machine-building sector are: existence of entrepreneurial spirit; highly qualified employees; exuberant managerial experience and intensive contacts with industrial associations (Table 1).
Table 1: Sources of financing as a favorable factors for innovations

<table>
<thead>
<tr>
<th>No.</th>
<th>Sources of financing</th>
<th>Relative share (%)</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>Profit from previous activity</td>
<td>98,51</td>
</tr>
<tr>
<td>2.</td>
<td>Savings (personal and of the management team)</td>
<td>94,11</td>
</tr>
<tr>
<td>3.</td>
<td>Family and friends</td>
<td>32,54</td>
</tr>
<tr>
<td>4.</td>
<td>Suppliers</td>
<td>22,11</td>
</tr>
<tr>
<td>5.</td>
<td>Clients</td>
<td>32,43</td>
</tr>
<tr>
<td>6.</td>
<td>Private persons – Bulgarian investors</td>
<td>0,35</td>
</tr>
<tr>
<td>7.</td>
<td>Corporations – Bulgarian investors</td>
<td>2,13</td>
</tr>
<tr>
<td>8.</td>
<td>Banks</td>
<td>49,42</td>
</tr>
<tr>
<td>9.</td>
<td>Risk capital funds</td>
<td>-</td>
</tr>
<tr>
<td>10.</td>
<td>Specialized national funds</td>
<td>-</td>
</tr>
<tr>
<td>11.</td>
<td>Private persons – international partners</td>
<td>2,13</td>
</tr>
<tr>
<td>12.</td>
<td>Corporations – international partners</td>
<td>4,27</td>
</tr>
<tr>
<td>13.</td>
<td>EU funds and programmes</td>
<td>1,24</td>
</tr>
<tr>
<td>14.</td>
<td>Mother company</td>
<td>0,76</td>
</tr>
<tr>
<td>15.</td>
<td>Other</td>
<td>0,92</td>
</tr>
</tbody>
</table>

From the viewpoint of the size of analyzed companies, the entrepreneurial spirit has have major impact over the medium sized units. Their managers have managerial experience (68%) and have at their disposal the necessary human resources (54,2%). Those two factors are determinant and for the small business units (resp. 66,22% and 51,50%), but for the most of them connections with industrial associations had been a basis of the decision for innovation. Use of consultant services, which is very widespread among SMEs in developed countries, does not receive the necessary positive attitude from small and micro enterprises. In regard to financial institutions the survey confirms the prevailing status quo that with the growth of company’s size the confidence in financial institutions also grows, respectively and the possibility for fast and easy access to new financial resources.

A very small part of non-innovative enterprises have indicated highly-qualified specialists, experience and entrepreneurial spirit as factors stimulating innovations. Although their presence, they had not been sufficient to motivate managers for working in that direction. Good relations with industrial associations had advantaged their normal existence more than the innovational activity.
6. Factors preventing innovations

In the conducted empirical survey managers of the machine-building companies give more explicit evaluations for the barriers that innovative process face. They could be divided to internal and external. Among internal factors the major problem is the lack of knowledge in the field of innovations. In dynamic aspect, 75% of micro enterprises and ¼ of small and medium companies define such difficulties. In the second place is insufficient information about contemporary achievements and technologies (65.2%). Again, this a serious problem for 75% of micro units. The low technical and technological level is a suspensory factor for 55.15% of innovative and for 78% of all interviewed companies. More than half of the SMEs does not have enough market information, and 40% have problems with personnel. The negative influence of insufficient managerial experience has the lowest impact, which could be due to the subjective answer of the question.

The analysis of the external factors has found that the major problem is a financial one (Table 2).

Table 2: External barriers for innovations

<table>
<thead>
<tr>
<th>No</th>
<th>Main barriers</th>
<th>Micro (%)</th>
<th>Small (%)</th>
<th>Medium (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High direct cost for introducing innovations</td>
<td>86,63</td>
<td>87,03</td>
<td>45,62</td>
<td>73,09</td>
</tr>
<tr>
<td>2</td>
<td>Lack of sources for financing</td>
<td>89,20</td>
<td>79,20</td>
<td>46,82</td>
<td>71,74</td>
</tr>
<tr>
<td>3</td>
<td>Too big economic risk</td>
<td>67,30</td>
<td>79,20</td>
<td>65,13</td>
<td>70,54</td>
</tr>
<tr>
<td>4</td>
<td>The price of financing is too high</td>
<td>90,20</td>
<td>95,10</td>
<td>69,87</td>
<td>85,06</td>
</tr>
<tr>
<td>5</td>
<td>Lack of sound state policy in the field of innovations</td>
<td>52,11</td>
<td>47,84</td>
<td>65,70</td>
<td>55,22</td>
</tr>
<tr>
<td>6</td>
<td>Lack of consumer interest to new products and services</td>
<td>27,10</td>
<td>25,92</td>
<td>25,40</td>
<td>26,14</td>
</tr>
<tr>
<td>7</td>
<td>Presence of dominant companies on the market</td>
<td>65,20</td>
<td>14,65</td>
<td>35,20</td>
<td>38,35</td>
</tr>
<tr>
<td>8</td>
<td>Other</td>
<td>55,23</td>
<td>40,32</td>
<td>85,11</td>
<td>60,22</td>
</tr>
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</table>

For micro companies the major problems are the high price of financing and the lack of sources for financing. Small economic units perceive as primary important, besides the factors mentioned above, the high direct costs for introducing innovations. The medium units have some
fears about too high risk level and they are unsatisfied from the lack of sound state policy in the field of innovations.

The shortage or the insufficiency of financial resources is very important, but not a primary problem for the choice whether to innovate or not. The profound knowledge and timely information for scientific and technical attainments is also of vital importance.

A visual comparison among the three types of enterprises and significance of the main factors with prevention role is shown on figure 1.

**Figure 1**: Main barriers that innovative SMEs in machine-building sector face

If a conclusion about the common problems of SMEs should be drawn, there is a consensus that these could be lack of reliable protection of intellectual property; difficulties in finding partners for joint activity; frequent changes and imperfections of state legislation and standards. Solving of the vast number complicated economic, political, financial, psychological, personnel, social and organizational barriers that SMEs face, need clear rules for doing business, favorable innovational environment and mostly effectively working institutions for stimulating innovations.

7. **Results from the innovational activity**

Clients and suppliers are the most important source of information for innovative SMEs. Suppliers are more important for micro companies (91.23%), while clients have bigger importance for small (89.13%) and medium (88.32%) structures. The positive role of branch associations is significant mainly for small enterprises. One third of companies with
number of employees between 10 and 50 people indicate independent consultants as important source of information and knowledge. Technological and research centers are important for twice more of the medium units than for the small firms. Universities and scientific centers have been a source of information mainly for the small companies than for the medium ones, while for the micro units their importance is relatively low. European institutions has not been a significant source of information not only for the micro and small units, but for more than 75% of the machine-building companies with higher innovational potential – the middle sized ones.

As main channels for distribution of knowledge respondents point exhibitions, fairs and trade events. They provide easy access to knowledge and are major factor for all groups of enterprises. Patents include valuable and professionally structured information but that supposes the user of that information to have serious knowledge, which makes them more significant for more of the small and medium companies, than for the micro units. A negative fact is that a lot of the companies think that channels for distribution of information are not so important. In the majority these are structures which are not innovative.

The innovative projects performed during the period 2007-08 have achieved considerable results in several directions:

- Expanding the range of goods and services. For 59.7% of the respondents that results was very significant. Small and micro units have had similar achievements. As a whole, for 42% of the companies innovational projects have resulted in substantial changes in the product/service range, and for each fifth enterprise the changes have been moderate.

- Increasing the market share of the company (57.2%). Half of micro units, ¾ of small ones and 63% of medium enterprises have achieved an increase in the market share.

- Improving the quality of goods and services (45.22%). The best results of quality improvement are achieved by micro enterprises, while only 35.12% of small companies succeed in increasing the quality.

As a general conclusion it could be said that for a very small part of enterprises innovational changes have resulted in decreasing of labor and material costs or in attaining ecological effect. Innovational projects have not succeed in increasing the labor productivity and improving the technical and technological level of production. That reveals the risk in the next several years the differences in characteristics and indicators of Bulgarian and European SMEs to become even larger.
8. Main conclusions and summaries

1. The share of innovative SMEs in machine-building sector is still too low. Compared with countries from EU, in Bulgaria product innovations prevail and most of the innovative products are with low added value and with local or regional importance. Micro enterprises focus on improving innovations in limited market segment, while medium companies concentrate their attention on international market, innovate more intensively and with higher degree of technological change. Small is the portion of process innovations, which in general have more complicated and risky nature, need more intensive collaboration, but at the same time bring more significant effects.

2. In order to increase the innovativeness and competitiveness of SMEs in machine-building sector, several directions can be formulated:

- Increasing of entrepreneurial and innovational culture in companies;
- Investing in human capital and intensive exchange of technological and production experience;
- Stimulating and motivating the personnel working on innovational project by developing and applying of different mechanisms, techniques and principles;
- Using the possibilities of technological transfer and cooperation in innovations: improving the collaboration between science and business and applying of new forms for public-private partnerships, interaction with the scientific and research centers within the higher education system, accelerating the realization of the idea for establishing of technological centers; stimulating establishment of techno starters in universities; creation of national network for fostering innovations in business; stimulating innovational activity of existing clusters and establishment of new ones; use of the potential of the electronic portal “Technological market”; forming relations with European, national and regional structures for supporting business and usage of instruments like European electronic database.
- Widening the range of used financial instruments and increasing the share of costs for innovational projects (particularly for scientific and research work) by financing innovational projects through the specialized national and European programs and funds, banks for risk capital, leasing companies, etc.
- Developing inside the enterprises of a system for constant acquiring and updating of information about legislation, patent description, scientific and technical novelties, market analyses and technical standards, as well as undertaking actions for protection of intellectual property.

**References**


An inter-industry analysis with emphasis on agriculture

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Abstract (only):
The basic purpose of this study is to provide a set of estimates of agriculture sector and to interpret the meaning and significance needed to understand the role of agriculture in economic development. More specifically, the study investigates the total production employment and income impact of agricultural sector on the Greek economy.

Because of the growing interest of industry differences individual industries are receiving an increasing amount of analysis. There have been attempts to systemize the measurement of sectoral economic effects that would describe the various interrelationships between sectors and forecast their growth.

The methodology approach is that of input – output analysis. The interindustry or input – output methodology provide a framework within which the role and contribution of each industry to the economic effects can be estimated. Furthermore, the input – output technique is a method capable of evaluating multiplier effects.

National data sources provide a common data basis for the construction of an interindustry model comprised of sixteen productive sectors, which should be applicable for further research.

The results of the model used in this study revealed some important features of the agriculture sector in Greek economy. The multipliers for certain sectors were large and had significant intersectoral and interregional direct and indirect linkages. A subsequent analysis of the data and multiplier results involved in this paper could be used to predict optimization of economic growth in different sectors assuming competitive advantages for each producing sector.

Finally, an analysis of input – output structure of the producing forces and sector interrelationships is useful to public and private planners interesting in economic growth.

Keywords:
Interindustry analysis, Sector of Agriculture, Agriculture interrelationships, Sectoral direct and indirect effects and linkages
Estimation of the Financial Characteristics of the
Manufacturing Industry: The Case of East-Macedonia &
Thrake Region, Greece

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Abstract:
The objective of this paper has focused on the estimation and statistical
presentation of financial ratios that can “picture” the identity of the manufacturing
sector and its subsectors in the Eastern Macedonia and Thrace (EMT) Region.
Moreover, it is considered that the systematic investigation and analysis of the
financial sufficiency by various criteria (subsector classification) will offer useful
information in order to identify precisely the characteristics of the current sector.
Thus, the paper used the financial-ratio-analysis methodology on liquidity,
solvency, effectiveness and efficiency categories via the Financial Statements of a
representative sample. From the analysis has resulted that the manufacturing
sector in EMT Region presents weak financial sufficiency and is exceptionally
heterogeneous about its enterprises’ administrative effectiveness. The results are
presented by financial ratio category concerning the whole manufacturing sector
and its subsectors.

Keywords:
Financial Ratios, Manufacturing Industry, East-Macedonia and Thrace
1. Introduction

Nowadays the role of manufacturing industry for the economic performance of a country is discussed mainly in contradiction to the increase of the tertiary sector’s role in the economic activity (SEV-Hellenic Federation of Enterprises, 2006). The discussion is focused mainly on the possibility that the reduction of manufacturing industrial activity could lead to phenomenon of deindustrialization and on the consequences that can be produced for the economic robustness and competitiveness of a country (Hassid et al, 2003).

During the last decades, the classic industrial production is developing on one hand with slower rhythms concerning the total economy and on the other hand, tends to be shifted to the less developed countries or at least in certain regions where are allocated competitive advantages of e.g. human resources, natural resources, labour cost, institutional, political and social frame, market size and geopolitical position (Zopounidis & Gaganis, 2005; Kadda, 2005).

The practised industrial policy appears to have significant contribution in the limited growth of the Greek manufacture sector, as Greece has not accomplished to develop appreciable industrial policy with concrete priorities and directions for this particular sector. In opposition, practised industrial policy was limited in supporting manufacturing industry without substantially facing the structural and other problems of the sector (Koutsogiannis, 1984).

The manufacturing sector’s structure in Greece has a lot of disadvantages of which the major are the particularly small size of the enterprises, the enterprises’ mainly individual operational character (sole proprietorships), the anisomeric growth of the manufacturing subsectors, the anisomeric enterprises’ geographic distribution and the lack of significant investments. Thus, the establishment of competitive enterprises has been diminished and the maintenance or even the deterioration of structural problems in the question sector is justified (KEPE, 1989; Greek Technology Foresight, 2002).

From a financial scope, the performances of the manufacturing sector confirm both its total picture and the differences between the domestic manufacturing industry subsectors. Based on the results of a relatively recent research by SEV (2005) concerning the nine main subsectors of the manufacturing sector (of which the production was up to the 74% of the total manufacturing production) has been found that between the subsectors are located noticeable differentiations in the basic financial ratios. Diachronically however, the financial performances of enterprises present insignificant improvements while the majority of these performances’ levels are low maintaining the gap from the international desirable levels and finally, an important part of these enterprises present
important liquidity and funding problems and they are placed in the category of highly credit risk enterprises (ICAP Group, 2009).

Under these circumstances, it is considered that the analysis and estimation of the manufacturing sector’s financial sufficiency would lead to useful conclusions that can constitute a base for more rational decision-making by the enterprises and also to the recognition of research priorities aiming at the configuration of a more effective manufacturing policy concerning the sector. Therefore, the research’s objective has focused on the estimation and statistical presentation of financial ratios that can express the identity of the manufacturing sector. Moreover, it is considered that the systematic investigation and analysis of the financial sufficiency by various criteria (subsector classification) will offer useful information in order to identify precisely the characteristics of the current sector.

The paper contains five sections and is structured as follows. The next section provides a description of the research methodology used, while in section 3 the variables used are coded and categorized. Moreover, section 4 presents the estimated financial ratios—research findings and in the last section are summarized the concluding remarks.

2. Research Methodology

For estimating the financial identity of the Eastern Macedonia and Thrace (EMT) Region’s manufacturing enterprises, this research used the financial-ratio-analysis methodology which has been used, the last years, by many researchers attempting to determine the financial situation of an enterprise or even of a total sector (Weston & Brigham, 1990; Batzios, 2001).

More specific, ratios constitute a methodology with which is summarised an important quantity of financial data, for evaluation and redefinition of the management objectives of an enterprise or a total sector (Tsaklagkanos, 1987; Sarri, 1996; Pnevmatikatou, 2000). Moreover, they are useful for comparisons between different administrative periods and simultaneously for comparisons between ratios of one enterprise with the corresponding ratios of other competitive enterprises of the same sector or with the average levels of the sector in which belongs the enterprise (Weston & Brigham, 1990). Furthermore, they can be used for evaluating enterprises’ effectiveness and efficiency (Klingborg, 1990; Langemeier & Purdy, 1996), as well as for estimating enterprises’ financial sufficiency-classification based on their financial identity-performance (Zopounidis, 1996).

In general, the analysis and evaluation of Financial Statements’ data via financial ratios can provide to the financial analyst the potential to control liquidity, solvency, effectiveness and efficiency of an enterprise’s activities and constitute an important "tool" during the decision-making process
(Downey & Trocke, 1981; Ylli- Olli & Virtanen, 1989; Bullock, 1985; Ranson, 1997; Bond, 1997).

Following this direction, the research used Financial Statements of a representative sample (148 manufacturing enterprises of EMT Region) concerning the fiscal period of 2004. The collection of the essential quantitative data of the sample was realised mainly by on-the-spot research method (March 2005-August 2006), while a part of these data (30 balance-sheets) were ensured through ICAP’s database.

The sample selection took place based on the relative lists of the EMT Region’s Chambers. More specific, only corporations were selected from the 5 prefectures of the Region. Moreover, enterprises that did not function anymore or did not have at least 5 years life duration from their initiation were also excluded even if they were cataloged in the Chambers’ lists in order to ensure a satisfactory level of long-lasting operational experience and activity, element essential for the quality of research’s results.

Based on these restrictions, were selected 148 enterprises, from the total sum of 5,987 manufacturing enterprises that function in the EMT Region, following random stratified sampling methodology for the manufacturing enterprises’ legal form, prefecture and subsector (Petridis, 2000; ICAP, 2005) and implying a 5% level of statistical significance (Saunders et al, 2000; Stathakopoulos, 1997).

For the needs of the research, the 37 manufacturing subsectors (STAKOD 2003) were unified in five basic subsectors: 1=Food & Beverages, 2=Clothing & Accessories, 3=Construction & Materials-Industrial Goods & Services, 4=Lumber & Wood Production and 5=Remainder Manufacturing Sectors. The paper proceed to the subsectors unification in order to raise data’s handling effectiveness as a significant number of subsectors had slight or even zero representation.

Based on these data, the most basic categories of ratio, as Liquidity Ratios (Current Liquidity Ratio, Quick Liquidity Ratio), Capital Structure Ratios (Debt to Total Assets Ratio, Debt to Equity Ratio), Activity Ratios (Total Assets Turnover Ratio, Fixed Assets Turnover Ratio, Average Collection Turnover Period) and Profitability Ratios (Net Margin Profit, Return on Equity, Return on Assets), were estimated and analyzed.

Trying to identify more accurate the financial sufficiency of EMT Region’s manufacturing sector the research proceed to a statistical analysis of the ratios and furthermore to an analysis of the financial sufficiency by various criteria (e.g. subsector classification).

Thus, it is considered that the financial analysis of the EMT Region’s manufacturing sector will produce the potential to determine the strengths and the weaknesses of its enterprises detecting the financial identity and the effectiveness that presents concerning the exploitation of the available
resources in the producing process (Plumley & Hornbaker, 1991; Tubbs & Fuchs, 1996).

3. Coding Variables

The sample’s data that were used in the research of the manufacturing sector’s financial identity were categorized and coded\(^1\). More specific, for every one of the 148 enterprises were totally created 56 variables from which an important part concerns Financial Statements’ data, while the remainder variables concern the various financial ratios that determine the structure of the enterprises’ financial identity.

4. Results: Financial Ratios of the Manufacturing Sector in EMT Region

4.1 Financial data of the sample

We’d like to start with some general comments on the total indicated data with the estimated descriptive statistics that affair the most basic variables-dimensions included at Financial Statements of the sample\(^2\).

A first observation advises that the means of all variables are associated with particularly high variation, as it is expressed by standard deviation. Indicatively, it is reported that the mean of the “Total Assets” is appreciated at 18.4 millions of Euros and presents high variation (18.4 millions±4.5 m) declaring that the individual prices included in the sample are excessively distributed around the mean. The distribution of this variable is right-skewed and, moreover, is characterized as leptokurtic.

Simultaneously, "Fixed Assets" mean of the total manufacturing enterprises was appreciated at approximately 8.8 millions of Euros and presents also high variation (8.8m±2.6m). It is noted that the fixed assets of an average manufacturing enterprise constitute approximately 48% of its total assets.

An average manufacturing enterprise presents "Gross Profit" of approximately 2.1 millions of Euros. Respectively, "Net Profits" were appreciated approximately at 27.7 thousands of Euros and emanated from "Sales" (Turnover) which was approximately 13 millions of Euros, in average. These findings are in contrast with the significant level of the total investments in the sector and it is interpreted by the important variation that is observed in the accounts that were mentioned before (Gross Profits, Net Profits and Sales). This variation implies the existence of enterprises with high profits and other with high losses, simultaneously.

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\(^1\) See Appendix
\(^2\) See Appendix
The manufacturing enterprises of EMT Region, on average, occupy 74 or 75 employees. In general, the variable "Employment" presents high variation and positive skew (right-skewed). This signifies that in the sector exist a number of enterprises that occupy considerably more employees comparing with the employment of an average enterprise. Furthermore, the level of kurtosis (25.443) implies that the distribution is leptokurtic.

In regard to the estimated financial ratios that “picture” the identity of EMT Region’s manufacturing enterprises, below are presented the results classified by ratio-categories based on the identification and the classification of the financial-ratio-analysis methodology.

4.2 Statistical analysis of the financial ratios of the total manufacturing sector in EMT Region

4.2.1 Financial Liquidity Ratios

From the analysis of the estimated Financial Liquidity Ratios are noted the followings:

- The average Current Liquidity ratio was appreciated at 1.844 which declares that the manufacturing enterprises in the EMT Region, in general terms, do not face significant liquidity problems due to their short-term liabilities. The variation, as it is identified by the standard deviation (0.163), is relatively high, which indicates that in total the manufacturing enterprises present important heterogeneousness about their current liquidity.

- The diagrammatic presentation of this ratio confirms the above observation. Hence, the kurtosis level of this ratio distribution implies the leptokurtic character of it. Finally evaluating, the skewness (5.583), implies that the distribution is right-skewed, i.e. it exists a noticeable number of enterprises that have high relatively Current Liquidity drifting the mean above and influencing the general “picture” of the total enterprises.

The above finding is also confirmed by analytical data where it can be clearly recognized that a huge percentage of the enterprises (73.3%) of the total manufacturing enterprises is characterized by highly current liquidity (mean = 2.23>1), while only 26.3% has considerable current liquidity problems (mean=0.74<1).

In regard to the Quick Liquidity Ratio mean of the total enterprises was appreciated at 1.23±0.09 (mean ± standard deviation), which denotes the

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1 See Appendix
2 See Appendix
ability of the sector’s enterprises to carry out their short-terms liabilities. The variation of the ratio’s individual prices around the mean is relatively high and the distribution is right-skewed which declares that exist enterprises that have particularly high quick liquidity and drift positively the mean of the whole manufacturing sector\(^1\).

More specific, 53.3\% of manufacturing enterprises recorded quick liquidity problems (mean=0.64<1) while an important percentage (45.6\%) did not, in the current sector (mean=1.91>1).

### 4.2.2 Financial Capital Structure Ratios

In regard to the capital structure of EMT Region’s manufacturing enterprises and their ability to correspond in their liabilities in the long-term, is estimated that total liabilities possess important percentage of their total invested capital. Specifically are indicated the estimated capital structures ratios’ descriptive statistics\(^2\).

It can be observed that Debt to Total Assets Ratio mean (0.53±0.01) is marginally high declaring that enterprises have been relatively highly financed and creditors face high financial risk concerning the return of their money. Moreover, it can be noted that manufacturing enterprises have limited options for borrowing new capital in the future.

The ratio’s variation has found to be relatively high which shows that the individuals Debt to Total Assets Ratio of the enterprises deviate significantly from the mean of the total enterprises. Thus, some enterprises are highly leveraged which explain the positive skew of the distribution. Furthermore, 54.73\% of the manufacturing enterprises presents high Debt to Total Assets Ratio (=0.69), while an equally important percentage (45.2\%) maintains small attendance of foreign capital in the total funding of its activities (0.33±0.01).

The Debt to Equity Ratio mean (1.46±0.12) indicates also the relatively high degree of manufacturing enterprises’ financial leverage. This ratio, even though it is relatively high, tends to move in mediocre levels for the Greek data, fact that is related with the increased investment subsidies at the particular region resulting to a minor need for foreign capital. In other words, Debt to Equity Ratio will be maintained “artificially” in mediocre levels as long as there are in effect the particularly beneficial provisions motives for investments in this Region. However, the estimated variation of the ratio is relatively high revealing that exist very highly leveraged enterprises, which is also confirmed by the right-skewed character of the ratio’s distribution.

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\(^1\) See Appendix
\(^2\) See Appendix
An analytical investigation of the sample leads to the ascertainment that an important percentage (47.5%) tends to move in an “independent” environment (=0.43<1), concerning the need for debts. On the contrary, 52.4% of the enterprises has very high Debt to Equity Ratio (=2.40>1) declaring particularly high level of lending.

4.2.3 Financial Activity Ratios

From the financial evaluation of the ratios, where the qualitative structure of the Activity ratios is indicated, are noted the followings:

The estimated Total Assets Turnover ratio mean (0.73±0.040) declares that manufacturing enterprises in EMT Region does not exploit sufficiently the total available resources that can, concerning the sales that they realise. The ratio’s variation is relatively high declaring thus the existence of enterprises that use efficiently enough their available assets, while the majority of the enterprises do not manage effectively their resources. The distribution of the mean is right-skewed meaning that the ratio is drifted above by these few enterprises that have indeed high Total Assets Turnover ratio.

More specific, only 22.97% of the manufacturing enterprises exploit sufficiently its available resources (mean=1.43). On the contrary, 41.8% of the total manufacturing enterprises uses relatively effectively an important part of its resources (mean=0.69), while the rest 35.1% faces serious problems of management which finally has as result low efficiency and less profit.

In regard to the Fixed Assets Turnover ratio mean (2.44±0.23), manufacturing enterprises generally present satisfactory utilisation of their fixed assets concerning the sales that are realised, with relatively high variations among enterprises. There are manufacturing enterprises which effectively use their fixed assets, while other experience old equipment or have likely over-invested in fixed assets. Thus, the estimated mean is not representative.

An analytical investigation leads to the ascertainment that the percentage of manufacturing enterprises that manage effectively their fixed assets (mean=14.54) is appreciated at 25.6%. An important percentage (45.95%) of enterprises appears to manage not effectively enough its fixed assets (mean=1.78) declaring limited degree of resources’ exploitation that has been invested in fixed assets. Moreover, 28.3% does not manage effectively its fixed assets (mean=0.59) noting that most likely exists underemployment of invested resources in fixed assets. The distribution of the ratio is right-skewed.

1 See Appendix
2 See Appendix
The Average Collection Turnover Period ratio for the total manufacturing enterprises (208 days±12) confirms the existing weaknesses of enterprises’ growth which are ascertained from the lenient credit policy that is followed by the manufacturing sector in total. The variation of the ratio is very high and reflects the role of some manufacturing enterprises that follow rational credit policy and also other enterprises that face serious problems with their receivable accounts. This also can be confirmed from where it can be observed the right-skewed distribution of the ratio.

More specific, 18.7% of the manufacturing enterprises (mean=451 days), anticipate customers that delay their duties on average above one year causing thus important liquidity problems. For the 38.88% (mean=216 days) it is realised that the customers delay enough the repayment of their duties. Simultaneously, 42.3% of manufacturing enterprises experience an Average Collection Turnover Period around 93 days due perhaps to their strict credit policy that follow or the satisfactory negotiation power that allocate.

4.2.4 Financial Profitability ratios

From the analysis of the estimated Profitability Ratios are noted the followings:

- The estimated Net Profit Margin mean (-8.03 ±5.01) shows that manufacturing enterprises have generally negative net profit margin, an estimation that does not portray accurately the reality. This happens due to the excessively high variation that characterizes the Net Profit Margin ratio. A part of the enterprises presents high losses drifting the mean negatively and shaping thus an elusive picture for the entire manufacturing sector.

- A further analysis reveals that only a part of manufacturing enterprises (26.4%) has relatively high net profit margin (mean=11.14). On the contrary, from the remainder enterprises, the majority (52%) has particularly low profitability (mean=2.12), while an important part (21.6%) has negative net profit margin (losses) that means low effectiveness of productivity/management/ competitiveness or other critical factors that influence considerably the growth of these enterprises. This implies that the current sector in EMT Region falls considerably short at the efficiency of the capital that has been invested (equity and liabilities).
The Return on Equity Ratio mean (-4.02±4.01) indicates that manufacturing enterprises, in general terms, have negative return on equity. This estimate does not portray also accurately the reality as the prices of the ratio among the examined enterprises are characterized by excessively high variation. As it was reported above, a significant number, of the enterprises, presents high losses drifting the mean negatively and shaping thus an elusive picture for the entire sector.

More specific, the variation of the ratio is estimated exceptionally high showing the heterogeneity in efficiency among the manufacturing enterprises. This is also confirmed from a further review, where the 21.6% of the manufacturing enterprises presents significantly negative return on equity (mean=-50.64). Hence, the majority of manufacturing enterprises (54%) presents very low return on equity (mean = 3.70), while the remainder enterprises (24.3%) noted approximately 20% return on equity. The distribution of the ratio is left-skewed.

The Return on Total Asset mean (0.95±0.65) shows that the manufacturing sector, in total, does not use effectively its total assets. It is observed significant variation which is explained by the existence of manufacturing enterprises that recorded highly negative returns, while other recorded highly positive returns.

More specific, 21.6% of presented negative Return on Total Assets Ratio (mean=–9.56), implying negative administrative and productive operational effectiveness. Also, 70.9%, of the manufacturing enterprises, presents particularly low total return (approximately 2.7% on net profits) testifying the limited utilisation and exploitation of assets and the unsatisfactory administration-management. Finally, only 7.4% presents high Return on Total Assets Ratio (mean=14.56) revealing that minimal manufacturing enterprises exploit effectively their capital.

4.3 Statistical analysis of the financial ratios of the manufacturing subsectors in EMT Region

For the statistical investigation and analysis of the manufacturing enterprises’ financial ratio (subsector classification), were used as much parametric methodologies as non-parametric methodologies of statistical analysis. The normality of the sample was checked by Shapiro-Wilk and the Lilliefors tests, as well as by graphical tests. Simultaneously, the variation homogeneity (equal variances) was checked by Levene test. In the cases where it was found necessary has taken part the suitable transformation of the primary data (logarithm, square root, etc), aiming at their normalization and the homogeneity of their variations (Zolman, 1993).
Where the conditions of normalization and homogeneity were achieved, it was applied the parametric analysis of variations (one-direction ANOVA) (Katos, 1986), and in the cases where the variation analysis was evaluated as statistically significant it was used the Duncan's new multiple range test, aiming at the evaluation of the precise statistical differences. In cases of variation heterogeneity and non-normal distribution of the data it was used the non-parametric Kruskal-Wallis test and then the Mann-Whitney U test.

All the tests took part in 10% level of statistical significance (P≤0.10) and for the analyses it was used the statistical package SPSS 13.0.

4.3.1 Estimates and statistical analysis of Liquidity ratios

Using the indicated basic liquidity ratios of the manufacturing subsectors in EMT Region and specifically the followings:

- The subsectors that do not face liquidity problems and recorded high Current Liquidity mean are “Construction & Materials-Industrial Goods & Services” (2.29 units), “Lumber & Wood Production” (1.95 units) and “Clothing & Accessories” (1.90 units). The remainder subsectors appear to have difficulties with their short-term liabilities since they are “under” the mean (1.84 units), they present high variation and abstain significantly from the desirable international level of the ratio (≥2).
- Proportional picture is also observed in the Quick Liquidity mean, with the only difference that the subsector “Construction & Materials-Industrial Goods & Services” which recorded high current liquidity ratio appears that has the biggest difficulties carrying out their direct short-term liabilities implying or high product reserves either slow receivables turnover, or both of them.
- The variation that characterizes the current and quick liquidity ratio as it is impressed by the standard deviation is generally high and particular in subsectors “Construction & Materials-Industrial Goods & Services” and “Foods & Beverages” indicating that the manufacturing subsectors in EMT Region present important liquidity heterogeneity between them.
- From the statistical analysis of the above ratios has not resulted statistically significant differences between the manufacturing subsectors (P>0.10).
4.3.2 Estimates and statistical analysis of Capital Structure ratios

The estimated results of the basic Capital Structure ratios of the manufacturing subsectors in EMT Region are described below:\(^1\):

- The subsectors that have low dependence from external capital and therefore their Debt to Total Asset Ratio is below the mean of the manufacturing enterprises (0.53) are “Lumber & Wood Production” (0.49) and “Clothing & Accessories” (0.53). The operational activity of the rest subsectors and particularly the subsector “Food & Beverages” is supported mainly by external capital producing highly bankruptcy risk, as well as significant operational cost.
- The above statement is also confirmed by the Debt to Equity Ratio mean with the only difference that in this particular category, subsector “Food & Beverages” has the highest ratio which justifies the high financial leverage that has adopted.
- The heterogeneity between the manufacturing subsectors’ capital structure is the result of the high variation that characterizes the Debt to Total Asset Ratio and particularly of the Debt to Equity Ratio as it is identified by the standard deviation, which is generally high and particularly in the subsectors “Food & Beverages”, “Remainder Subsectors” and “Construction & Materials-Industrial Goods & Services”.
- From the statistical analysis of the above two ratios has not resulted statistically significant differences between the manufacturing subsectors (P>0.10).

4.3.3 Estimates and statistical analysis of Activity ratios

As for the estimated basic activity ratios of the manufacturing subsectors in EMT Region we note:\(^2\):

- The subsectors that have the smaller degrees of their assets exploitation and therefore their Total Assets Turnovers are under the total manufacturing enterprises’ mean (0.73) are “Food & Beverages” (0.58), “Construction & Materials-Industrial Goods & Services” (0.62), "Remainder Subsectors" (0.63), and “Clothing & Accessories” (0.71). On the contrary, only one subsector use relatively satisfactorily its invested capital, subsector “Lumber & Wood Production” (0.99). The statistical analysis of this ratio strengthens the above opinion as Total Assets Turnover ratio for the subsector “Lumber & Wood Production”

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\(^1\) See Appendix
\(^2\) See Appendix
has found statistically significant higher (P>0.10) from the remainder manufacturing subsectors.

- The above statement is relatively differentiated in regard to the Fixed Assets Turnover ratio mean. More specific, subsectors with low Total Assets Turnover mean, as the “Clothing & Accessories” and “Construction & Materials-Industrial Goods & Services” appear to use relatively satisfactorily their fixed assets and they follow the subsectors “Food & Beverages” and “Lumber & Wood Production” that have the highest ratio in this category. This is explained at a part from the likely inability to effectively use investments on fixed assets in these subsectors and primarily from the particular high variation that characterizes this ratio for the above subsectors presenting an elusive “image”. However, the statistical analysis does not reveal statistically significant differences of the ratio between the subsectors (P>0.10).

- As long as it concerns the Average Collection Turnover Period ratio mean, subsectors that present the higher degree of their receivables liquidation and therefore their mean is placed under the mean of the total manufacturing enterprises (208 days) are “Lumber & Wood Production” (140 days) and “Construction & Materials-Industrial Goods & Services” (178 days), while the remainder subsectors appear to present major problems in liquidating their receivables accounts.

- The statistical analysis of this ratio reveals that its price in the subsectors “Lumber & Wood Production” and “Construction & Materials-Industrial Goods & Services” is evaluated as statistically significant different from the other manufacturing subsectors’ equivalent ratio, while it is not significantly differentiated between these two sectors.

### 4.3.3 Estimates and statistical analysis of Profitability ratios

From the estimated results of the basic Profitability ratios we note: 

- The subsectors with the higher Net Profit Margin means are “Clothing & Accessories” (4.05) and “Construction & Materials-Industrial Goods & Services” (1.65) which difference is not evaluated as statistically significant. Potentially, the high variation at all the subsectors causes distortions which do not allow the statement of reliable conclusions. The remainder subsectors have negative Net Profit Margin.

- The above statement is also repeated at the Return on Equity Ratio mean. If we exclude the subsectors “Clothing & Accessories” and “Construction & Materials-Industrial Goods & Services” that present positive Return on Equity and Total Assets Ratio mean, the remainder

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1 See Appendix
subsectors that were examined in the research have negative return. Although, this is relatively differentiated endogenous due to the high variation that most of the manufacturing subsectors present. However, this has not been statistically evaluated.

- Finally, in regard to the Return on Total Assets Ratio, commendable is the fact of the considerably higher return that is recorded by the subsector “Clothing & Accessories” comparatively with the subsector “Food & Beverages”.

5. Conclusions

From the estimated financial-ratio-analysis of the manufacturing sector in EMT Region has resulted that from the side of financing sufficiency the sector has, in general, important weaknesses, presenting a fusion “picture” concerning the average levels of Greece (relative superiority about the Liquidity and Debt to Total Assets Ratios and important inferiority about the Profitability Ratios). Simultaneously, the sector is exceptionally heterogeneous concerning its enterprises’ effective administration meaning that a minor part of enterprises effectively manage their resources while a major part presents limited or even negative efficiency of their capital.

More specific, from the estimated financial ratios of the manufacturing sector are noted the followings:

- Although the manufacturing sector appears that does not face particular liquidity problems, an important part of its enterprises is appreciated that faces serious problems of current and mainly quick liquidity influencing potentially their enterprising behaviour (inability of long-term planning, vulnerability to extraordinary incidents, decreased faculty of effective management etc.).

- Proportional image is also observed at the Debt to Total Assets Ratio. The increased financial leverage and the high heterogeneity that the sector presents certify that the majority of the enterprises do not present rational capital structure.

- Similar situation can also be identified at the Activity ratios where the total degree of the enterprises’ resources exploitation is not satisfactory, while an important part of these has small degree of their fixed assets exploitation. Moreover, worse is the situation in regard to the Average Collection Turnover Period, the price of which is relatively high implying that in most of the enterprises the utilisation of assets is not the most appropriate resulting to the reduction of these enterprises’ efficiency to minimal or even negative.
• The Profitability ratios confirm both the overall heterogeneity of the manufacturing sector at all of the financial ratios categories and the particularly bad image of the sector’s return on a capital (negative Net Profit Margin, negative Return on Equity Ratio and particularly low Return on Total Assets Ratio) supporting the opinion that a major part of the manufacturing enterprises does not effectively manage its invested capital and is found in terrible economic situation. From the side of financing sufficiency, this can be interpreted as a negative factor for the enterprises’ survival.

By the evaluation of the estimated financial ratios for each and every subsector it is realised that there is not any subsector which is evaluated positively for all the ratios. On the contrary, it is observed that each individual subsector presents good financial image in regard to certain ratios and it falls short in regard to other. More specific, are noted the followings:

• The subsectors that present satisfactory Current Liquidity ratios are “Construction & Materials-Industrial Goods & Services”, “Lumber & Wood Production” and “Clothing & Accessories” while the remainder subsectors do not correspond satisfactorily in their short-term liabilities. Proportional situation prevails also in regard to the Quick Liquidity Ratio, with the only difference that the subsector “Construction & Materials-Industrial Goods & Services” has the lowest ratio among the rest of the subsectors. Thus, it is revealed that the enterprises of this subsector face particular liquidation difficulties for their short-term receivables.

• The sectors that have lowest financial leverage are “Lumber & Wood Production” and “Clothing & Accessories”.

• The sector that presents relatively good Total Assets Turnover is “Lumber & Wood Production” while the remainder subsectors present low degree of their total asset exploitation.

• The subsectors with positive Net Profit Margin, which however “moves” in very low levels, are “Clothing & Accessories” and “Construction & Materials-Industrial Goods & Services”.

• Statistically, from the evaluation of the above ratios did not result significant differences between the manufacturing subsectors, apart from the case of Total Assets Turnover and Average Collection Turnover Period ratios. These ratios, for the subsectors “Lumber & Wood Production” and “Construction & Materials-Industrial Goods & Services” are evaluated as statistically significant higher against the rests. Simultaneously, the subsector “Clothing & Accessories” appears to be significantly differentiated only against the subsector “Food &
Beverages”, with relative superiority in the Return on Total Assets Ratio.

Concluding, we must point out that the research had several limitations. At first, the research has focused in a representative sample of manufacturing enterprises of the EMT Region that their legal form were either Plc or Ltd and their life duration were at least 5 years, in order achieve quality results by ensuring a satisfactory level of long-lasting operational experience and activity. Therefore, from the research was excluded a significant amount of existing enterprises and as a result the estimations of the manufacturing sector’s financial identity are produced based on the “elite” enterprises of the particular Region.

Thus, a future research including a comparative and diachronic research of the enterprises’ (Plc, Ltd) financial behaviour with life duration of more than 5 years as well as of those with less than 5 years of operation could enrich the estimated financial profile of this sector, giving additional information with regard to the potential differences between old and new enterprises as for the their financial management-administration as well as for the picture of enterprises’ financing position and their diachronic course/movement.

Finally, we must also state that other researches that has been conducted in regular time intervals for the course of manufacturing sector in Greece has brought up restrictions and limitations depending on the objectives of our research (Association of Greek Industrialists, ICAP, etc.).
### Appendix

**Table 3.1:** Variables for estimating the financial sufficiency of the manufacturing sector

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
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<tbody>
<tr>
<td>V1  Net Fixed Assets (V2+V3+V4+V6+V7-V5)</td>
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<td>V2  Land</td>
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<td>V3  Buildings - Fixtures</td>
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<td>V4  Intangible Fixed Assets and Capitalized Expenses</td>
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<td>V5  Accumulated Depreciation</td>
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<td>V6  Long-Term Receivables</td>
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<td>V7  Participations</td>
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<td>V8  Inventories (V9+ V10+ V11)</td>
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<td>V9  Finished Products - Merchandise</td>
<td></td>
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<td>V10 Semi- Finished Products</td>
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<td>V11 Raw Materials - Supplies</td>
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<td>V12 Receivables(V13+ V14+ V15)</td>
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<td>V13 Customers Receivables - Bills &amp; Notes Receivables</td>
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<td>V14 Securities</td>
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<td>V15 Other Receivables</td>
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<tr>
<td>V16 Cash and Cash equivalents</td>
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<td>V17 Total Assets (V1+ V8+ V12+ V16)</td>
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<td>V18 Equity (V19+ V20+ V21)</td>
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</tr>
<tr>
<td>V19 Share Capital</td>
<td></td>
</tr>
<tr>
<td>V20 Reserves</td>
<td></td>
</tr>
<tr>
<td>V21 Retained Earnings (Losses)</td>
<td></td>
</tr>
<tr>
<td>V22 Long-Term Liabilities and Provisions</td>
<td></td>
</tr>
<tr>
<td>V23 Short-Term Liabilities (V24+ V25+ V26+ V27+ V28)</td>
<td></td>
</tr>
<tr>
<td>V24 Liabilities to Banks</td>
<td></td>
</tr>
<tr>
<td>V25 Bills &amp; Notes Payable</td>
<td></td>
</tr>
<tr>
<td>V26 Dividends Payable - Distributable Profit</td>
<td></td>
</tr>
<tr>
<td>V27 Stock Account</td>
<td></td>
</tr>
<tr>
<td>V28 Other Liabilities</td>
<td></td>
</tr>
<tr>
<td>V29 Total Equity and Liabilities (V18+ V22+ V23)</td>
<td></td>
</tr>
<tr>
<td>V30 Sales (Turnover)</td>
<td></td>
</tr>
<tr>
<td>V31 Cost of Sales</td>
<td></td>
</tr>
<tr>
<td>V32 Gross Profit (V30- V31)</td>
<td></td>
</tr>
<tr>
<td>V33 Commissions and Other Operating Income</td>
<td></td>
</tr>
<tr>
<td>V34 Interest and Related Expenses</td>
<td></td>
</tr>
<tr>
<td>V35 Other Operating Expenses (Administrative, Selling)</td>
<td></td>
</tr>
<tr>
<td>V36 Operating Profit Margin (V32+ V33- V34- V35)</td>
<td></td>
</tr>
<tr>
<td>V37 Non Operating Income</td>
<td></td>
</tr>
<tr>
<td>Variable/Dimension</td>
<td>Sample</td>
</tr>
<tr>
<td>--------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Total Assets (€)</td>
<td>148</td>
</tr>
<tr>
<td>Fixed Assets (€)</td>
<td>148</td>
</tr>
<tr>
<td>Inventories (€)</td>
<td>148</td>
</tr>
<tr>
<td>Receivables (€)</td>
<td>148</td>
</tr>
<tr>
<td>Cash and Cash</td>
<td>148</td>
</tr>
<tr>
<td>Total Current Assets (€)</td>
<td>148</td>
</tr>
<tr>
<td>Equity (€)</td>
<td>148</td>
</tr>
<tr>
<td>Long-term Liabilities</td>
<td>148</td>
</tr>
<tr>
<td>Short-term Liabilities</td>
<td>148</td>
</tr>
<tr>
<td>Sales (€)</td>
<td>148</td>
</tr>
<tr>
<td>Gross Profit (€)</td>
<td>148</td>
</tr>
<tr>
<td>Net Profit (€)</td>
<td>148</td>
</tr>
<tr>
<td>Employment</td>
<td>148</td>
</tr>
</tbody>
</table>
### Table 4.2: Estimated Liquidity Ratios of the manufacturing sector

<table>
<thead>
<tr>
<th>Liquidity Ratios</th>
<th>Sample (N)</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Current Liquidity Ratio</td>
<td>148</td>
<td>1.844</td>
<td>0.163</td>
<td>5.583</td>
<td>41.87</td>
</tr>
<tr>
<td>2. Quick Liquidity Ratio</td>
<td>148</td>
<td>1.238</td>
<td>0.099</td>
<td>3.916</td>
<td>21.02</td>
</tr>
</tbody>
</table>

### Table 4.3: Qualitative structure of Liquidity Ratio of the manufacturing sector in EMT Region

<table>
<thead>
<tr>
<th>Liquidity Ratios</th>
<th>Ratio Level</th>
<th>% of manufacturing</th>
<th>Mean ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Current Liquidity Ratio</td>
<td>&lt; 1</td>
<td>26.35%</td>
<td>0.745±0.029</td>
</tr>
<tr>
<td></td>
<td>&gt; 1</td>
<td>73.65%</td>
<td>2.237±0.208</td>
</tr>
<tr>
<td>2. Quick Liquidity Ratio</td>
<td>&lt; 1</td>
<td>53.38%</td>
<td>0.647±0.026</td>
</tr>
<tr>
<td></td>
<td>&gt; 1</td>
<td>46.62%</td>
<td>1.916±0.180</td>
</tr>
</tbody>
</table>

### Table 4.4: Estimated Capital Structure Ratios of the manufacturing sector

<table>
<thead>
<tr>
<th>Capital Structure Ratios</th>
<th>Sample (N)</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Debt to Total Assets Ratio</td>
<td>148</td>
<td>0.533</td>
<td>0.019</td>
<td>0.671</td>
<td>2.05</td>
</tr>
<tr>
<td>2. Debt to Equity Ratio</td>
<td>145</td>
<td>1.467</td>
<td>0.121</td>
<td>0.853</td>
<td>2.73</td>
</tr>
</tbody>
</table>

### Table 4.5: Qualitative structure of Capital Structure Ratios of the manufacturing sector in EMT Region

<table>
<thead>
<tr>
<th>Capital Structure Ratios</th>
<th>Ratio Level</th>
<th>% of manufacturing</th>
<th>Mean ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Debt to Total Assets Ratio</td>
<td>&lt; 0.5</td>
<td>45.27%</td>
<td>0.332±0.014</td>
</tr>
<tr>
<td></td>
<td>&gt; 0.5</td>
<td>54.73%</td>
<td>0.699±0.019</td>
</tr>
<tr>
<td>2. Debt to Equity Ratio</td>
<td>&lt; 1</td>
<td>47.58%</td>
<td>0.438±0.084</td>
</tr>
<tr>
<td></td>
<td>&gt; 1</td>
<td>52.42%</td>
<td>2.401±0.152</td>
</tr>
</tbody>
</table>

### Table 4.6: Estimated Activity Ratios of the manufacturing sector

<table>
<thead>
<tr>
<th>Activity Ratios</th>
<th>Sample (N)</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total Assets</td>
<td>148</td>
<td>0.733</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Fixed Assets</td>
<td>148</td>
<td>2.447</td>
<td>0.232</td>
<td>3.824</td>
<td>20.39</td>
</tr>
<tr>
<td>3. Average Collection</td>
<td>144</td>
<td>208.1</td>
<td>12.879</td>
<td>2.007</td>
<td>5.22</td>
</tr>
</tbody>
</table>
Table 4.7: Qualitative structure of Activity Ratios of the manufacturing sector in EMT Region

<table>
<thead>
<tr>
<th>Activity Ratios</th>
<th>Ratio Level</th>
<th>% of manufacturing enterprises</th>
<th>Mean ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Total Assets Turnover</td>
<td>&gt;0 &amp; &lt; 0.5</td>
<td>35.14%</td>
<td>0.315±0.019</td>
</tr>
<tr>
<td></td>
<td>&gt;0.5 &amp; &lt; 1</td>
<td>41.89%</td>
<td>0.697±0.018</td>
</tr>
<tr>
<td></td>
<td>&gt; 1</td>
<td>22.97%</td>
<td>1.433±0.081</td>
</tr>
<tr>
<td>2. Fixed Assets Turnover</td>
<td>&lt;1</td>
<td>28.38%</td>
<td>0.596±0.045</td>
</tr>
<tr>
<td></td>
<td>&gt;1 &amp; &lt; 3</td>
<td>45.95%</td>
<td>1.785±0.073</td>
</tr>
<tr>
<td></td>
<td>&gt; 3</td>
<td>25.67%</td>
<td>14,544±8,753</td>
</tr>
<tr>
<td>3. Average Collection Turnover</td>
<td>&lt; 150</td>
<td>42.36%</td>
<td>9.683±4.449</td>
</tr>
<tr>
<td></td>
<td>&gt;150 &amp; &lt; 300</td>
<td>38.88%</td>
<td>216.648±5.787</td>
</tr>
<tr>
<td></td>
<td>&gt; 300</td>
<td>18.76%</td>
<td>451,176±34,352</td>
</tr>
</tbody>
</table>

Table 4.8: Estimated Profitability Ratios of the manufacturing sector in EMT Region

<table>
<thead>
<tr>
<th>Profitability Ratios</th>
<th>Sample (N)</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Net Profit Margin Ratio</td>
<td>148</td>
<td>-8.029</td>
<td>-5.009±2.117</td>
<td>-8.585</td>
<td>85.02</td>
</tr>
<tr>
<td>2. Return on Equity Ratio</td>
<td>148</td>
<td>-4.023</td>
<td>4.013</td>
<td>-6.849</td>
<td>59.71</td>
</tr>
<tr>
<td>3. Return on Total Assets Ratio</td>
<td>148</td>
<td>0.955</td>
<td>0.648</td>
<td>-1.076</td>
<td>5.76</td>
</tr>
</tbody>
</table>

Table 4.9: Qualitative structure of Profitability Ratios of the manufacturing sector in EMT Region

<table>
<thead>
<tr>
<th>Profitability Ratios</th>
<th>Ratio Level</th>
<th>% of manufacturing</th>
<th>Mean ± Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Net Profit Margin Ratio</td>
<td>&lt;0</td>
<td>21.62%</td>
<td>-55.808±21.262</td>
</tr>
<tr>
<td></td>
<td>&gt; 0 &amp; &lt; 5</td>
<td>52.02%</td>
<td>2.117±0.162</td>
</tr>
<tr>
<td></td>
<td>&gt; 5</td>
<td>76.36%</td>
<td>11.141±11.301</td>
</tr>
<tr>
<td></td>
<td>&lt;0</td>
<td>21.62%</td>
<td>-50.645±11</td>
</tr>
<tr>
<td></td>
<td>&gt;0 &amp; &lt;10</td>
<td>54.05%</td>
<td>±15.871±3.703</td>
</tr>
<tr>
<td></td>
<td>&gt;10</td>
<td>24.33%</td>
<td>3.703±0.323</td>
</tr>
<tr>
<td>1. Return on Equity Ratio</td>
<td>&lt;0</td>
<td>21.62%</td>
<td>-9.559±1.487</td>
</tr>
<tr>
<td></td>
<td>&gt;0 &amp; &lt;10</td>
<td>70.94%</td>
<td>2.733±0.239</td>
</tr>
<tr>
<td></td>
<td>&gt;10</td>
<td>7.44%</td>
<td>14.566±1.922</td>
</tr>
<tr>
<td>3. Return on Total Assets Ratio</td>
<td>&lt;0</td>
<td>21.62%</td>
<td>-55.808±21.262</td>
</tr>
<tr>
<td></td>
<td>&gt;0 &amp; &lt;10</td>
<td>70.94%</td>
<td>2.733±0.239</td>
</tr>
<tr>
<td></td>
<td>&gt;10</td>
<td>7.44%</td>
<td>14.566±1.922</td>
</tr>
</tbody>
</table>
### Table 4.10: Estimated Liquidity Ratios of the manufacturing subsectors (mean±standard deviation)

<table>
<thead>
<tr>
<th>Liquidity Ratios</th>
<th>Current Liquidity Ratio</th>
<th>Quick Liquidity Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foods and Beverages</td>
<td>1.7314 ± 0.26654 ( ^a )</td>
<td>1.1921 ± 0.28197 ( ^a )</td>
</tr>
<tr>
<td>Clothing &amp; Accessories</td>
<td>1.9015 ± 0.23482 ( ^a )</td>
<td>1.2591 ± 0.13161 ( ^a )</td>
</tr>
<tr>
<td>Construction &amp; Materials - Industrial Goods &amp; Services</td>
<td>2.2942 ± 0.95140 ( ^a )</td>
<td>0.8868 ± 0.17020 ( ^a )</td>
</tr>
<tr>
<td>Lumber &amp; Wood Production</td>
<td>1.9461 ± 0.24712 ( ^a )</td>
<td>1.4683 ± 0.22976 ( ^a )</td>
</tr>
<tr>
<td>Remainder Subsectors *</td>
<td>1.5638 ± 0.23282 ( ^a )</td>
<td>1.2029 ± 0.22732 ( ^a )</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1.8440 ± 0.16281</td>
<td>1.2388 ± 0.09987</td>
</tr>
</tbody>
</table>

**Note:** Means in the same column with common exhibitor do not significantly differ (P>0.10)

### Table 4.11: Estimated Capital Structure Ratios of the manufacturing subsectors (mean ± standard deviation)

<table>
<thead>
<tr>
<th>Subsector</th>
<th>Debt to Total Assets Ratio</th>
<th>Debt to Equity Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foods and Beverages</td>
<td>0.5587±0.5110 ( ^a )</td>
<td>1.9153±0.47698 ( ^a )</td>
</tr>
<tr>
<td>Clothing &amp; Accessories</td>
<td>0.5305±0.3210 ( ^a )</td>
<td>1.3929±0.18603 ( ^a )</td>
</tr>
<tr>
<td>Construction &amp; Materials - Industrial Goods &amp; Services</td>
<td>0.5511±0.07252 ( ^a )</td>
<td>1.2687±0.38719 ( ^a )</td>
</tr>
<tr>
<td>Lumber &amp; Wood Production</td>
<td>0.4946±0.04523 ( ^a )</td>
<td>1.1005±0.24933 ( ^a )</td>
</tr>
<tr>
<td>Remainder Subsectors *</td>
<td>0.5497±0.03229 ( ^a )</td>
<td>1.7577±0.21743 ( ^a )</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>0.5329±0.01936 ( ^a )</td>
<td>1.4672±0.12082 ( ^a )</td>
</tr>
</tbody>
</table>

**Note:** Means in the same column with common exhibitor do not significantly differ (P>0.10)

### Table 4.12: Estimated Activity Ratios of the manufacturing subsectors (mean ± standard deviation)

<table>
<thead>
<tr>
<th>Subsector</th>
<th>Activity Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Assets Turnover</td>
</tr>
<tr>
<td>Foods and Beverages</td>
<td>0.5821±0.11836 ( ^a )</td>
</tr>
<tr>
<td>Clothing &amp; Accessories</td>
<td>0.7124±0.07942 ( _a )</td>
</tr>
<tr>
<td>Construction &amp; Materials -</td>
<td>0.6184±0.07142 ( _a )</td>
</tr>
</tbody>
</table>
### Table 4.13: Estimated Profitability Ratios of the manufacturing subsectors (mean ± standard deviation)

<table>
<thead>
<tr>
<th>Subsector</th>
<th>Profitability Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Net Profit Margin Ratio</td>
</tr>
<tr>
<td>Foods and Beverages</td>
<td>-5.9436±4.2901&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Clothing &amp; Accessories</td>
<td>4.0568±1.56406&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Construction &amp; Materials - Industrial Goods &amp; Services</td>
<td>1.6484±2.79533&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lumber &amp; Wood Production</td>
<td>-0.4769±2.37748&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Remainder Subsectors *</td>
<td>-27.9384±15.9423&lt;sup&gt;a, β&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total</td>
<td>-8.0295±5.00881</td>
</tr>
</tbody>
</table>

**Note:** Means in the same column with common exhibitor do not significantly differ (P>0.10)
References


Customer satisfaction of Greek mobile phone services

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Abstract:
The mobile telephony market is one of the fastest-growing segments in the global economy. The competition in this sector has become very intense and the companies’ need for survival, in these very difficult conditions that dominate in this sector, force them to search for ways to attract and retain customers. The main condition for the maintenance of their brand life, in the long term, is to win customers’ loyalty. Customer satisfaction consists a basic factor for achieving this aim.

The objectives of this research, is to capture the present situation with regard to the satisfaction of Greek users of mobile phone services. The research model that has been developed incorporates many factors that influence customers’ satisfaction. Structured questionnaires from mobile phone services users are collected to test the research model.

The results indicate that company image is the main factor affecting not only customer satisfaction, but also perceived value, service quality and customer loyalty.

Keywords:
Customer Satisfaction, American Customer Satisfaction Index (ACSI), Customer Loyalty, Company Image
1. Introduction

The enormous competition in the area of mobile telephony services (MTS) has forced companies that are active in this field to find ways to cope with the great demands of the market and to increase their market share (Rust & Zahorik, 1993). For these enterprises, the increase in customer satisfaction is a fundamental goal, while their utter purpose is to enforce the customer loyalty to the company and to maintain a long-term customer relationships (Kotler, 1982).

The purpose of the present survey is:

- the understanding of the importance of consumer satisfaction and its effect on the efficiency of a company,
- the creation of an improved model for measuring consumers’ satisfaction of MTS companies in the Greek market, and
- to draw some useful conclusions for the most important factors and the way they affect the level of satisfaction of the consumers of the MTS providers in Greece.

1.1 Development of mobile telephony in Greece.

Mobile telephony networks started their operations worldwide during the 1980s. They reach their peak in the early 90s with the introduction of the digital cellular systems. In Europe, the introduction of the pan – European digital system (GSM) had a vast contribution to the impressive spread of the mobile telephony.

The penetration of mobile telephony in Greece in the end of 2004 was estimated to 101% of the Greek population (Grigoroudis & Siskos, 2004). Mobile telephony appears to have faster growth rates than the conventional telephony market, which results in the increase of the mobile telephony revenues.

With the liberalisation of the market, the entrance of several companies providing telephony services, both conventional and cellular, an intense competition, focusing on prices, has emerged this fact, along with the rapid advancement that the communication technologies has brought, contributed to the constant reduction of the prices of telephony services (Athanassopoulos, 2000).

The main target of all the companies in the telecommunication industry in Greece was the dominance over the mobile telephony market, with first place changing hands many times. Today, while Cosmote is first, as far as the number of contract subscribers is concerned, Vodafone is first
considering the number of prepaid telephony subscribers (Grigoroudis & Siskos, 2004).

2. Literature Review

Companies’ need for survival forces them to find ways to preserve and to augment the market share they posses. It is essential for a company to keep its customers satisfied, because it is far more expensive for a company to attract new customers than to maintain the ones it already has (Kotler, 1982). Previous studies have proven the importance of consumer satisfaction and its effects on both the maintenance of customers and the efficiency of a company (Rust & Zahorik, 1993). The first step for managing customer satisfaction is the understanding of what the customers really want.

Customer satisfaction has been the center of the research for some time in the area of consumer’s psychology. Yi (1991) summarised some of literature’s definitions in customer satisfaction. Consumer satisfaction has been defined as "the evaluation that the consumer experience is at least as good as it is supposed to be" (Hunt, 1977: 4591), or as "an evaluation where the chosen alternative choice is in agreement with the prior beliefs and always keeping in mind this alternative " (Engel & Blackwell, 1982: 5011), and also as "the response of the consumer to the evaluation of the perceived differences between the prior beliefs (or a performance pattern) and the actual performance of the product, the way it is perceived after its consumption" (Tse & Wilton, 1988: 2041). A recent and more concise definition is given by Oliver (1997), who defines satisfaction as the “response to consumer fulfilment”.

Customer satisfaction is also defined as a result that comes from the pre - purchasing customer comparison among the expected performance, the perceived actual performance and the existing cost (Churchill & Surprenant, 1982). Literature supports that customer satisfaction acts in two different ways: the satisfaction of a certain transaction and the overall satisfaction (Yi, 1991).

Generally, the level of satisfaction indicates to what extent customers are satisfied and to what degree their expectations have been confirmed. In this research, this factor evaluates the level of the total customer satisfaction, the fulfilment of their expectations and the efficiency of the company in comparison with the ideal (Turkyilmaz & Ozkan, 2007).

2.1 Factors that affect customer satisfaction

Many and different models of customer satisfaction have been proposed since the beginning of 1970, mainly due to the difference in interpretation of the word satisfaction by a number of researchers. Erevalles & Leavit
(1992) conducted a review and gathered the characteristics from most of the customer satisfaction models that had been developed in the 1980s.

Company image is defined as the total impression that the public has for a company (Barich & Kotler, 1991; Dichter, 1985; Finn, 1961; Kotler, 1982). From the companies’ perspective, being reliable, professional and innovative, having social contribution and valuing the customers are the elements that form the company image. Martensen et al. (2000) indicate that the image is an important element in the customer satisfaction model. The image is expected to have a positive relationship towards the customer expectations, customer satisfaction and loyalty of customers to the company.

Customer loyalty has been defined as a long-term commitment for the consumer to remain in the same company, and use more products and services in the future (Dick & Basu, 1994; Flavian & Guinaliu, 2006). Company image and customer satisfaction are found to affect positively customers’ loyalty (Anderson & Fornell, 2000).

Signal quality and network coverage have always been essential criteria for selecting MTS providers. During the previous years, where technology had not advanced so much in this area, company networks were limited only to certain locations. Today the signal quality has been improved and the company networks have grown to a great extent. Surveys have shown that both signal quality and network coverage affect positively consumer’s satisfaction and the image of the company (Woo et al., 1999).

Perceived value is defined as the perceived quality level of a product, compared to the price that a customer pays to acquire it (Fornell et al., 1996). As some researchers have concluded (Day, 1990; Narver and Slater, 1990), the creation of high perceived value is the main target of the market-driven companies. Perceived value provides a comparison measure to the companies in proportion to the price – value ratio (Anderson et al., 1994a).

In the past years, various researches have been conducted on different aspects related to service quality. Traditionally, the quality of services is defined as the difference between the expectations of the customer and the perception of services (Gronroos, 1984; Parasuraman et al., 1988, 1991).

MTS providing companies consider the area of customer service as very important. A proof for the above statement is the continuous expansion of their customer service departments. Customers however, apart from customer service departments, want to have constant communication with the people from other departments within the company. For this reason, all companies are providing free communication with almost all their departments.

The selection of appropriate and qualified personnel is considered to be an essential issue for these companies. Customers in order to be
satisfied from a transaction, in addition to the quality of the product and the low price, are also interested in being treated well from the personnel.

The strategic importance of managing customers’ complaints was examined for the first time by Fornell & Westbrook (1984). They showed that by encouraging the expression of customer complaints today, a company might be able to decrease future complaints. It is very important for any customer to know where he can address his complaints which will be given the proper consideration.

3. Research Model

Through this survey, an effort is made to study the role of consumers’ satisfaction in the area of MTS and its influence on the efficiency of companies. The model incorporates many of the research conclusions and views of other researchers who have been studying similar subjects in other fields or/and in other countries. Their views are various and diverse, and for this reason the proposed research model (Figure 1) includes many factors that affect consumer satisfaction and lead to increased customer loyalty.

The hypotheses that will be tested in this research are the following:

Hypothesis 1: Perceived value has a positive effect on customer satisfaction.

Hypothesis 2: Service quality affects positively: a) perceived value, and b) customer satisfaction.

Hypothesis 3: Signal and network coverage affects positively: a) service quality, and b) customer satisfaction.
Hypothesis 4: Company image affects positively: a) customer devotion, b) perceived value, c) customer satisfaction, and d) service quality.

Hypothesis 5: Customer satisfaction has a positive effect on customer loyalty.

4. Research Methodology

The research was limited to MTS providers that operate in Greece. Through this survey, an attempt has been made to discover to what extent customers of MTS are satisfied by the services offered to them. The questions were chosen so that answers would be given to all the factors that may affect consumers’ satisfaction from MTS according to the research model. The questionnaire was consisted of 48 questions and was divided in 9 sections. The Likert scale measurement was used for all the questions (1=“strongly agree” and 7=“strongly disagree”).

5. Analysis and Interpretation of the results

5.1. Frequency Analysis

The first category of question in the survey questionnaire contains general information about the respondents and the MTS company they use. In the present survey 50.7% of the questionnaires were answered by men, while the remaining 49.3% by women. The age of the majority of the respondents ranges from 18 to 25 years and represents 38.3% of the total number of respondents. As far as the education level is concerned, most of the respondents are high school graduates (40%), while another 36.3% holds a university degree. Moreover, 61.7% of the research participants have a contract with the company, while 39.3% have a prepaid connection package.

Considering the signal quality and network coverage of the company that every respondent uses, it was found that the respondents are generally satisfied. Certainly, the satisfaction from the network coverage outdoors is slightly higher (average=2.31) than the satisfaction from the network coverage indoors (average =2.47). Furthermore, the respondents are satisfied from the transmission quality of the signal (average =2.55).

As far as the perceived value from the customer’s point of view is concerned, it was found that they are neither satisfied nor dissatisfied. Specifically, looking at the price of the service packages as well as the quality of the provided services the average response was found to be around the middle point (average 3.18 and 3.44 respectively).

In regards to customer service, the results are rather positive, given that the companies are moving to the right direction and satisfy their
customers. Particularly, customers respond that the bills sent to them from the MTS company are precise, undoubted and with fully understandable data (average=2.36). Examining customers’ satisfaction from the repair and maintenance services that the customer service departments offers, it is found that although the results show a disposition in favour of satisfaction, it is clear that customers want more and even better services (average=3.02). An explanation for this result could be provided by the fact that only in a limited number of cases customer service departments can respond immediately to customer’s demands, while in most of the cases they send the products to be repaired at their headquarters.

The results also reveal that MTS providers pay great attention to the selection of personnel for their offices/shops, as well as to the constant supply of services. The responses concerning the supply of constant services indicate that customers are relatively satisfied (average=2.34). Similar results occur when the satisfaction from the willingness of the personnel (average=2.45) and the satisfaction from the personnel’s ability to resolve a given problem (average=2.76) are examined. Thus, it is clear that companies have put great emphasis on these areas and by doing so they have succeeded to increase the level of customers’ satisfaction.

Further, evaluating the results concerning customer complaints, it is obvious that there is a customers’ tendency to express their dislike, officially or unofficially, when they believe that the services and products companies offer them do not meet their expectations (average=3.12). The frequency of these complaints in many cases is high (average=2.45). Yet, customers claim that there is a difficulty to find where they should address their complaints (average=3.01).

The next category of questions refers to customer loyalty (devotion). It is very obvious that customers have the intention to remain customers of the same company (average=2.35). As regards to whether the respondents have proposed the company they use to others and their satisfaction from the company’s pricing policy, the replies were found to be around the middle point (average 3.57 and 3.53 respectively). The conclusion that could be drawn from these results is that the customers are, generally, devoted to their companies. This may imply that customers are happy with the overall package offered to them, or that the financial, psychological and procedural costs to change the MTS company they are currently using are high.

As far as the image of the company is concerned, respondents consider the company they use to be reliable (average=2.19) and professional (average=2.26). Considering its social contribution, the results were not as positive as the previous ones (average=3.07). Satisfactory enough were the replies about whether the company keeps good relations with the customers (average=2.62). The creation of the company image,
which is often related to symbols and values, is a continuous process that can be improved fast with some technological achievements, or, on the contrary, be destroyed if the needs and expectations of various users related to the company were to be disregarded (Dichter, 1985; Herbig et al., 1994).

Finally, examining the questions referring to the level of the total customers’ satisfaction from their companies, it is revealed that for the majority of the questions the results were positive (average=2.68). Yet, the mean of the question referring to quality of the services provided by the company provides approach the ideal level is relatively low (average=3.54), and this should be food for thought for these companies.

5.2. Factor Analysis

Factor analysis was initially used to examine the research model that was presented in Figure 2. The results are presented in Table 1. The indicators that are being examined for the evaluation of the results are: (i) Kaiser-Meyer-Olkin (K.M.O.), (ii) Bartlett’s test of sphericity, (iii) Total Variance Explained (TVE) and (iv) the loadings of every variable in the factor that it belongs.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Statistics</th>
<th>Variables</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K.M.O. = 0.720</td>
<td>Network coverage is satisfactory indoors</td>
<td>2.47</td>
<td>1.591</td>
<td>0.847</td>
</tr>
<tr>
<td></td>
<td>Bartlett’s Sig = 0.00</td>
<td>Network coverage is satisfactory outdoors</td>
<td>2.31</td>
<td>1.459</td>
<td>0.893</td>
</tr>
<tr>
<td></td>
<td>(TVE) = 76.458</td>
<td>Transmission quality of signal is satisfactory</td>
<td>2.55</td>
<td>1.445</td>
<td>0.883</td>
</tr>
<tr>
<td></td>
<td>Cronbach (a) = 0.844</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>There is a big variety of packet services</td>
<td>2.65</td>
<td>1.513</td>
<td>0.777</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The cost of packet services is satisfactory</td>
<td>3.18</td>
<td>1.660</td>
<td>0.809</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The cost of mobile is satisfactory</td>
<td>3.55</td>
<td>1.717</td>
<td>0.793</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rating of price has given quality</td>
<td>3.44</td>
<td>1.715</td>
<td>0.838</td>
</tr>
<tr>
<td></td>
<td>K.M.O. = 0.756</td>
<td>Perceived value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bartlett’s Sig = 0.00</td>
<td>My bills are sent are printed with accuracy, clarity</td>
<td>2.36</td>
<td>1.674</td>
<td>0.730</td>
</tr>
<tr>
<td></td>
<td>(TVE) = 64.752</td>
<td>and full data informations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cronbach (a) = 0.818</td>
<td>The service centers’ locations are easy to be found.</td>
<td>2.30</td>
<td>1.437</td>
<td>0.836</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I’m satisfied by the working hours of service centers.</td>
<td>2.48</td>
<td>1.623</td>
<td>0.818</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I’m satisfied by the product maintenance of the service centers.</td>
<td>3.02</td>
<td>1.676</td>
<td>0.803</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The communication with the company is satisfactory.</td>
<td>2.81</td>
<td>1.748</td>
<td>0.798</td>
</tr>
<tr>
<td></td>
<td>K.M.O. = 0.829</td>
<td>Customer service</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bartlett’s Sig = 0.00</td>
<td>The service is continuous.</td>
<td>2.34</td>
<td>1.353</td>
<td>0.880</td>
</tr>
<tr>
<td></td>
<td>(TVE) = 63.660</td>
<td>Company’s personell is eager.</td>
<td>2.45</td>
<td>1.537</td>
<td>0.916</td>
</tr>
<tr>
<td></td>
<td>Cronbach (a) = 0.854</td>
<td>The company put efforts to solve customer’s inconvenience</td>
<td>2.76</td>
<td>1.736</td>
<td>0.906</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Selection of personell for their establishment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>K.M.O. = 0.738</td>
<td>Customer complaints</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bartlett’s Sig = 0.00</td>
<td>Had the customer complained either formally or informally about the product or service.</td>
<td>3.12</td>
<td>2.095</td>
<td>0.793</td>
</tr>
<tr>
<td></td>
<td>(TVE) = 81.172</td>
<td>My complaints are frequent.</td>
<td>2.45</td>
<td>1.618</td>
<td>0.859</td>
</tr>
<tr>
<td></td>
<td>Cronbach (a) = 0.880</td>
<td>Was hard for me to find where to complain.</td>
<td>3.01</td>
<td>1.932</td>
<td>0.633</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
I have no intention not to leave the specific company. 2.35 1.481 0.730
I have suggested the company I use. 3.53 2.143 0.816
I’m satisfied by the pricing policy. 3.57 1.884 0.811
Intended to use much more services. 4.14 1.925 0.682
The contents company controlled the private and information and transaction data well. 3.10 1.700 0.691

Customer loyalty
K.M.O.= 0.815
Bartlett’s Sig = 0.00
(TVE) = 56.013
Cronbach (a)=0.800

Being reliable. 2.19 1.403 0.711
Being professional. 2.26 1.359 0.820
Social contributions to society. 3.07 1.781 0.763
Customer relations. 2.62 1.563 0.852
Innovations and overlooking. 2.85 1.672 0.864
Add value to user. 3.28 1.837 0.832

Company image
K.M.O.= 0.841
Bartlett’s Sig = 0.00
(TVE) = 65.428
Cronbach (a)=0.891

I’m overall satisfied. 2.57 1.449 0.801
I’m pleased for fulfillment of expectations. 2.80 1.605 0.876
I’m pleased for services compare with ideal. 3.54 1.712 0.804
I’m pleased for fulfillment of personal needs. 2.54 1.466 0.865
I’m pleased for overall quality. 2.71 1.474 0.901
I’m pleased for service quality. 2.73 1.505 0.907
I’m pleased for product quality. 2.74 1.477 0.839

Customer satisfaction
K.M.O.= 0.900
Bartlett’s Sig = 0.00
(TVE) = 75.389
Cronbach (a)=0.944

According to Malhotra (1999) for factor analysis to apply: (i) the K.M.O. indicator must have values over 0.6, (ii) the significance of Bartlett’s test of sphericity must be lower than 0.05, (iii) TVE must be bigger than 60% and (iv) the loadings of every variables must be higher than 0.7. It is easily confirmed that the examined indicators fulfill the above requirements and therefore can be used to further examine the model and test the research hypotheses. It must be stressed that for factors with two variables K.M.O.values higher than 0.5 are accepted (Malhotra, 1999).

5.3. Reliability Analysis

There are various ways that reliability can be evaluated (de Vellis, 1991; Carminexus & Zeller, 1979), with Cronbach alpha (a) being the most common one. According to this indicator, values bigger than 0.6 imply consistency and reliability in the way the factors were measured (Nunnally, 1978; de Vellis, 1991; Carminexus & Zeller, 1979). In the present study the values of Cronbach alpha indicator are >0.8, except for the factor “customer complaints” where the Cronbach indicator is 0.629.

5.4. Structural Equation Model

For the development of the model the stuctural equation method (Structural Equation Modeling Σ SEM) was used. Confirmatory factor analysis (CFA) was used to examine whether customer satisfaction consists of all 5 factors included in the analysis. The overall model fit was evaluated using four fit measures: (i) chi-square/ degree of freedom (χ²/d.f.), (ii) goodness of fit index (GFI), (iii) comparative fit index (CFI), and (iv) root mean square error of approximation (RMSEA) (Smith and McMillan, 2001). The level
of all the above indexes was within acceptable range indicating good fit of the measurement model.

![Diagram](image)

**Figure 2: Research model**

Direct, indirect and total effects between the factors, are presented in Table 2. The total effect of perceived value, signal quality, service quality and company image on customer satisfaction is from high to very high (0.226, 0.189, 0.217 and 0.759). All of them explain about 77% of customer satisfaction.

**Table 2a:** Total effects (directs and indirects)

<table>
<thead>
<tr>
<th>Factors Effect</th>
<th>Signal Quality Direct</th>
<th>Indirect</th>
<th>Total</th>
<th>Perceived value Direct</th>
<th>Indirect</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived value</td>
<td>0.237</td>
<td></td>
<td>0.237</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service quality</td>
<td>0.237</td>
<td>0.078</td>
<td>0.237</td>
<td>0.093</td>
<td>0.093</td>
<td>0.226</td>
</tr>
<tr>
<td>Customer loyalty</td>
<td>0.052</td>
<td>0.078</td>
<td>0.189</td>
<td>0.226</td>
<td>0.226</td>
<td>0.226</td>
</tr>
</tbody>
</table>
Table 2b: Total effects (directs and indirects)

<table>
<thead>
<tr>
<th>Factors</th>
<th>Effect</th>
<th>Service quality</th>
<th>Customer loyalty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>Indirect</td>
<td>Total</td>
</tr>
<tr>
<td>Signal quality</td>
<td></td>
<td>0.090</td>
<td>0.090</td>
</tr>
<tr>
<td>Perceived value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service quality</td>
<td></td>
<td>0.605</td>
<td>0.605</td>
</tr>
<tr>
<td>Customer loyalty</td>
<td></td>
<td>0.312</td>
<td>0.697</td>
</tr>
<tr>
<td>Company image</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td></td>
<td>0.217</td>
<td>0.217</td>
</tr>
</tbody>
</table>

Table 2c: Total effects (directs and indirects)

<table>
<thead>
<tr>
<th>Factors</th>
<th>Effect</th>
<th>Company image</th>
<th>Customer satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Direct</td>
<td>Indirect</td>
<td>Total</td>
</tr>
<tr>
<td>Signal quality</td>
<td>0.757</td>
<td>0.757</td>
<td></td>
</tr>
<tr>
<td>Perceived value</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service quality</td>
<td>0.605</td>
<td>0.605</td>
<td></td>
</tr>
<tr>
<td>Customer loyalty</td>
<td>0.412</td>
<td>0.412</td>
<td></td>
</tr>
<tr>
<td>Company image</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>0.457</td>
<td>0.302</td>
<td>0.759</td>
</tr>
</tbody>
</table>

This evidence shows how important these factors are together, and indicates that the MTS providers should pay attention to them. The total effect of customer satisfaction and company image on customer loyalty is also very high (0.412 + 0.697). In this case, 58% of customer loyalty is explained from the other factors. This is also an important finding which should be taken into consideration by MTS companies.

6. Conclusions – Research Limitations

Many and very significant conclusions are derived from this research:

- To begin with, the factors that were examined have a significant effect on consumers’ satisfaction. Companies must consider plenty of parameters in order to succeed in their goal.

- The increase in customer satisfaction leads to an increase in customer loyalty. This can lead to a decrease in the price elasticity, lower costs for future transactions, decreased costs of failure, lower costs for attracting new customers and an improvement in the reputation of the company (Anderson et al., 1994b).

- Moreover, it is understood that the signal quality and network coverage is the factor that least affects customer satisfaction. Although the above conclusion was not expected, the explanation may be simple. When
MTS first came into our lives, the signal quality was the greatest issue that concerned consumers. MTS companies did not offer network coverage in many locations and customers sought the one that would cover them the most. Nowadays, the services offered by MTS companies have been improved significantly in this respect.

- As expected, it was found that the customer satisfaction affects to a great extent customer’s loyalty to the company. When a customer is pleased and satisfied by the services that are offered to him, he remains a customer of the company and uses even more services from the same company. Therefore, companies are obliged to keep their customers satisfied if they want to survive in a such competitive environment as the one of MTS service providers.

- Finally, the most important conclusion that was drawn from the present study is that the image of the company is the factor that affects more than any other factor customer satisfaction and furthermore, affects to a great extent the customer loyalty. The most obvious interpretation is that customers are greatly affected by the “name” of the company and do not equally value other factors such as the quality of the services or the network coverage.

Through the present study, many useful information can be derived that involve the image of the Greek market in the sector of MTS. From an administrative viewpoint, acquiring the knowledge of what more people want to be offered by a company is very important. Customers of MTS providers indicated that the main issue that concerns them is the reduction in the cost of the services, thus, where substantial emphasis must be given by the providers on this issue.

This study has some limitations:

- The survey was carried out in a sample of 300 people. Perhaps, the survey should be repeated using a larger sample for better results.

- The survey was based on a certain consumer satisfaction model. Even though useful conclusions were drawn, the inclusion of some other factors could improve the model.

- Since some people from the sample, especially people of older age, are not substantially conversant with the subject but they are simple users, that may have had an impact on their answers.

- Moreover, due to the fact that the questions have elements of subjectivity, some of the respondents may have overestimated a
question by evaluating it with 1 (on Likert scale) when it should be 2, or underestimated one by evaluating it with 6 when it should be 5.

- Furthermore, the present research has many parameters which presented a problem for the collection of all the data that were necessary.

- Finally, people that used Q-telecom did not participate in the research, due to the fact that the company does not have a privately-owned telecommunication network.

References


Consumers’ online buying behaviour in the context of different product types

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Abstract:  
Online shopping is one of the most popular activities that take place on the internet. Yet the reasons why consumers buy online and what drives them to do so are still unclear. Although it is implied that consumer acceptance of online shopping is affected by the different products (Liang and Huang, 1998) that are being marketed online, not many studies have adopted this view. The purpose of this study is to examine consumers’ behaviour when making online purchases in the context of different product types. After a thorough review of the existing literature the factors that were selected to be tested in this study are Personal Innovativeness of Information Technology (PIIT), Self-efficacy, Product involvement and how they affect consumer attitude towards online shopping. Correlation analysis, at first, to determine the relationships among the variables and regression analysis afterwards to verify the extent of the variable interaction were used to test the hypotheses. Based on the aforementioned analyses, results were drawn and compared to the results found by Lian and Lin (2008) in a similar study. All questions were measured in a five point Likert scale and a total of 204 questionnaires were entered in the S.P.S.S. (Statistical Package for Social Sciences) statistical programme.

Keywords:  
Personal Innovativeness of Information Technology (PIIT), Self-efficacy, Product involvement
1. Introduction

Online consumer attitude is an issue that concerns many researchers (Cheung et al., 2003; Verhagen, van den Ham and Creemers, 2003). One of the essential questions in this area is, which are the factors that determine consumers’ decision to make a purchase from a certain electronic shop (Lowengart and Tractinskky, 2001). Finding the characteristics of possible buyers can help enterprises to accurately find potential target markets.

Furthermore, Peterson, Balasubramanian and Bronnenberg (1997) support the view that due to the special features of the internet its suitability to market products and services depends on the features of the products and services being marketed. Also, Liang and Huang (1998) showed that different products types affect consumers’ acceptance of online shopping.

Although many studies have shown that consumer characteristics are important when it comes to online shopping, the majority of those ignore the effect of different product types. Wanting to overcome this limitation, this study focuses on the characteristics that drive users to buy products online while at the same time it examines how these characteristics differ when the product in question changes. In the present survey four different categories of product types were adopted to examine how they affect consumer behaviour.

In the first section a review of the literature is provided, involving determinants of consumer characteristics, factors that determine the consumer acceptance of online shopping, product classifications and previous studies. Then, the research model and hypotheses are presented followed by the methodology that was used to conduct the research. The empirical analysis, which includes the results of the research and discussions, is presented afterwards based on the results.

2. Theoretical background

The internet is developing rapidly and while its popularity is growing, more and more users become familiar with it and adopt it as a medium to search for information and shop online (Hou and Rego, 2002; Farag et al., 2007). This section summarises the factors that determine the user acceptance of online shopping and a brief review of previously conducted researches concerning the aforementioned.

2.1. Factors which determine user acceptance of online shopping

Four factors were found that determine user acceptance of online shopping and are presented in Table 1.
### Table 1

<table>
<thead>
<tr>
<th>Factors which determine user acceptance of online shopping</th>
<th>Variables</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumer characteristics</strong></td>
<td>personality traits</td>
<td>O’Cass and Fenech, 2003; McCrae and Costa, 1997; Li and Zhang, 2002</td>
</tr>
<tr>
<td></td>
<td>self-efficacy</td>
<td>Eastin, 2002; Li and Zhang, 2002; Perea y Monsúwe, Dellaert and de Ruyter, 2004; Bandura, 1997</td>
</tr>
<tr>
<td></td>
<td>demographic profiles</td>
<td>Koufaris, 2002; Park and Jun, 2003; Mutum and Ghazali, 2006; Dholakia and Uusitalo, 2002; Perea y Monsúwe, Dellaert and de Ruyter, 2004</td>
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<tr>
<td></td>
<td>acceptance of new IT applications</td>
<td>Childers et al., 2001; Citrin et al., 2000; O’Cass and Fenech, 2003; Al-Gahtani and King, 1999</td>
</tr>
<tr>
<td><strong>Personal perceived values</strong></td>
<td>perceived danger</td>
<td>Eroglu, 1992; Pedersen and Nysveen, 2005; Mathews and Healy, 2007; Cheng and Huang, 2007; Gupta, Su and Walter, 2004; Youn, 2005; Shergill and Chen, 2003; Ratchford, Talukdar and Lee, 2001; Senecal 2000; Sukpanich and Chen 1999; Han, Ocker and Fjermestad, 2001; Li and Zhang, 2002</td>
</tr>
<tr>
<td></td>
<td>perceived convenience</td>
<td>Eastin, 2002; Eastlick and Feinberg, 1994; Lim and Dubinsky, 2004; Wang et al, 2005; Li, Kuo and Russell, 1999; Wolfinbarger and Gilly, 2001</td>
</tr>
<tr>
<td></td>
<td>perceived web site quality</td>
<td>O’Cass and Fenech, 2003; Shergill and Chen, 2003; Wolfinbarger and Gilly, 2001; Gefen and Straub, 2000</td>
</tr>
<tr>
<td></td>
<td>perceived benefits</td>
<td>Eastin, 2002; Childers et al, 2001; Bakos, 1991; England et al, 1999</td>
</tr>
<tr>
<td><strong>Website design</strong></td>
<td>security</td>
<td>Belanger, Hiller and Smith, 2002; Liao and Cheung, 2001; Ranganathan and Grandon, 2002; Swaminathan, Lepkowska-White and Rao, 1999; Mummalaneni, 2005; Youn, 2005; Chou, 2007; Li and Zhang, 2002; Park and Kim, 2003; Kelly and Erickson, 2004; Flavián and Guinalíu, 2006</td>
</tr>
<tr>
<td></td>
<td>privacy</td>
<td>Belanger, Hiller and Smith 2002; Ranganathan and Grandon, 2002; Swaminathan, Lepkowska-White and Rao, 1999; Dolnicar and Jordaan, 2006; Birring, 2007; Galanxhi-Janaqi and Fui-Hoon Nah, 2004; Flavián and Guinalíu, 2006; Wang, Lee and Wang, 1998</td>
</tr>
<tr>
<td><strong>Product</strong></td>
<td></td>
<td>Peterson, Balasubramanian and Bronnenberg, 1997; Perea y Monsúwe, Dellaert and de Ruyter, 2004; Lian and Lin, 2008; Bhatnager, Misra and Rao, 2000; Liao and Cheung, 2001;</td>
</tr>
</tbody>
</table>

#### 2.2. Online product classifications

There are several different product classifications but only the one proposed by Peterson, Balasubramanian and Bronnenberg (1997) refers to marketing products through the internet. They insisted that a different categorisation was needed, one that would focus on online products. Based
on the special characteristics of the internet, they proposed a classification for online products which consists of three dimensions: cost and frequency of purchasing, value proposition and degree of differentiation (Table 2).

### Table 2

<table>
<thead>
<tr>
<th>Dimension 1</th>
<th>Dimension 2</th>
<th>Dimension 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low cost, frequently purchased</td>
<td>tangible and physical goods</td>
<td>High differentiation potential</td>
</tr>
<tr>
<td>products</td>
<td>intangible services</td>
<td>Low differentiation potential</td>
</tr>
<tr>
<td>High cost, rarely purchased products</td>
<td>tangible and physical goods</td>
<td>High differentiation potential</td>
</tr>
<tr>
<td></td>
<td>intangible services</td>
<td>Low differentiation potential</td>
</tr>
</tbody>
</table>

From “Exploring the Implications of the Internet for Consumer Marketing”, by Peterson, Balasubramanian and Bronnenberg (1997).

The first dimension ranges from low cost, frequently purchased goods to high cost, rarely purchased goods. The second dimension involves from tangible and physical goods to intangible services. The third dimension refers to the product degree of differentiation, which allows companies to gain a competitive advantage.

### 2.3. Previous studies

Many studies have been conducted about online consumer behaviour. Most of them have tried to identify factors that affect or contribute to online consumer behaviour. Researchers seem to adopt different points of view and focus on different factors in different ways (Li and Zhang, 2002).

Donthu and Garcia (1999), during their research for consumer characteristics related to online shopping, found that consumers who shop online seek convenience and variety. Moreover, they are more innovative and spontaneous than conventional buyers. Also they are less aware of the brand of the product and tend to have a more positive attitude towards advertising and direct marketing.

On the other hand, Siu and Cheng (2001) found that the most important factors in classifying online shoppers are the economic benefits that derive from online shopping, the product availability, the security dangers, their monthly income, the product technology opinion leaders and their attitude towards technological development.

Jarvenpaa, Tractinsky and Vitale (2000) examined a model of consumer behaviour towards specific online shops, in which perceptions about reputation and size affect consumer trust of the retailer. The level of trust had a positive relationship to the attitude towards the shop and a negative relationship towards perceived risk. Finally, attitude and risk
perception affected consumer intention to buy from a specific store (Jarvenpaa and Tractinsky, 1999; Lowengart and Tractinsky, 2001).

3. Research model and hypotheses
Based on the above discussion Lian and Lin (2008) proposed an integrated model which involves the four most common factors that define user acceptance of online shopping (see 2.2.). From these factors derived the three variables that were included in the research model (figure 1). The critical consumer characteristic variables include personal innovativeness of information technology (PIIT), Internet self-efficacy and product involvement.

**Figure 1**: Research model

![Research model](Lian and Lin (2008))

3.1. Personal innovativeness of information technology (PIIT)
Personal innovativeness was defined as the degree that one adopts new ideas faster than the other members of a system (Rogers, 1995; Ha and Stoel, 2004; Youn, 2005). Based on this definition Agarwal and Prasad (1998) applied the term of personal innovativeness in the domain of information technology, named it PIIT and defined it as the willingness of a user to experiment on new information technologies.

Consumer behaviour towards online shopping is significantly affected by PIIT and so users with high levels of PIIT are more likely to accept online purchasing. The following hypothesis derives from the aforementioned:

H1: High levels of PIIT have a positive effect on consumer attitude towards online shopping.
3.2. Self-efficacy
Internet self-efficacy derives from the social cognitive theory proposed by Bandura (1997). Within this perspective, one's behaviour is constantly under reciprocal influence from cognitive (and other personal factors such as motivation) and environmental influences. Bandura calls this three-way interaction of behaviour, cognitive factors, and environmental situations the "triadic reciprocality" (Bandura, 1989).

Eastin (2002) and O’Cass and Fenech (2003) and Perea y Monsuwé, Dellaert and de Ruyter, (2004) applied that term in the context of internet; they named it internet self-efficacy and defined it as the belief in one’s abilities to use the internet effectively. Moreover, Eastin (2002) and O’Cass and Fenech (2003) showed that personal internet self-efficacy has a positive effect on user acceptance of online shopping. According to Perea y Monsuwé, Dellaert and de Ruyter (2004) consumers who have low self-efficacy levels are insecure and feel uncomfortable making purchases over the internet. Thus, the following hypothesis is inferred:

H2: High level of internet self-efficacy positively influences consumer attitude towards online shopping.

3.3. Product involvement
Product involvement represents a concern with a product that the consumer brings into a purchase decision (Bei and Widdows, 1999; Pedersen and Nysveen, 2005). Consumer involvement with a product reflects its relevance (Zaichkowsky, 1985), influences consumer motivation to make a purchase decision (Peter and Olson, 1996) and has an impact on his shopping experience and behaviour (Koufaris, 2002).

In this study it is expected that high product involvement levels positively influence consumer behaviour towards shopping online and thus, the following hypothesis is stated:

H3: High product involvement levels positively affect consumer attitude towards online shopping.

3.4. Product categories
Many researchers (Bhatnager, Misra and Rao 2000; Peterson, Balasubramanian, and Bronnenberg 1997; Liao and Cheung, 2001; Lian and Lin, 2008) have insisted on the importance of different product types when being marketed online.

Most of the previous studies have focused their attention on one product or one category of similar products. For example Liang and Lai (2002) studied the online book purchase, Dahlen and Lange (2002) examined the retail purchase of grocery products and Ruyter, Wetzels and Kleijnen (2001) focused on travelling services. This type of researches restricted the generalisation of the results to few products at best.
In this study an attempt is made to examine different product types and their influence between consumer characteristics and consumer attitude towards online shopping and from the aforementioned the following hypothesis is derived:
H4: Product categories affect the relationships between consumer characteristics and attitudes toward online shopping.

4. Methodology

4.1. Sample selection
The sample of this study consists of Greek internet users who know how to make an online purchase, possibly have made one or are willing to make one in the future. 51.5% of the sample has more than 5 years experience on the internet and 34.8% of the sample uses the internet for more than 14 hours weekly. Moreover, 46.6% were male and 53.4% were female. The age of the majority of the sample (83.3%) is between 18 and 44 years old.

This study will try to resolve the relationships between consumer characteristics and their attitude towards online shopping in the context of different product types. A total of 232 internet users were selected to complete a questionnaire.

4.2. Measurement development
The collection of the necessary data was done with the use of a questionnaire. The questionnaire consists of three parts: the introduction where the purpose of the research is stated, the personal information section which includes questions about age, education, internet experience and online shopping experience and the third and main part where the questions for measuring the variables are. All 19 questions of the third part of the questionnaire were adopted from the model proposed by Lian and Lin (2008).

The research was carried out in Greece, especially in East Macedonia and Thrace, and all the questions were translated into Greek by a professional translator, assisted by English professors. Then a pilot testing was conducted to avoid any miscomprehensions by the Greek users. All questions were measured in a five point Likert scale. From the distributed questionnaires 28 were unsuitable due to obvious random answering and thus, excluded. A total of 204 questionnaires were entered in the S.P.S.S. (Statistical Package for Social Sciences) statistical programme.

4.3. Online product selection
Due to the special characteristics of the internet, in this study the classification proposed by Peterson, Balasubramanian and Bronnenberg (1997) is used. This model consists of three dimensions: the cost and frequency of purchase, the value proposition and the degree of differentiation. The last dimension is omitted because the Greek market is
not mature enough with regard to online shopping and it is even less mature in the high-low differentiation products.

<table>
<thead>
<tr>
<th>Table 3</th>
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<tbody>
<tr>
<td><strong>Products employed in this research</strong></td>
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<tr>
<td>Tangible products</td>
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<td>Intangible products</td>
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</table>

As a result the four products selected are based on the two dimension classification. Books are used for tangible, low cost, frequently purchased products, e-tickets (movie tickets, concert tickets etc.) are used for intangible low cost, frequently purchased products, TV set are used for tangible, high cost, rarely purchased products and subscriptions are used for intangible high cost, rarely purchased products (Table 3).

5. **Empirical analysis**

5.1. **Instrument validity**

Before examining the hypotheses it is essential to examine the validity of the questionnaire that was used for measuring the six factors of the research model. Validity is the degree in which variables measure accurately what they are supposed to measure (Hair *et al.*, 1998) and consists of content validity and construct validity.

5.1.1. **Content validity**

The purpose of the instrument content validity is to eliminate or to correct those questions that have not accomplished their research goal (Bock and Kim, 2002). Although, the content validity is confirmed from a previous study (Lian and Lin (2008), before the beginning of the present research a discussion with academic staff and a pilot testing was made to avoid any miscomprehensions.

5.1.2. **Construct validity**

Construct validity was accomplished by using exploratory factor analysis and reliability analysis based on the Cronbach Alpha statistical metre.

5.1.2.1. **Exploratory factor analysis**

The exploratory factor analysis shows the number of factors that were empirically created and how the 19 questions employed in this study were distributed in those four factors. For that cause Principal component analysis and Varimax rotation were used.
The results of this analysis (Table 4) show that the use of exploratory analysis was justified. Kaiser-Meyer-Olkin (KMO) statistics range from 0.791 to 0.895 and Bartlett’s Test of Sphericity is significant at 0.00 level. The analysis showed all items, had loadings greater than 0.45, which are acceptable considering the sample size (Hair et al., 1998).

### Table 4

<table>
<thead>
<tr>
<th>Factor and reliability analysis results</th>
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<tbody>
<tr>
<td><strong>Factor</strong></td>
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<td><strong>PIIT</strong></td>
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<td><strong>Self-efficacy</strong></td>
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<td><strong>Product involvement</strong></td>
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<td><strong>E-shop</strong></td>
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<td><strong>Product involvement</strong></td>
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<td><strong>Subscriptions</strong></td>
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<tr>
<td><strong>Attitude towards online shopping</strong></td>
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<tr>
<td><strong>E-shop</strong></td>
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<tr>
<td><strong>TV and online shopping</strong></td>
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</tbody>
</table>
5.1.2.2. Reliability analysis
Reliability is one of the most important criteria for evaluating research instruments and refers to the internal consistency of the factors (Chu & Murrmann, 2006). Cronbach’s alpha ($\alpha$) is employed to test instrument reliability. According to Nunnally (1978) any value above 0.7 indicates reliability. The results show that all factors range between 0.839 and 0.915, which surpasses the criteria of reliability (Table 4).

5.2. Correlations
Correlation is a statistical method used for measuring or describing the relationship between two variables (Karageorgos, 2001). Finding correlations among variables is essential, yet it cannot be described as a relationship between cause and effect. The information given can only be taken as an indicator (Dimitriade, 2000). Correlation analysis can either be applied independently or as a preliminary stage to regression analysis. Correlation analysis can show which variables have closer relationships with the independent one and should be included in the model (Zacharopoulou, 1995).

Correlations among the four factors, in the context of four product types are presented in Table 5.

<table>
<thead>
<tr>
<th>Items</th>
<th>PIIT</th>
<th>SE</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (books) 0.210**</td>
<td>0.109</td>
<td></td>
<td>0.594**</td>
</tr>
<tr>
<td>A (e-tickets) 0.208</td>
<td>0.048</td>
<td></td>
<td>0.658**</td>
</tr>
<tr>
<td>A (TV sets) 0.205**</td>
<td>0.119</td>
<td></td>
<td>0.633**</td>
</tr>
<tr>
<td>A (subscriptions) 0.308**</td>
<td>0.147*</td>
<td>0.684**</td>
<td></td>
</tr>
</tbody>
</table>

* Correlation is significant at the 0.05 (2-tailed)
** Correlation is significant at the 0.01 (2-tailed)

From the above it is safe to say that consumers’ attitude towards online shopping is affected by different product types. Moreover the factors that are considered important are different for every product type.

5.3. Regression analysis
As mentioned before, correlation analysis cannot be described as a relationship between cause and effect (Dimitriadi, 2000). To overcome this limitation linear multiple regression was employed to describe the association among the factors and to form a mathematic model.

Attitude towards online shopping in the context of different product types is the dependent variable ($Y_1$: books, $Y_2$: e-tickets, $Y_3$: TV sets, $Y_4$: subscriptions) and PIIT ($X_1$), self-efficacy ($X_2$) and product involvement
(X₃) are the independent variables. The mathematical models are displayed below.

\[ Y_1 = b_{0.1} + b_{1.1}X_1 + b_{2.1}X_2 + b_{3.1}X_3 \]
\[ Y_2 = b_{0.2} + b_{1.2}X_1 + b_{2.2}X_2 + b_{3.2}X_3 \]
\[ Y_3 = b_{0.3} + b_{1.3}X_1 + b_{2.3}X_2 + b_{3.3}X_3 \]
\[ Y_4 = b_{0.4} + b_{1.4}X_1 + b_{2.4}X_2 + b_{3.4}X_3 \]

Regression results are shown in tables 6 and 7. In table 6 computed F-values and R² are displayed to understand the overall significance of each equation. All of the models yield significant p-values (p < .01) and R² above 40% of the variance in attitudes toward online shopping was explained.

<table>
<thead>
<tr>
<th>Summary of regression analysis</th>
<th>Books</th>
<th>E-tickets</th>
<th>TV sets</th>
<th>Subscriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-value</td>
<td>27.831</td>
<td>30.878</td>
<td>29.900</td>
<td>39.102</td>
</tr>
<tr>
<td>p-value</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>R²</td>
<td>0.413</td>
<td>0.438</td>
<td>0.430</td>
<td>0.497</td>
</tr>
<tr>
<td>Durbin – Watson</td>
<td>1.873</td>
<td>1.986</td>
<td>1.952</td>
<td>1.700</td>
</tr>
</tbody>
</table>

The results of significance testing of the study variables are listed in table 7. The regression results suggest the following: In the context of book buying, PIIT (p = 0.000) and product involvement (p = 0.000) yield coefficients with significant p-value. In the context of e-tickets purchases, only product involvement (p = 0.000) yield significant p-value for its coefficients. Furthermore, in the context of TV purchases, p-values are significant for PIIT (p = 0.047) and product involvement (p = 0.000). Finally, in the context of subscription purchase, two variables yield significant p-values including PIIT (p = 0.009) and product involvement (p = 0.000). The above results are displayed in table 8.

<table>
<thead>
<tr>
<th>Analysis of the four products</th>
<th>Regression coefficient</th>
<th>Standard error of coefficient</th>
<th>Standardised regression coefficient</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Books</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-7.253E-17</td>
<td>0.054</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PIIT</td>
<td>0.211</td>
<td>0.060</td>
<td>0.211</td>
<td>0.000</td>
</tr>
<tr>
<td>Self-efficacy</td>
<td>-0.058</td>
<td>0.060</td>
<td>-0.058</td>
<td>0.338</td>
</tr>
<tr>
<td>Product involvement</td>
<td>0.611</td>
<td>0.550</td>
<td>0.611</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Books</td>
<td>E-tickets</td>
<td>TV sets</td>
<td>Subscriptions</td>
</tr>
<tr>
<td>---------------------</td>
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<tr>
<td><strong>Hypothesis 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High levels of PIIT have a positive effect on consumer attitude towards online shopping</td>
<td>Verified</td>
<td>Rejected</td>
<td>Verified</td>
<td>Verified</td>
</tr>
<tr>
<td><strong>Hypothesis 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High level of internet self-efficacy positively influences consumer attitude towards online shopping.</td>
<td>Rejected</td>
<td>Rejected</td>
<td>Rejected</td>
<td>Rejected</td>
</tr>
<tr>
<td><strong>Hypothesis 3</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>High product involvement levels positively affect consumer attitude towards online shopping.</td>
<td>Verified</td>
<td>Verified</td>
<td>Verified</td>
<td>Verified</td>
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<tr>
<td><strong>Hypothesis 4</strong></td>
<td></td>
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<tr>
<td>Product categories affect the relationships between consumer characteristics and attitudes toward online shopping.</td>
<td>Verified</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
6. Conclusions
This study developed a model for determining online shopping attitudes and tested it in the context of different product types. Results demonstrated that the four regression functions were all significant in the context of different products. The results are discussed below.

To begin with, in this study books were chosen to represent low cost, frequently purchased, tangible products. The factors that seem to positively affect consumer attitude towards buying books online are PIIT and product involvement. This is probably due to the fact that books are inexpensive and are the first thing that someone buys when he wants to experiment with online shopping.

Low cost, frequently purchased, intangible products are represented by e-tickets. The only factor that seems to have a significant positive effect on consumer buying e-tickets online is product involvement. E-tickets are inexpensive and consumers’ interest is focused solely on the purpose that it accomplishes to fulfil. That can also be said for other low cost, frequently purchased, intangible products.

For high cost, rarely purchased, tangible and intangible products, TV sets and subscriptions were adopted respectively. The factors that have a positive effect on them are the same and are PIIT and product involvement. This is probably because of the relatively high cost that these products have and the reluctance to buy them from the internet. Users are not willing to experiment with buying high cost products online unless they consider them important.

It is obvious from the above that self-efficacy does not have any effect on consumers’ attitudes towards online shopping no matter what the product is. Viewing the answers given by the sample, it is safe to say that all respondents consider themselves able to use the internet effectively (mean = 4.31). The only explanation for this is that online shopping is a relatively new technology in Greece and whether they will choose it as a purchase medium has nothing to do with their ability to use it effectively.

All product categories have in common the product involvement factor and this is probably because consumers are reluctant and buy online only products that they really need and consider important.

Comparing the present study to the one carried out by Lian and Lin (2008) in Taiwan, it is observed that they have similarities but are not identical. The only factor that is shown to have the same positive effect towards online shopping is product involvement. Moreover the only product category that has the same results in both studies is the one of low cost, intangible products that is solely affected by the product involvement factor. In the rest of the results there are variations. This indicates that possible geographical limitations can affect online consumers’ attitudes in the context of different product types.
From all the above, it is made clear that different product types are responsible for the differentiations of the results. As a final conclusion it can be said that consumer attitude towards online shopping is affected mainly by the product in question.

The present study provides a starting-point for understanding what drives consumers to buy their products online and can be used by companies that promote their products through the internet. However, no privacy and security issues were raised, nor any personal perceived values such as perceived convenience, perceived danger, perceived website quality and perceived benefits, that could alter the findings of the research. If further attempts were to be made to expand the present model and to further examine the consumers’ online buying behaviour, it would be interesting if they included personal perceived values and website design characteristics.

References


Topic: Uncertainty / Risk

Criticism of the concept of probability determination

Nikolay Ivanov Petrov

Insurance as a fundamental and personal risk management system

Aija Graudiņa

Viable Systems Modeling (VSM) and the problem of managing uncertainty

Inga Krättli

Experiences from teaching the viable system model

Panagiotis Panagiotakopoulos
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Abstract:
In the present lecture, the philosophic term ‘determination’ is discussed as a high level of knowledge or ‘diversification’ of probability determination in homogeneous and heterogeneous systems. Having that in mind, the idea of chance forms the opinion that the way the state of objects and systems changes is not simple, i.e. it can form branches. Consequently, the science itself introduces a notion of a new type of interactions by restricting the form of determination diffusion.

Key words:
determination; chance; probability

1. Introduction

The stable character of natural relations (existing between objects and object systems) has an opposite side called ‘equipollence’. That side is a main characteristic of the strong determination concept. Each relation in question, regardless of the nature of its properties or parameters, is necessary to a corresponding degree. The process, a contribution of each relation to the common result, can differ in quantity only in terms of intensity, but not in its character or in the peculiarities of its inner nature. In the systems, functioning according to the rules of stable determination, breaking of any independent relation leads to the system break down. Not studying it means not knowing the system and its inner subordinations. In fact, such systems should not be reconstructed ‘in action’ without knowing them in depth or without determining their process.
2. Presentation

The increasing of the functioning reliability of stable determination systems requires the strictest restrictions of mental images. In support of that the following statement by Norbert Winer would be of interest: ‘The inflexible world could be called ‘organized’ only in the sense in which the bridge between all the elements in a solid system is organized. In such constructions each element depends on all the rest and all parts of the building are equally important. As a result, there are no parts of the bridge which could take the strongest tension. If it is constructed with materials which can stand, without any obvious deformations the existing inner tensions, it is almost impossible the concentration of those inner tensions to cause the bridge to collapse. On the other hand, the bridge stands the load only because it is not 100% solid.’

Here, the author of this lecture allows himself the following thesis: To provide the necessary level of reliability of determinate systems (technical, social, economic, biological, etc.) a certain level of flexibility is required. The real problem is finding a tool for measuring of that flexibility and the indeterminateness of the measuring method.

In the traditional philosophic analyses the idea of equipollence of the basic parameters characterizes the state of the studied object. That means that all the parameters in the particular theory are considered equally necessary. Besides, seeing the role and the value of the simple dynamic laws as absolute for the knowledge development has led to a strong juxtaposition of necessity and chance. As a result, all the parameters referring to the chance aspects of the studied processes and phenomena are excluded from the researches.

In fact, we use ‘chance’ to refer to those links and relations which are either not well-known or can be neglected as not important, secondary or external. In the relations between the quantities, the quantity interaction of the different parameters on the required result has to be determined. Only under that condition can a gradation in the necessary parameters of the objectively existing regulations exist.

In the process of knowledge development the idea of different types of interaction within the frames of stable determination has been formed. The latter is illustrated in the process of studying complex and complex-organized systems. Complex systems such as living organisms, for example, include in themselves a considerable hierarchic component which characterizes the structure organization. The relation between the notions, referring to the different levels of system structures, is not within the strict limits of the equipollent subordinations. The corresponding notions differ in the level and character of generalization. Besides, the more generalized
notions do not simply refer to low-level notions but they rather refer to the possible changes of the latter.

The issues of the interaction of the notions of different community level are discussed at large in the process of system researches, the information theory and the cybernetics. The new forms of interactive relations are revealed in the process of development of ideas for the level of information coding and the level of management. Here we have to consider the ideas of the Russian scientist Academician Nikolay Amosov for the level of information coding. Having in mind Academician Amosov’s theories we can point out the following:

- A high code is formed by integrating information, transferred by low-level codes, i.e. the signs of a high-level code are characteristic in a particular order or system, formed by the signs of low-level codes.

- A high code is more abstract and has a greater capacity. In a transition towards a high-level code large quantities of information substitute one code sign.

- The signs of a high level code (separated from the corresponding information quantity) are transferred to a low-level code by using flexibly determinate approach.

- From the information, transferred by low-level codes, a lot of high-level codes could be separated if the methods of re-coding are known. The reverse procedure is impossible without a considerable information loss.

- The full system information is acquired only when it includes a low-level code language.

- The more complex a system is the larger is its number of levels and methods of information coding.

The interactions between the signs and codes, subject of this lecture, referring to the different levels of information coding actually express the main problems and achievements which are used for analysis of modern processes of generalization in the knowledge development.

The signs referring to the different levels of information coding are notions of different degree of community. The commonness is not a one-way mechanical integration of basic single notions. The commonness shows an existence of a particular organization and a particular system of reciprocal relations in the mass of phenomena.

The character of parameter interactions reveals different levels of information coding. In particular, these aspects can be found in the
repeatedly studied in the history of philosophy order of notions ‘apple’ – ‘fruit’ – ‘organic body’ – ‘material object’. The whole problem here is revealed by analyzing the interactions between the notions ‘apple’ and ‘fruit’: how they were defined, how people moved from one notion to the other, etc. Here the problem of a definitely determinate deduction method of moving from one notion to the other should be studied.

It is clear that the interactions between the above-mentioned notions are not included in the concept of interaction equipollence. In the process of knowledge development, the concept of interaction equipollence has been undergoing an increasing critical analysis. It is important for the researchers to understand that this way of thought is the basis for the effective development of the idea of chance in technical systems.

We have to point out that the idea of chance characterizes that type of reciprocal relations and subordinations which differ from the design of stable determination. The latter is the reason for the fact that each object or system change in time in a strongly individual type and in an authentic or possible way.

At the same time, the notion of chance leads to the opinion that the way that the state of objects and systems changes is not simple, i.e. it can form branches. Consequently, the science itself introduces a notion of a new type of interactions by restricting the form of determination diffusion.

Determination is discussed as a high level of knowledge or diversification of probability determination in homogeneous and heterogeneous systems.

The concept of probability determination is actually the concept of measurement and calculation of phenomenon and factor quantities which have sense and importance for the existence, change and authenticity of the searched, by us, information, knowledge and values.

3. Total chance and one-way interaction

The classical theoretical ideas of the world are quite broad. They are systems of expert opinions about the structure, the evolution and the knowledge of the world. As a system for the development of the worldwide ideology, the idea of such a world system is not always seen as a value by the people of the governing elite.

The basis of the idea is the concept of world structure which is being built up by the direct influence of mechanics (classical and quantum) and its achievements in the study of different phenomena. It is supposed that the world consists of different unities (atoms, molecules, objects, object systems, etc.) which have interaction laws similar to the mechanics laws. When studying the character of classical theory, taken as the basis, usually a strictly one-way character of all the subordinations between the object
(system) parameters within the limits of the particular concepts and theories are studied.

If the parameters of a particular object are studied the relations between them could have a strictly one-way correspondence. And if the quantity changes of the particular object parameters are to be considered, then these changes could be done following a strictly one-way law. The research of a particular object behaviour, which is part of a particular system, is defined in only one way by all the system elements. A negation of such a theory with a certain probability means that certain laws should not be applied if there is no strict one-way interaction. Besides, considering the studied group of subordinations, it can be concluded that in those cases in which there is some kind of more than one-way interaction or undefined interaction we cannot refer to one-way objective law. In such cases, we can refer to the conclusion for incompleteness of knowledge about the particularly studied objects.

Here a definition for ‘system determination’ should be given: this is determination (order) of static and dynamic laws of the system interactions (technical, social, economic). The laws of that order are defined by the probability theory.

The concept of the simple dynamic laws has been developed on the basis of the classical mechanics. So, the classical mechanics with its theories and laws should be considered in the process of research.

The main aim of the classical mechanics is researching and defining the trajectory of macro-object movements. This trajectory is defined by the mechanics laws (equations) by taking as a basis the knowledge about some (initial) state of a particular object and the forces influencing it during the studied time period. In other words, the laws of Isaac Newton explain the relation structure between the states of the macro-objects in their mechanical movement.

If a certain initial state of the object and the forces influencing it are set, that allows any other state of the object to be defined, i.e. its movement trajectory. Moreover it is important to be confirmed that the movement trajectory of macro-objects in the mechanics can be defined by one way only.

Any possible state of macro-objects is defined by a strictly determined numerical value of all its parameters. If the trajectory of the macro-object movement is not one-way defined or some of the parameter values are not correct (i.e. are not defined), then, having in mind the classical mechanic laws, we have to say that we have not reached the solution of the problem. That means that the problem has been set incorrectly or that the situation analysis is not within mechanics limits.

The logical constructing, resulting from the classical physics theory, is in fact analogous to the scheme of classical mechanics. We can take
classical electrodynamics as an example. The use of that theory as an example is really interesting because Isaac Newton’s mechanics shows a reference to classical physics of corpuscular aspect of matter structure. Electrodynamics features the classical natural science approach towards the matter structure from the point of view of pure continuity. Classic electrodynamics is actually a physics theory of electromagnetic field. By that theory, the laws of the electromagnetic phenomena are explained. An important task of electrodynamics is certain basic characteristics of the electromagnetic field – electric and magnetic tension – in vacuum environment and in macroscopic objects depending on the space distribution of electric loads and currents. The solution of this problem can be reached only in one way and that is done by using Maxwell’s equation.

So, the class of simple dynamic laws characterizes simple values of all of its correlation relations. The presented concepts can be the basis for the philosophic idea about nature laws. Considering such an idea leads us to the conclusion that the task of a scientific research is to reveal (define) the one-way relations between all the parameters (properties) of the studied objects and systems.

Only such one-way relations should be evaluated as objects worth studying and providing knowledge about the real nature laws.

The latter is in fact a form of the ultimate scheme of simple dynamic laws which, as a philosophic concept, is called Laplace’s concept or more precisely classic determinism.

The following statement by Pierre Laplace is often quoted in science: ‘The mind which, at a certain moment, would be able to know all the forces animating nature (the relative state of all its parts), if the mind were broad enough to analyze that data, it would put in one formula only the movement of the greatest objects of the Universe together with the movement of the atoms. So, there would be nothing left which the mind could not know – the future as well as the past would be seen by it.’

The above quotation is the best definition of classical (Laplace’s) determinism. Classical Determinism is the basis for the attempts to transfer the logical system of classical mechanics laws to the whole nature by studying it as an object system. According to the conceptions of classical determinism, the relations, which feature the real relations in a system, are those which define each of its objects. The behaviour of each object in a system determines the behaviour of all the rest objects in a mutual one-way. In that aspect, we speak of a stable determination of each system element.

These conceptions about science laws and determinism provided for the progress of solid object mechanics and dense environment physics in the 20th century. On the other hand, they turned out to be elementary
unstable in contact with more complex phenomena and especially in the
analysis of biological and social phenomena and systems.

In order to understand clearly what a ‘stable determinate structure’ is,
we have to carry out a mental experiment (a research of a team of scientists
working according to the principle of stable determination).

The term ‘stable determination’ means that each defined detail of the
individual behaviour is connected with each of the surrounding individuals
in only one way. This way of mutual correlation is defined by the social
system structure or by the group of individuals. If in such a social system
or group of individuals, the initiative of one of the members prevails then
the system’s performance is possible only in case the others are deprived of
initiative.

If two individuals have initiatives the functioning of the group will be
paralyzed. The reason for that is the fact that an initiative supposes a
certain degree of autonomy of decisions and actions. That means that after
choosing the main direction of the system development, the details will be
coordinated while moving forward. However, stable determinate structures
exclude such development strategies. In correspondence with this the fact
that one of the first achievements of the probability concept of the world is
the rejection of the absolute role of the one-way relations and
subordinations. In revealing the nature of probability methods a special
attention is paid to that particular achievement of thought and knowledge.

The more than one-way nature of the probability decisions turned the
study of civil rights observance into a science. Here it has to be pointed out
that: ‘The probability approach to studying the world determines the non-
one-way nature of all processes, phenomena, objects and systems.’3, 4 In
addition, the probability non-one-way nature is always connected with a
certain degree of one-way nature of relations. This can be seen in the fact
that the language of the probability theory and statistics laws is, at the same
time, the language of probability distributions.

4. Summary

The term ‘stable determination’ excludes any autonomy and independence
of the elements within the system limits. Its explanation by the means of
mathematics is ‘solving a linear differential equation’. It defines
probability and its relation to chance and one-way descriptions and
solutions. That is its strength and weakness which provided for the
progress of classical physics in the 20th century and for the technical
science as a whole. Unfortunately, it is absolutely unsuitable to depict the
structures of complex organized system in nature (economic, biological,
social, ecological, etc.)
Bibliography
Insurance us a fundamental and personal risk management system

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Abstract:  
Insurance service us a risk management can be described historically, in chronological order: approximately every fifty years a new insurance service product is created as a response to social and economic problems. For example, in the late 6th century and early 7th century – in the period when large European countries faced risks related to the sea – the marine risk insurance service was formed. The first official policy of this kind was issued in England on 20th September 1547. After the Great Fire of London in 1666, the first insurance company "Fire Office" (1680), later renamed as "Phoenix", started offering fire risk insurance policies". One of the latest 21th century insurance cover (the benifits available under this policy) is „Your Identity data protection” insurance. Fayol H. (1949), a French theoretician of management, believes that the management of each company has at least six typical management functions, one of those being the security function (property and personal security). In the 1950-s and 1960-s, risk management in all insurance markets was associated with insurance only. (Crockford G.N. 1982). The economists Gaunt L.D. (1998) and Rejda G.E. (2003) use the following elements for guaranteeing the financial stability of commercial activities in risk management: risk assessment; risk control; risk financing. Technical steps of risk financing: risk retention, risk transfer, insurance. The choice of administration and the nature of risk (fundamental – systematic; personal) of the insurance systems determines the nature of insurance: Private insurance; State insurance – public secto; Combined insurance – private and public sectors. The combined model system of administrative insurance is the optimum choice for fundamental (systematic) risk management from both a theoretical and practical point of view and the private insurance for personal risk management. The elements describing the administration system of insurance:
1. insurance coverage assessment;
2. insurance rate calculation and insurance premium determination;
3. loss identification and compensation.

Keywords: Managing system, fundamental risk, private risk
1. Introduction


In the European Union, cereal crop risk management is effected on two levels: governmental emergency funds (ad hoc) and private insurance. The experience of the EU shows that public and private partnerships are possible on both levels and in different proportions as far as compensated losses are concerned. Procedures and requirements for the formation of emergency funds are set and defined on the European Union level. (Collin, Hanson, 2000; "Agricultural Insurance Schemes", 2006; Risk Management Tools for EU Agriculture..., 2001, Meuwissen, Huirne, Hardaker, et.al., 1999)

Fundamental and personal risk management system is based on administration system of insurance service. The methods for calculating coverage; premiums and compensation by using average crop indicators in Latvias agricultural, when a systematic database of statistics of crop loss is not available.

2. Insurance as a financial risk management tool

Insurance service can be described historically, in chronological order: approximately every fifty years a new insurance service product is created as a response to social and economic problems. ("The Chartered Insurance Institute, 1997). For example, in the late 6th century and early 7th century – in the period when large European countries faced risks related to the sea – the marine risk insurance service was formed. The first official policy of this kind was issued in England on 20th September 1547. (Purvis, Mc Call , Schroder , 1996) After the Great Fire of London in 1666, the first insurance company "Fire Office" (1680), later renamed as "Phoenix", started offering fire risk insurance policies. One of the latest 21st century insurance cover (the benifits available under this policy) is „Your Identity data protection” insurance. Until the end of the 18th century, mutual insurance companies were common to the insurance market. After the Industrial Revolution, insurance joint stock companies started to appear. (Aizsilnieks, 1968) Skipper, (1998) classify life and non-life insurance sectors into types
and pointed out, that insurance is one of the risk management system finance tools. In general, risk is related to uncertainty, which refers to occurrence of an event or lack of knowledge of the outcome of the event, with the focus of the risk’s link to unfavourable events. Uncertainty and fear get transferred into actual risk, which can result in moral and material loss. (Rejda, 2003)

Not all risks can be insured. Insurable risks should comply with specific requirements and classification. In a number of monographs, authors classify risks according to final results and depending on their causes, effects or processes and places, levels, frequencies and other categories. Classifying risks according to final results, risks are subdivided into two groups in the general risk classification system: pure (personal risks) and speculative risks. The need for differentiating between pure and speculative risks is primarily due to the fact that, as a rule, only pure risks, but not speculative risks can be insured. (Rejda, 2003; Harrington, Niehaus, 2003; Skipper, 1998; Pettere, Voronova, 2004; Graudina, 2004)

A fundamental (systematic) risk is a difficult-to-insure risk, whose frequency cannot be forecast, but almost the entire world population is subject to its influence. Such risks include global economic depression, hurricanes affecting the Western coast of America, floods in Europe, earthquakes in the Middle and Far East and possible loss of cereal crop yield due to natural risks. (Harrington, 2003)

According to insurance theory, agricultural risks typical of climatic conditions fundamental-systematic risks are ranged in the group of risk between pure and speculative risks, which are difficult to insure.

The insured risks have a double nature: peril – an object of insurance, hazard – insured risks. (Rejda, 2003) Illustrating peril and hazard in cereal crop insurance, we assume that possible rye crop is "peril" (an object of insurance), which is characterized by "hazard": wind, hail, drought, rainfall, etc.

Apart from the mentioned factors, risk in insurance is also characterized by the subjective feelings of the insurance policy holder: moral hazard, market information asymmetries (adverse selection). (Harrington, Niehaus, 2003; Skipper, 1998).

Fayol, 1949, a French theoretician of management, believes that the management of each company has at least six typical management functions, one of those being the security function (property and personal security). In the 1950-s and 1960-s, risk management in all insurance markets was associated with insurance only. (Crockford, 1982) The economists Shapiro, Titman, (1985) believe that risk management object is aimed at provision of financial stability for business activities. Non-professional risk management may have an impact on the company's financial status and trigger bankruptcy. The economists Gaunt, (1998) and Rejda, (2003) use the following elements for guaranteeing the financial

3. Research hypotheses and Methodology

The choice of administration and the nature of risk (fundamental – systematic; personal) of the insurance systems determines the nature of insurance: private insurance, state insurance – public sector, combined insurance – private and public sectors. In the European Union, cereal crop risk management is effected on two levels: public/governmental – special funds compensating for loss (ad hoc payments), with average annual amount of compensations paid being EUR 904.3 mio. The risks most often compensated for are: drought, frost and flood; private insurance, where the risks most often compensated for are: hail and fire, with average total amount of compensations paid being EUR 1061.0 mio. Insurance premiums are subsidized by the State; insurance premiums are not subsidized by the State. ("Agricultural Insurance Schemes", 2006; Risk Management Tools for EU Agriculture..., 2001, Meuwissen, Huirne, Hardaker, et.al., 1999)

The combined model system of administrative insurance is the optimum choice for fundamental (systematic) risk management from both a theoretical and practical point of view and the private insurance for personal risk management.

Hypothesis: Fundamental and personal risk management system is based on administration system of insurance service. The elements describing the administration system of insurance service:

- insurance coverage assessment;
- insurance rate calculation and insurance premium determination;
- loss identification and compensation.

The author of the paper analyzes specific grain cultivation insurance risks and creates an insurance product, where the insurance object is: value of cereal crop yield products. Insurable risks (natural factor), which have an impact on cereal crop yield, are classified into three groups: drought, hot wind, excessive humidity, storms, frost, flood, earthquake, landslide; plant diseases and pests; damage caused by animals.

The research methods envisaged for solving the set tasks: in the event that statistically significant data regarding the insurance product creation process are not available, actuarial mathematics elements are applied, using the insurance premium calculation method of the US Federal Crop Insurance Corporation (FCIC):

1) The size of the insurance coverage in cereal crop insurance is calculated (Ray, 1998; Manitoba crop insurance ..., 2005):
(1) Insurance coverage = Crop_{avg} \times Price, LVL t^{-1},

where: Crop_{avg} – the average cereal crop yield in 2000 – 2004 in the country, according to categories, t ha^{-1}; Price – the assumed average cereal price LVL 66.90 t^{-1} in the country in total and according to categories; it is constant in all examples offered LVL.

2) The expected value is calculated using the following formula (Pettere, Voronova, 2004; Skipper, 1998):

\[ EV = \sum_{i=1}^{n} p_i x_i, \]

where: \( p_i \) – probability of the occurrence of event “i”; \( x_i \) – amount of losses.

In cereal crop insurance \( x_i \) – probability of any possible yield loss \( p_i \).

Probability of yield loss is determined according to the quality of available data:

- no data on yield loss is available. To determine the loss ratio, Ray, (1998) offers to use the indicators of average productivity for at least the last five years when calculating the probability of yield loss. The US Federal Crop Insurance Corporation (FCIC) used the insurance premium calculation method in 1936. This method is used in calculations of this Paper.

3) Actuary insurance premium should completely cover the potential loss (Pettere, Voronova, 2004; Skipper, 1998):

\[ P = Z, \]

where: \( P \) – insurance premium; \( Z \) – potential loss.

4) Loss arrays \( x_i \) are created separately for each category and calculated using the formula (Ray, 1998):

\[ x_i \begin{cases} \text{Actual Yield – Coverage, if } < 0 \\ 0, \text{ if } > 0 \end{cases}, \]

where: \( x_i \) – potential loss.

5) The indicators of cereal crop yield loss calculated for every unit characterising risks are used when calculating the probability of the occurrence of yield loss \( p_i \) (Ray, 1998).

\[ p_i = \frac{N_{loss}}{N}, \]
where: $N_{loss}$ – is the number of events when loss $x_i$ occurs; $N$ – is the number of units characterising insured risks in all categories.

6) To calculate the actuarial premium per hectare for Category 1, we use the criterion of statistical indicator of "expected value" –

$$(6) \quad \text{EV} = 0.024 (t \text{ ha}^{-1}) \times 66.9 (LVL \text{ t}^{-1}) \times 0.139 = 0.223 (LVL \text{ ha}^{-1})$$

Assuming that loss records are precise, we can calculate the actuary calculation using the following equation (Ray, 1998; Minisotba crop insurance..., 2005):

$$\begin{align*}
(7) & \quad \text{Average yield} (\text{ t ha}^{-1}) \times 80\% - \text{Actual yield} \times \text{Price} = \text{Compensation for loss}
\end{align*}$$

4. Results and discussion

To reduce the impact of adverse selection and moral hazard on the insurance market, we will use the classical insurance mechanism for alignment of adverse selection and moral hazard: deductible where the amount of deduction is fixed, coinsurance where a set percentage is fixed. The size of the insurance coverage in cereal crop insurance is calculated depending on the indicators of the average cereal crop yield in a year, during a period of at least five years, unless significant loss of cereal crop yield has occurred within these five years (formula 1). Insurance coverage amount for instance, if insurance coverage is 100%, borders of categories differ by LVL 99.34 ha\(^{-1}\); if insurance coverage is 90%, borders of categories differ by LVL 89.41 ha\(^{-1}\); if insurance coverage is 80%, borders of categories differ by LVL 79.41 ha\(^{-1}\). (Table 1) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005).

The statistical equation of "expected value" (formula 2), on which the insurance premium calculation is based, can be simplified according to the classical insurance theory stating that the actuary insurance premium should completely cover the potential loss (formula 3).

We will use the formula (4) for estimation of the premium, calculating insurance compensations paid (potential loss) $x_i$ and probability $p_i$, with which such losses may occur. Loss arrays $x_i$ are created separately for each category and calculated using the formula (4).

To calculate potential loss $x_i$, we calculate the average yield in the regions for the period of five years, observing the classification of the regions into categories, apply the calculated average yield to the relevant insurance coverage of 80%, 90% and 100%, observing the classification of the regions into categories. We calculate the potential average cereal crop
loss $x_i$ for insurance coverage of 80%, 90% and 100%, according to categories and create a joint base of indicators of the average dynamic cereal crop yield loss according to categories for all units characterising risks with the insurance coverage of 80%, 90%, 100% ($t\, ha^{-1}$) (Table 2) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998). The indicators of cereal crop yield loss calculated for every unit characterising risks (Table 2) are used when calculating the probability of the occurrence of yield loss $p_i$ (formula 5).

For each category we calculate the average loss from the probability of loss. To determine the average arithmetic value for the yield every year, the annual assessment of probability of loss should be made for instance: value 0.1385 is the assessment of probability where in 13.85% of cases loss occurs 0.024 $t\, ha^{-1}$.

Loss for Category 1 (the first group of households) with the average cereal crop yield of 1.68 $t\, ha^{-1}$ is 0.024 $t\, ha^{-1}$. To calculate the actuarial premium per hectare for Category 1, we use the criterion of statistical indicator of "expected value" (formula 6). It means that the actuarial premium of cereal crop yield for Category 1 with the insurance coverage of 80% is LVL 0.22 $ha^{-1}$, (see table 3) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998). For the actuarial cereal crop insurance premium according to categories with the insurance coverage of 80%, 90%, 100% calculated for three categories.

Applying the insurance coverage of 80%, 90% and 100% for the calculations of cereal crop insurance premiums, we obtain the following results: cereal crop insurance premium with the insurance coverage of 80% for Category 1 is LVL 0.233 $ha^{-1}$, and cereal crop insurance premium with the insurance coverage of 100% is LVL 2.783 $ha^{-1}$. The amount of loss according to categories varies depending on the insurance coverage and average indicators of cereal crop yield. If the insurance coverage of cereal crop of the cereal producers of this category is 90%, the actuarial cereal crop insurance premium is LVL 0.868 $ha^{-1}$ (Table 3) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudiņa, Jansons, 2006; Ray, 1998).

Pursuant to the calculated example, the most profitable insurance coverage is 90%, where the actuarial insurance premium for cereal crop is: Category 1: LVL 0.849 $ha^{-1}$; Category 2: LVL 0.868 $ha^{-1}$; Category 3: LVL 0.134 $ha^{-1}$. The dramatic differences of the calculated insurance premiums according to categories can be mainly explained by the fact that 10% of crop loss occurs much rarer in households with high cereal crop productivity than in households where the average cereal crop productivity is lower.

The most difficult task is to determine the actual loss, as there exist many factors affecting yield loss in nature that are not discussed and analysed in the present paper. Assuming that loss records are precise, we can calculate the actual calculation using the following equation (formula
7). Let us assume that the actual cereal crop yield is by 10% smaller than the average cereal crop yield in all categories with the insurance coverage of 80% is. LVL 8.69 ha\(^{-1}\)

In this case the scope of compensation for cereal crop yield loss within Category 1 is equal to LVL 8.69 ha\(^{-1}\), if insurance coverage is 80% (Table 4) (Lauku saimniecības Latvijā ..., 2001, 2002, 2004, 2005; Graudīna, Jansons, 2006; Ray, 1998).

5. Conclusions

Insurance service us a risk management can be described historically, in chronological order: approximately every fifty years a new insurance service product is created as a response to social and economic problems. Skipper,(1998) pointed out insurance us one of the risk management system finance tools. Classifying risks according to final results, risks are subdivided into two groups in the general risk classification system: pure (personal risks) and speculative risks. As a rule, only pure risks, but not speculative risks can be insured. According to insurance theory, agricultural risks typical of climatic conditions fundamental-(systematic) risks are ranged in the group of risk between pure and speculative risks, which are difficult to insure. The combined model system of administrative insurance is the optimum choice for fundamental (systematic) risk management and the private insurance for personal risk management. Fundamental and personal risk management system is based on administration system of insurance service. The elements describing the administration system of insurance service: insurance coverage assessment; insurance rate calculation and insurance premium determination; loss identification and compensation.

The system to reduce the impact of adverse selection and moral hazard on the insurance market is classical insurance mechanism deductible. Pursuant to the calculated example, the most profitable insurance coverage is 90% (deductible 10%), where the actuarial insurance premium for cereal crop is: Category 1: LVL 0.849 ha\(^{-1}\),Category 2: LVL 0.868 ha\(^{-1}\),Category 3: LVL 0.134 ha\(^{-1}\).

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Viable Systems Modeling (VSM) and the Problem of Managing Uncertainty

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Abstract:
VSM is supposed to serve as a generative scientific model to discover and analyse behavioral characteristics and synergy effects of complex adaptive systems. The aim is to make realistic predictions of how to organize an existing reality in a viable way. Successfully implemented, it contributes to use the human goal oriented energy for the formation of Team Syntegrity within a meaningful concept. In our studies on multidimensional controlling and the impact on corporate culture we attempt to theorize the available observations on digital technologies and virtual reality in a way the gained knowledge could be applied to control socio-economic systems. However, in our quest for certainty we often neglect that individually meaningful happenings can cause significant changes in rationally prepared projects. Since life is a product of random information processes not even the best VSM can avoid unforeseen coincidences that can have an inherent power to shake our world, as we experience it momentarily. Hence, VSM's ultimate goal is to evaluate the possibilities for a proactive management of uncertainty.

Keywords:
Non-linear and linear systems aspects; complementarity of regulation and process; management of uncertainty; limits of operationalism.

1. The Methodological Dilemma
The VSM concept is based on the vision of an ecological universe by viewing our planet as a living system with non-linear as well as linear aspects. Since non-linear processes require pluralistic description methods that demonstrate complementarity towards each other, the evaluation of initial conditions does not suffice to illustrate the direction of improvement or failure in an actual situation. When research is called for, the problem must first be defined. This depends on which aspects from interacting parts are most salient, and where the opposition of hard facts and soft values is inverted. VSM as a scientific model enables us to discover and analyse
behavioral characteristics and synergy effects of complex adaptive systems.

As such it contributes to use our goal oriented energy for the formation of Team Syntegrity within a meaningful concept. In this context the question arises: What is a non-linear system? Non-linearity refers to the system’s striving for equilibrium, a state of sustained stability deriving from its dynamic path. Hence *equilibrium* is a process where the dynamic path of the system leads to a reproduction in successive states of an initial equilibrium state. Here stability acts as a subspecies of change. Since each level of structure requires its own description we have to conceptualize the dual complex of questions: 1) Who and which parts are to be evaluated; 2) in which direction and in which manner policies for social or economical development should be promoted.

The VSM view is based on the recognition that economical systems are open systems with a dynamic interaction between coexisting systems, i.e. a collection of concepts where a coordinated set of rules is used to reach coherent certainty. This coherence in complexity through reciprocal constraints can only be explained in terms of an entire set of relations between the components. This led to the *Concept of Correlation*, which is based on the fact that when energy collides with matter, matter shows its particle character in form of photon clusters. At the moment of this concurrence they start to communicate and to interact. This reciprocal action is of regulatory character.

### 2. The Paradox of Mutual Dependencies

Societies as the result of interaction between inherently random elements exist under particular boundary conditions. Since living with such selective environments means confronting a combatant being partly unknown and potentially dynamic, priority must be given to processing information from it and adapting structure to it. This implies an enormous reduction of relevant data and sorting out the rest as "noise". Since survival requires cooperation it depends on learning from the environment and reflecting the gained knowledge in adaptive structural relationships. Hence nature’s tendency towards disorder can be combated by adjusting its parts to purposive ends. By using information and communication, a certain degree of order and equilibrium can be installed.

Parsons termed this evolutionary potential, resulting from the human subject/object position in a system’s dynamics, *double Contingencies*: "On the one hand, ego’s gratifications are contingent on its selection among available alternatives; on the other hand, alter’s reaction is contingent on ego’s selection". Hence a system’s codes and policy are influenced by cultural implications and differences in individual perception. Such immensely complex social systems are laced with non-
linear feedbacks. No one can predict what participants of a collective system will do or how they will react to changes. Man habitually organizes his perceptions of reality with the ability to shift from one way to another, often being unaware of these alternate constructions.

In the cybernetic context, the patterns of alienating behavior are of major interest. During the process of alienation from interaction, when an individual gets involved in unsociable solitary tasks, the task takes on a weight, affording the performer a firm sense of reality. This focus of attention appears as a state of socialized trance, where reality makes demands on its own behalf. The hypnotic effect is illustrated by the fact that an individual can simultaneously engage in other goal directed activities. To avoid the resulting instability we must concentrate on the procedures by which social systems evolve. This in particular since chaotic behavior exhibits its own interior order, built on morphic resonance, which often is neither perceptible nor measurable. Since our goal oriented concepts of imitating and changing an observed reality can never be based on an absolute truth, we are confronted with operational limits. Built on inductive con-clusions and statistical knowledge our modeling strategies are reignied by probability.

3. The Synchronicity of Regularity and Process

Hence we must admit that our dealing with reality takes place in realms between knowledge and belief. To avoid that success turns into failure we therefore must gain an understanding of living systems non-linear and linear aspects and their proactive management in a dynamic environment. This requires to reconcile living systems' inherent uncertainties and our striving for sustainable development. Nobel-Laureate Poincare initiated in 1903 the scientific change by combining the linear with the non-linear view. He stated: A very small cause which escapes our notice, determines a considerable effect that we cannot fail to see. Even when the natural laws are no secret for us we can only approximately know the initial situation.

This illustrates that small differences in initial conditions can produce great ones in the phenomena under investigation and shows the dependencies of the parts upon the whole. At one level the operations of a sub-system can be explained in terms of its constituents, at another level the constituent parts must be defined in terms of goals, operations and meaning of the whole. Yet, what if noise is not generated by the system's complexity but by the properties of the system itself? Since our way of modeling viable systems strategies suggests that every adverse situation can be analyzed as an isolated problem with a corresponding control, the question is: How does this fit in our picture of wholeness? The idea of combining living systems and regulation as complementary parts was
already latent in the late 19th century, when the French physiologist Bernard revealed the existence of an internal milieu in the living being, thus stating a clear difference between an internal and external environment.

According to Bernard, regulation's task is to install harmony, which implies the notion of balanced interrelations. This equilibrium between interacting parts together with Poincaré's discovery of the dynamics of existential interaction revealed the synchronicity of stability and instability, all of which implied to go beyond reductionism. J. G. Miller's General Theory of Living Systems conceptualizes living systems complexity as a pyramid of hierarchically ordered levels. According to his seven layer model - from the original cell up to a supra-system - each level with its own sub-systems sheds out into a more complex level. Interactions at an emergent level are initially weaker than at the preceding level, and thus more subject to the effects of natural selection. Yet newly emergent levels develop more refined control capabilities than the simpler forms at the lower level, and generate new weak levels of control above them.

4. Measurement and Meaning

Hence we have to accept dynamic as open systems' preconditioning factor which implies the complementarity of regularity and process with entropy loosing its relevance. With regard to VSM, where we deal with conceptual open systems, Miller's brilliant level proposal supplies an abstracted structure and meaning for the object under evaluation. Yet since living systems' non-linearity allows no simple predictability we have to deal with the question: What is reality? Life is an evolutionary process, where far from equilibrium open structures complicate on each level and simplify as new levels emerge, which provide more efficient dissipation of energy. In our globalizing world with an ever increasing complexity we have to find our own subjective meaning. Yet since Niels Bohr revealed the indivisibility of nature, we also have to deal with the world as a whole. This means that we deal with at least two overlapping kinds of reality: An individual's perception is unconsciously colored by its brain's survival strategy implications. Apparently nature doesn't want that we really know what we see. By building on Pauli's and Jung's principle of acausal relationships David Peat offers here his Synchronicity Principle, which implies to accept the existence of alternate realities.

New technologies like radionik, bio-resonance, or telekinesis have made it possible that convincing studies with regard to extrasensory perception could emerge. Since the Copenhagen Interpretation of Heisenberg's uncertainty confirmed that randomness is a basic feature of nature, we have to cross the complexity barrier, i.e. not to think in react-ion...
chains, but in reaction patterns. Being guided by several paradigms simultaneously we have to create an organized complexity. VSM's task is to make viable organization proposals for systems with random informational processes. Thus we have to find basic concepts of how to maintain a steady state of negentropy even though entropic changes occur. Heisenberg was the first to postulate an inherent restriction of precision in our observations and established his **Uncertainty Equation** for relationships and impulses.

He wrote: “**Science has brought us to the point where we must face the fact that we cannot have only one set of principles about how reality works. We need to allow for a number of alternate realities.**” Hence alternate forms of patterns, structures, relationships, and messages must be evaluated and built into an all-over paradigm which relieves most of the inherent uncertainty and allows for setbacks that occur. J.G. Miller is concerned with the measurement of meaning, but neither is the quantity of information important, nor is it the quantification of meaning. The important point is: what kind of meaning is involved. A system as a network of relations implies to evaluate the source and reasons of the displayed information.

Synchronicity emerges through meaning and meaning is created by setting events or experiences into a context, that the system’s latent potential and its functions become structured. While at one level we can analyze synchronicities in terms of a release of viable outcomes, at another level these patterns are a function of the system as a whole and an expression of its meaning. On one hand we deal with products and entities, on the other with adaptive scenarios like relationships, processes, and patterns. When dealing with interaction processes, we impose order on chaos that always refers to limited aspects of reality, because it is based on the observer’s subjective frame of reference.

**5. Managing Uncertainty**

According to quanten mechanics there exist unavoidable interactions between the measurement operator and the object to be evaluated. This unpredictable behavior is possible even with simple non-linear but fully deterministic systems. The recognition of this fact had to wait for scientific acceptance, as we know from Einstein's remark: **God doesn't play with dices.** Man has changed his role from an observer into a participator. This growing extent of the observer’s role implies even more to accept Heisenberg’s uncertainty principle. In recognition that doubt is inherent in our existence, second-order cyberneticians created a philosophy of constructivism with the key idea that the observer should be included in our scientific investigations. Regarding our modeling intentions this means
that our results, including statistics, are subjective, and we never work
without having an effect on the observed system.

David Peat's statement that consciousness is an epiphenomenon of
complex electro-chemical reactions rectifies G.A. Swanson’s statement: "It
is the information that controls the system". This implies that we accept
that certain "acausal" apparently un-connected events play an often
significant role in that they appear as clusters. As an expression of an
overall "integrative tendency of the universe" they are meaningful.
Synchronicity begins with the very fact of meaning and as such is
concerned with patterns or correlations between dissimilar forms,
structures, and connections made between physical processes and mental
states. Synchronicities are manifestations in mind and matter of the
unknown ground that underlies them both.

The Physicist Vince Ebert recently stated in an interview: Scientific
Thinking is a method to check guessings. At least we offer an answer: By
combining objective and subjective elements i.e. by daring the paradox,
we can use the concept of synchronicity for VSM analysis. Events have a
certain kind of meaning. If we recognize the pattern behind them we can
exclude their arbitrariness. According to Norbert Wiener a pattern is a
message. Since messages are information, patterns are meaningful
clustered information. This raises the question about relativism and
uncertainty. Relativity Theory deals with high velocities and distances on a
cosmological scale. Yet we as human beings have to deal with an earth-
bound world, where time and space play a pivotal role and rapid changes
or other aspects of experience appear as “quantum leaps”.

According to Sheldrake form and energy bear an inverse relationship
towards each other. Energy is the principle of change, but a form or
structure can only exist as long as it has a certain stability and resistance to
change. Life means to create structural energy which implies energy to be
added. In the general stream of increasing entropy, chaos and
dedifferentiation we have to find a way to constitute homeostasis. The
pattern maintained by homeostasis is the touch-stone of our identity. As
living open systems we exchange matter and energy with our environment,
and it is our identity that marks the personal borderlines by filtering the
incoming and outgoing messages. Thus our identity reveals an individually
framed pattern which appears as a message and tends to maintain, even to
increase its structures.

6. Complementarity and Process

Since in our digital world the acceleration of messages and processes
create for every event a simulation of an infinite trajectory, the quest for
meaning and interpretation, previously characteristic for our species,
becomes more and more obsolete. Beyond the gravitational effect which
keeps bodies in orbit, the atoms of meaning get lost, and hermeneutic empirism is replaced by a digitalized Jurassic Park. The emerging popularity of non-linear communication quickly proliferating our social existence, has a dramatic impact on our cultures. Though a certain continuity can be observed in developmental processes as a kind of stored memory, which has been built up by the effects of past developments, we know from quantum physics that the Uncertainty Principle rules even the smallest not measurable particles of life.

Hence uncertainty as a ground building factor has to be included in our modeling projects. The problem is that even quantum physicists, who can predict experimental results to an accuracy of several decimal points, have to admit that no picture of reality can emerge from their equations. When Heisenberg published in 1967 his unified field theory he ended at the boundary between science and metascience. Science would here be associated with possibility and meta-science with probability. Yet both mean the same.

If according to the antirealistic picture of the Copenhagen Interpretation everything is awash in a sea of possibilities, how can we then build a strategy for our aims that serve a peaceful survival? In search for a description of the atomic phenomena Heisenberg formed his positivistic principle, i.e. that only observable facts should be taken into consideration. Together with Niels Bohr he elaborated a unified theory, where all observable elementary particles and their changing processes could become recorded by using the maintenance theorems which expressed the symmetry characteristics of nature's laws. Hence it is only when we discover an underlying pattern that we can find measurement criteria for probabilistic systems.

By using these insights as an import of chaos control in combination with a functional sensitivity to initial conditions we could create a relevant concept. The lesson is that communication takes priority over control, yet control only works when a system is perfectly adapted to a stable environment. In a dynamic environment, however, where effects can be disproportional to their causes even minor bits of new information can have systemwide effects. In business-life the stress is on creating flexibility through decisions that result in low-cost limited exposure to losses on the downside and in profit opportunities on the upside. Diversification strategies which result in symmetric pay-offs, reduce both, upside profit and downside losses.

Therefore, we are concerned with flexibility strategies with asymmetric payoffs, i.e. that we need a Process Work Theory. In order to understand the Januslike duality of life we must accept that our being is summed up in one of the most fundamental tenets of quantum theory: The Principle of Complementarity, which represents a fundamental tenet for
viable strategies. When Bohr realized that the consequences of Heisenberg's uncertainty exceeded by far the application on measurements in the atomic realm, he generalized the relations between perceptual and interpretational modes into more fundamental dichotomies between subject and object or analysis and application.

7. Chaos Control in the Mind Age

The resulting concept of complementarity integrated consciousness as an important re-search aspect, stating that each way of describing being as a wave or as a particle complements the other, and that a whole picture emerges only from the package. Complementarity is not only a differential balance between our appearance but also of the way our actions are pursued, a Complementarity between Regularity and Process. While neither state is complete in itself and both are necessary to get a complete picture of reality, each complementary part supplies an information that the other lacks.

During his work with C.G. Jung Pauli realized that the mind results from a dynamic equilibrium of dualities. Together they produced a diagram showing how synchronicity balances causality. By introducing the value of meaning Pauli integrated the objective approach of physics, i.e. constant connection through effect, with subjective values like contingency or meaning. Since complex phenomena proved to be more than the sum of properties of isolated causal chains Van Bertalanffy developed his matrix of General Systems Theory, which delivered profound insights in the patterns of social behavior. To shape the supreme goals and values in a society of radical indeterminacy Joslyn and Turchin suggested The Concept of Cybernetic Immortality, where they addressed ultimate values as the central problem of our society.

The transfer of organizational knowledge, gained in centuries, into structured techno-spheres and virtual communities fostered the advent of the simulation of complex non-linear dynamics via computerized technologies. The emancipation of signs, codes or symbols, released from their archaic meaning, initiated an exchange among themselves exclusively, unless we can read them. Subsequently, "the real" is presented as an effect of the code or system, and we begin to live in a radically relativistic imaginary universe. Survival in such an abstract scenario is only possible if the experiences belonging to different spheres of reality are integrated by incorporation in the same overarching universe of meaning, where parallel visions in space and time appear synchronized.

In our attempt to control socio-economic systems by way of computer-mediated processes we propose to use Miller's System's Level Method and Pauli's Exclusion Principle, which give us in our virtual world of technoscience possibilities to disembark its utopian character and
ground it in adequate social contexts. The 20th century consumer society has prepared the climate for a structural evolution never seen before. Urbanization, industrialization, secularization and excessive supply of information have led to highly individualistic cultures, characterized by the dual trademarks of narcissism: masterful and bounded on the outside, yet empty underneath.

Yet if small changes have strong effects, it should be possible to control and stabilize the chaotic regime by appropriately inserting perturbations. In natural evolution, the leaps toward higher levels of complexity are associated with improved abilities to generate and process information. Information measures the decline in an observer’s uncertainty. The more dynamic is in an observer’s environment, the more uncertainty is inherent. Since the number of possibilities in dynamic environments is great, the incoming information must be encoded contextually. This can be achieved by logistic equations with the goal to stabilize the dynamics on periodic trajectories.

Today computers can solve almost any dynamical set of equations by numerical integration. However, they tend to become substitutes for thought and scientific rigor. Digital worlds offer the illusion of total control, because they replace the human time-space oriented reality. Codes constitute primary organizing principles and simulation enhances a dramatical "end of the social". The navigating individual communicates with a projection of his own self. These Second Selfs navigate in an electronic hyper-space where time and space have no meaning. These actions are dramatically artifactual, liberated from the constraints of the real world. While hyperspace provides the means to tunnel through space and time, the navigator’s expectations have to cope with very real limitations, set by a machine that represents very unreal his own self.

The main problem is that the computer’s piece of art is preprogrammed by somebody else, and learning is restricted to the experience of an artificial program. Hence virtuality can easily lead into a one-way road, which might be the only exit in a world where nothing is left but the game with a machinelike self. However, we can use our freedom of choice. Niels Bohr said: *In our search for harmony of life we should never forget that in the drama of existence we are both participants and observers.*

8. Conclusion

In order to include uncertainty in our VSM modeling concepts, we have to consider the following aspects:

- Principles of existence and underlying patterns must be understood in order to recognize interdependencies and interaction relations. This requires to create filter functions.
Communicate with the involved organizations or parties and make clear that they are participants in a survival strategy for their own purposes.

Realize together with them what results should and could be achieved and where and when the barriers to predictability emerge.

The Viability Concept gives opportunities, to accept uncertainty as an evolut-ionary imperative and therefore has to be included in management concepts.

Any form of control must be executed in compatibility with Miller's Systems Pyramide which clearly demonstrates the hierarchical levels of action perform-ance, thus excluding unrealistic commands of single parts of the system.

Take into account the systems limitations of effectiveness as well as its natural learning and adaptation capabilities.

As suggested in Bill Powers Perceptional Control Theory (PCT) human action should use control only as an essential variable, what forces us to look for enough alternatives to reach a given goal.

Managing uncertainty is always a kind of using Game Theory, where you must be prepared to deal with pirates even if you are not sailing at Somalia's coast.

Hence consider that a) every perceptual signal is subjective and very limited in time and space, and b) that there exists an unknown "wholeness" beyond our expectations and knowledge.

All of this means: If we want to avoid failure, we have to create a collaborative working environment with enough alternatives for driving, retardation or even braking oppo-unities. By calculating that the peak of the mountain is not always the greatest possible success of you are not like Messmer under the call of the Mount Everest.

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Experiences from Teaching the Viable System Model

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Abstract:
The Viable System Model (VSM) (Beer, 1979; 1981; 1985) is the only Organisational Cybernetics model that has an extended variety of applications and has not yet been falsified. The VSM is being taught for the past three years in the “Systems Engineering and Management” postgraduate programme, as part of the “Systems Engineering Principles” course. The experience from teaching the VSM so far has brought to surface certain theoretical issues, which students find difficult to grasp and deal with and which are reflected both in class and in the term projects. Despite the difficulties of the students in grasping the VSM and its related concepts, they seem to acknowledge its usefulness and immediate applicability. Apart from their positive feedback in class, this is also reflected in the increasing number of students who use the VSM in their postgraduate theses.

Keywords:
Viable System Model; Education; Teaching; Management.

1. Introduction

The Viable System Model (VSM) (Beer, 1979; 1981; 1985) is the only organisational cybernetics model that has an extended variety of applications and has not yet been falsified. For the past three years, the VSM is being taught in the first-semester core course Systems Engineering Principles (SEP) of the Systems Engineering and Management (SEM, http://sem.eng.duth.gr/) postgraduate programme.

In this work, the VSM teaching curriculum in the postgraduate programme is presented, as well as the issues that were brought to surface from the teaching experience so far. Finally, some possible solutions are given to improve the teaching method. The paper assumes that the reader is familiar with the viable system model as a tool to model an organisation's structure.

2. VSM teaching courses and methods

Even thought it is not as popular as other management models, the VSM has been taught for years in the academic context, both abroad, for
example at the Institute of Management of the St. Gallen university (Schwaninger, 2001), the Liverpool John Moores University (Adams et al. 1993) and the Open University of UK (www.open.ac.uk), but also in Greece at the SEM Program analysed here, and the University of Pireaus. Moreover, the VSM has been taught at professional education programmes or seminars, such as the Certified Systemic Analyst Professional (CSAP) (http://www.hsss.gr/csap/) joint program of the University of Pireaus and the HSSS and the programmes offered in the UK by the consulting company Syncho Ltd. (www.syncho.com).

The usefulness and value of the VSM for both undergraduate and postgraduate students is testified by Adams et al. (1993). They found out that even inexperienced users of the VSM usually provided three to ten times more diagnostic points than those provided by international management consultants on the same subjects.

Regarding the VSM teaching methods, the Viplan method and learning system (Espejo et al., 1999) developed by Syncho Ltd. is a concise teaching tool to understand the VSM and to use it to model organisations. Moreover, it is supported by the Viplan Software which is an interactive self-learning tool. The Viplan logic was followed to a certain extent by the SEP course as well.

3. The SEM Program and SEP course

3.1 The SEM Program

The SEM program is offered jointly by the Faculty of Engineering of the Democritus University of Thrace in Xanthi (Departments of Civil, Electrical, Environmental and Industrial Engineering) and the University of Macedonia in Thessaloniki (Department of Business Management & Administration). Each year the Program accepts up to thirty (30) students holding undergraduate degrees in engineering, science or economics. For the acquisition of the Degree, a student must complete four intensive background (harmonization) courses (Economics; Law; Management; and Systems Theory), seven core courses and four courses in one of three speciality areas (Information and Communication Systems Management; Infrastructure Systems Management; and Energy, Industrial and Environmental Systems Management). Each course corresponds to 39 lecture hours. The duration of the studies ranges from a minimum of 18 to a maximum of 30 months. About one third of the students are in full employment in various cities in Greece.
3.2 The SEP course

The *Systems Engineering Principles* is a first-semester core course (39 lecture hours) which is organised in two parts. The first part introduces the student to basic system concepts and elaborates the *Systems Analysis* method. Some of the concepts that are presented are: systems approach; systemic problem; criteria vs. constraints; performance indicators; hierarchy of objectives vs. hierarchy of systems; modelling and black-boxes; recognition of hyper-, sub-, and parallel systems; problem boundaries, breadth and depth of the analysis; feedback; soft/hard, open/closed, dynamic/static systems; structure; state; emergence; evolution; stability, stress and crisis. All these are presented through specific problems and case studies, thoroughly discussed in the classroom; there is no use of the computer. The second part, which is the focus of this paper, introduces the VSM and is analysed in the next paragraph.

4. The VSM curriculum

4.1 VSM syllabus and teaching material

The second part of the SEP course focuses on the VSM. The topics that it covers are:

a) *Introduction to Cybernetics*: First the origins of cybernetics are traced to the thought of Plato (as presented in “The Republic”) and its subject matter is defined as the science of communication and control. Certain basic characteristics and advantages of cybernetics are then presented, such as its focus on the relationships between systemic elements and its interdisciplinary character and descriptive power in a variety of system types. Lastly, a number of ideas and notions central to cybernetics are briefly presented, such as control, communication, organisation and hierarchy.

b) *Management Cybernetics*: The first attempts to apply the cybernetic laws and principles to the management of organisations are presented here. These are related to the machine metaphor and the input-transformation-output schema. The basic disadvantages of management cybernetics are then related to its hard systems principles.

c) *Organisational Cybernetics*: Here the VSM is introduced as the main organisational cybernetics model. Its difference from management cybernetics is emphasized, as it is based on the human/living organisation, rather than the machine metaphor. Its advantages and differences over typical organisation charts are also stressed. Being based on the science of cybernetics, it has a wide applicability on a large variety of organisations, regardless of type and size. It can be
used either as a diagnostic tool of existing organisations, or a design tool for new organisations.

d) Preliminary VSM concepts: Before getting into the full VSM structure, a number of basic cybernetic concepts are analysed, so that students are better prepared to understand the complete logic behind the model. These concepts are:

i. variety: the measure of complexity of a system;

ii. the law of requisite variety (Ashby, 1956): describes the control relations between systems;

iii. viability: it has the meaning of maintaining a system’s existence and fulfilling its purpose, in the VSM context;

iv. operation - meta-system – environment: the basic macro-components of the VSM whose interactions need to be managed in order to maintain viability;

v. variety engineering: its purpose is to balance the differences of variety among the basic VSM elements, with the use of appropriate variety attenuators and amplifiers.

e) VSM Structure: The full VSM structure is analysed, by successively presenting Systems 1 to 5. For each system the main purpose, functions and relations with other systems are explained. Moreover, examples of real-life organizational functions and units are given that typically perform the functions of each system. The VSM presentation ends with the explanation of its recursive structure.

f) VSM Diagnosis: Having described the VSM structure, the basic steps in making a VSM diagnosis of an existing organisation are presented, based on the diagnostic method of Espejo (1989). These include: a) the proper identification of the operational systems or “primary activities” in the organisation under study (purpose clarification, hierarchical structuring and boundaries), b) the mapping of the revenant to the VSM functions of the organisation, c) the identification of problems which may threaten the viability of the organisation (diagnostic points). For each function, examples of typical viability problems are given. The teaching material includes a set of slides presented in the class and complementary reading material (books, journal papers and websites). This material is available to students in electronic format through the Democritus University of Thrace e-learning platform “e-Class” (eclass.duth.gr).

4.2 Term Project

As part of the course requirements, students are asked to submit a term project (by groups of two). Projects, similar to those presented in class, are chosen by the students (a suggestive list is supplied by the instructors); if
they agree, their work is discussed in the class. They are encouraged to choose a project from their work environment and, in any case, something that they understand. There is a possibility of preliminary submission for comments by the instructors.

The project is organized in two parts following the structure of the course: the first part focuses on VSM, and the second on Systems Analysis. The purpose of the first part is to deepen the understanding of the VSM, by implementing a simple VSM diagnosis to an organization they are familiar with. This way, students may witness the usefulness of the VSM, as it provides them with a new perspective on their own work environment and its problems. Specifically, the students have to:

a) identify the *hierarchical (recursive) structure* of their organisation
b) choose and identify one *system-in-focus*
c) describe two *primary activities* (*S1*)
d) describe for each *metasystemic element* (*S2-S5*): i) functions, ii) persons/units responsible, iii) communications with other elements, iv) an example of a crisis it can solve, and v) which element would be charged with its functions if it was missing,
e) list the *performance indicators* used by the control function (*S3*),
f) list the *environmental elements* interacting with the intelligence function (*S4*).

Apart from giving their responses in writing, students have to graphically illustrate the hierarchy of their organization and the VSM of their system-in-focus, using the diagrams that are shown in Figure 1 a) and b) respectively.

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**Figure 1.** Diagrams used in the term project
Another goal of the term project is to bind the two parts of the course (basic system concepts/Systems Analysis and VSM). This is attained by:

a) asking students to first draw a systems input-output diagram that shows the technological activities (i.e. all the processes that are necessary for the fulfillment of the system’s purpose), and then continue in identifying the primary activities (and in extent the boundaries of their system-in-focus). This follows the logic of Espejo (1989).

b) Asking students to define and solve a problem that their organization is facing using the Systems Analysis methodology. However, they also have to identify which parts of the VSM are (or should be) participating in each phase of the methodology. For example, the identification of possible problem solutions can be performed by System 4, the final choice of the solution can be performed by System 5, and its application by Systems 1 to 3.

Twenty-one term projects have been submitted so far, referring to organizations from sectors ranging from heavy industry, construction and manufacturing to consulting and public services.

4.3 Student Evaluation

The student evaluation system has evolved as follows over the years:
- class participation: 10%
- term project: 20% to 80% depending on the project complexity and set upon project assignment;
- final written and oral exam: the remaining %.

The questions of the oral exam refer to the term projects, while those of the written exams refer to a different organization, but are similar to those of the term project.

5. Teaching problems

The experience from teaching the VSM so far has brought to surface certain theoretical issues, which students find difficult to grasp and deal with, as well as some problems that relate to the teaching of the subject, which are reflected both in class and in the term projects.

5.1 VSM theory

As regards the VSM theory, students in general seem to be uneasy in using system concepts. A questionnaire survey which was conducted over the past two years showed that new students had little or no previous knowledge, not only of VSM related concepts (e.g. cybernetics, variety, control), but also of general systems theory concepts. This was even the
case for students with engineering undergraduate background, who are expected to have been exposed to hard system concepts. This may be attributed to a general lack of systems theory education in universities, both in Greece and abroad (Sterling, 2003). System concepts (e.g. input-output, feedback) are mainly taught in engineering and information technology courses, however these are usually confined within the boundaries of technical courses and their use is not generalized to form a common theoretical and methodological framework, or even an alternative worldview. This deficiency is covered in the SEP course by introducing the systems approach early in the lectures, as it is regarded a prerequisite for understanding both the Systems Analysis method and the VSM.

Another problem, relating to the previous one, is the difficulty students seem to have with the use of the VSM as a systemic model. VSM is not a series of good practices, that “should” be followed, or a group of physical “laws” that govern every organisation system. As a systemic model, VSM is rather a representation of those aspects of organizations that relate to their viability; as such it should be used to the extent that it is useful to the researcher or practitioner. The previous reductionist or “analytical” education of students seems to hinder this view.

In particular, since VSM is a cybernetic model it focuses on control, hence on information and function. Moreover, VSM differentiates between those elements that “do the job” (operations) and those who control it (Metasystem), i.e. “serve” it. However, there is no implication of subordination between these two and what is more the organisational hierarchy is formed around the former. This point is also elusive to students, as they are usually “trapped” in the logic of the Organisation Chart, where hierarchy means subordination and there is a complete absence of function. Thus, students, both in class and in their term projects, attempt to structure the hierarchical structure of their organisations (i.e. the recursive levels) using only parts of the organisation chart. Moreover, they tend to place parts of the Metasystem (e.g. General Manager) in higher recursive levels than they actually belong, since they feel management should be “up there” giving orders.

What is more, they find it difficult to differentiate between the title of an organisational unit, as shown in the organisation chart, and the actual function(s) it performs. More than often, job titles or even job descriptions do not accurately correspond to the set of responsibilities and tasks a person or a unit actually do in an organisation, which is the focus of the VSM analysis. They also find it difficult to see that an organisational unit (e.g. general director) may do more than one functions (parts of S3 and S4) at the same time.
5.2 Term project

As regards the term project, the different type of organizations that students chose to study, brought to surface the significant difference that exists between technical or industrial organizations and knowledge organizations. Identifying technological activities (and subsequently primary activities, S1) is relatively straightforward in an organization with a technical subject, since it is likely that the organization is already structured around technical processes. For example, a factory is likely to have departments or other organisational groupings linked to the various production stages, e.g. raw material processing, assembly, finishing, packaging and shipping. In other words, these organizations have a more “hard” (in the systemic sense) nature and their transformations are easy to identify, by following the relevant material or energy flows. This is not the case in knowledge organizations where there is no product to follow, in the above sense, but instead their transformations usually involve intangible information, which can have different interpretations from different groups of people. This characteristic often makes it very difficult to identify primary activities in such an organization (Malik, 1993), as there is a number of different meaningful alternatives to group the relevant operations. Thus, the students groups who chose a knowledge organization (e.g. consulting and engineering firms) as their topic had a greater difficulty in structuring its VSM, as opposed to those with industrial organizations.

Another problem relates to the form of the project questions and the expected answers. The project questions were phrased so that students are expected to answer in a narrative/descriptive manner. For example, the question is “Describe the function and responsible unit/person for the S3 functions” and they might answer “...the general director performs the S3 function of budgeting”. This creates two problems:

1. students tend to repeat parts of the theory, which do not relate to their organisation, or reflect their comprehension of the relevant concept (e.g. “S4 scans the continuously changing environment...”).
2. some students refer to the organisation units first, and then to the corresponding VSM functions they perform (e.g. “...the general director (S3)”), while others do the opposite (e.g. “...the S3 (general director)”). This creates confusion both to the lecturer and themselves.

These problems are dealt with the response table discussed in the next paragraph.
6. Improvement possibilities

First of all, regarding the term project, the use of minimum standards should be used in the selection of subject organisations, in order to exclude organisations that could be inappropriate or difficult for the completion of the project. For example these standards could include: the size and complexity of the organisation (e.g. recursion levels, geographical spread), the accessibility to data (website, interviews) and the geographical region (e.g. narrowed to Greece or Thrace).

Moreover, a differentiation in the grading of the project could be used between industrial and knowledge organisation, in order to level off the differences in difficulties between the two types. Organisation types could be graded according to their difficulty level (e.g. Industrial=1, Consulting=1.5), which would accordingly affect the grading of the project.

Concerning the response issue of the term project, a possible solution would be to use a pre-determined response table (Table 1) that groups all the questions and answers, and departs from the narrative style used so far. This way the student is better guided to give only the relevant answers. The narrative/descriptive style could still be used at the end of the project in order to describe some sum up the VSM diagnosis.

**Table 1.** Example of response table. This table refers to System 2. Similar tables could be made for each VSM element

<table>
<thead>
<tr>
<th>VSM element</th>
<th>Relevant Functions</th>
<th>Responsible(s) person or units of current organisation (e.g. from organisation chart)</th>
<th>Interaction with other VSM elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant</td>
<td>Protocol</td>
<td>1. Secretary</td>
<td>...</td>
</tr>
<tr>
<td></td>
<td>Keeping</td>
<td>2. ...</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Scheduling</td>
<td>Human Resources Manager</td>
<td>Department Heads (S1)</td>
</tr>
<tr>
<td></td>
<td>of staff holidays</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Production Schedule</td>
<td>1. Production Department Manager</td>
<td>Production Manager (S3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A final improvement point could be to expand the focus of the theory and the term project to **variety analysis**. By performing a variety analysis, even in a qualitative from (Malik, 1993) students would be able to see how the different parts of the VSM come into action in order to balance the variety that an organisation has to handle and maintain its viability. This
way the function of each VSM element would also be clarified. However, the VSM as a teaching subject currently constitutes only part of a course, and this expansion (or deepening) might require a whole postgraduate course dedicated to it.

7. Conclusions

Despite the difficulties of the students in grasping the VSM and its related concepts, they seem to acknowledge its usefulness and immediate applicability. Apart from their positive feedback in class, this is also reflected in the increasing number of students who use the VSM in their postgraduate theses. Another positive point is that even after the completion of the SEP course, students seem to remember the VSM language and use it in other courses as well, in cases where organisational or complexity issues arise. It thus seems that a common organisational language is forming among them, or in other words, they develop a shared, systemic mental model. It is hoped that as the VSM matures as a teaching subject, it will be more effective in the transmission of the relevant concepts and it will even expand to cover more topics of the theory.

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**Topic:**

Human Resource Management

- Human resource involvement, job analysis and their impact on firm performance
  
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- The gap between the existing and the ideal human resource management (HRM) system: it’s impact on the performance of Greek enterprises
  
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Renewal of skills in response to the crisis: the proliferation of research on adult skills

Anastasios Bisopoulos
Human resource involvement, the job analysis practice and their relation with firm performance

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Abstract:
A great deal of debate exists regarding the relationship between human resource practices and firm performance. The purpose of this paper is to examine the relationship between human resource involvement in firm’s strategic planning, job analysis and their impact on firm performance. As Noe, Hollenbeck, Gerhart and Wright (2006, p. 145) state “job analysis is such an important activity … that refers to the fact that almost every human resource management program requires some type of information that is gleaned from job analysis”. In this study, the ten most commonly used HR practices, which compose a standard job analysis process, (in detail, job facilities, job climate, career opportunities, training and development, job communication, job security, job satisfaction, job design, job requirements and rewards) are incorporated in the proposed research model. The aim of this study is to propose a model for gathering job-related data, through the job analysis process, and to examine its usefulness in measuring the affect of these factors on firm performance.

Keywords:  
Human resources management practices; job analysis; human resource involvement; firm performance

1. Introduction
Over the past decades, several researchers have examined the relationship between human resource management practices and organizational performance (Dess and Robinson 1984; Delaney and Huselid 1996; Guest
1997; Bjorkman and Xiucjeng 2002; Gelade and Ivery 2003; Sels, De Winne, Delmotte, Faems and Forrier 2006). As Mayo (2001, p. 31) points, “people are a unique type of capital, they loan their human capital, their individual capability and commitment and their personal knowledge and experience to the firm”, adding, thus, value to themselves and, at the same time, affecting firm’s performance. Further, Becker, Huselid and Ulrich (2001) state that employees may become a valuable strategic ‘asset’ for the firm, which, in turn, may increase firm’s competitive advantage. According to Pf effer (1994), firms are aware of the potential of their employees to become a source of possible competitive advantage. Wright, Gardner and Moynihan (2003) go one step further saying that the improvement of firm’s competitive advantage through its employees needs cautious attention to the human resource practices that utilize these ‘assets’.

Boxall and Purcell (2003) argue that the term human resource management, in a broader sense, refers to the firm’s selection of policies, practices and structures, which are adopted in order to manage its employees. On the other hand, human resource management, in a strategic perspective, refers to every firm’s individually designed mix of human resource practices, which are followed in order to improve its effectiveness and performance (Boselie, Dietz and Boon 2005). Furthermore, Wright and McMahan (1992, p. 298) described the term ‘strategic human resource management’ as “the pattern of planned human resource deployments and activities intended to enable the firm to achieve its goals”. Their description consists of four basic factors: i) the term ‘human resources’ refers to firm’s employees as a source of competitive advantage, ii) the term ‘activities’ refers to human resource policies and practices, iii) the terms ‘pattern’ and ‘plan’ refer to the goal of firm’s strategy and iv) the term ‘goal achievement’ describes firm’s major goal, which is the maximization of firm’s performance (Wright 1998).

Hornsby and Kuratko (2003) believe that human resource management is a large firm phenomenon. Various researchers imply that small firms make less use of human resource practices than larger firms because of lack of time, financial resources and the absence of human resource experts (Bayo-Moriones and Merino-Diaz de Cerio 2001; De Kok and Uhlander 2001; De Kok, Uhlaner and Thurik 2002).

Job analysis is a fundamental part of any organization’s human resource function. According to Doron and Marco (1999), the term job analysis refers to a technique for the exposure and systematic collection of significant and detailed job-related information. Various researches (Cascio 1998; Bowin and Harvey 2001; Siddique 2004) have examined the relationship between job analysis practice and firm performance and found evidences supporting the existence of a positive relation between them.
Additionally, some researchers (Wright, McMahan, McCormick and Sherman 1998; Siddique 2004) suggest that the organizational human resource involvement in human resource practices may affect firm performance.

The main objective of the present research is to examine the impact of job analysis, a human resource practice, on firm’s performance (financial and non-financial) and more specifically, to explore the relationship between human resource involvement, job analysis and firm’s performance.

This paper is organised as follows. In section 2, a theoretical framework and the research hypotheses are presented. Section 3 provides the concluding remarks, research limitations as well as directions for future research.

2. Theoretical Framework and Hypotheses

2.1 The relationship between job analysis and firm performance.

There is a great deal of research focusing on the impact of strategic human resource management practice on firm performance (Huselid 1995; Huselid, Jackson and Schuler 1997; Bjorkman and Xiucjeng 2002). Job analysis is an important human resource research topic (Dessler, Cole and Sutherland 1999; Gatewood and Field 1994). McEntire, Dailey, Osburn and Mumford (2006) argue that job analysis is an important strategic human resource management practice that assists firms to have a better insight of the tasks that must be performed and the employees that will complete them. As Gatewood and Field (1994) state, job analysis can be viewed as a systematic process for collecting information on work-related aspects of a job. This strategic human resource practice provides organizations with important information that will aid human resource managers to improve their decision making (Chang and Kleiner 2002) and enhance organizational performance (Sherman, Bohlander and Snell 1998). Moreover, a strategic human resource practice is dealing with the conduciveness of human resources management to firm performance by connecting human resource practices to business objectives (Wright, Gardner, Moynihan and Allen 2005). Additionally, Brannick and Levine (2002) pointed out that the term job analysis incorporates all the activities that are directed toward collecting and gathering information regarding jobs’ needed skills, abilities, knowledge and performance. In this way, job analysis practice constitutes the basis for resolving virtually human resource problems (Brannick and Levine 2002).

In this study, the job analysis practice is decomposed into ten human resource practices. The examined practices, gathered from various studies,
are: job security (Guest, Michie, Conway and Sheehan 2003; van Veldhoven 2005), job communication (Guest et al. 2003), job satisfaction (Green, Wu, Whitten and Medlin 2006; Bowling 2007), job facilities (Sims, Szilagyi and Keller 1976), job design (Guest 1997; Guest et al. 2003), job training (Guest 1997; Guest et al. 2003) and development (Theranou 1997; Jacobs and Washington 2003), career opportunities (Feldman and Bolino 2000; van Veldhoven 2005), job requirements (Ellström 1997), rewards (Guest 1997; van Vergchel, de Jonge, Bakker and Schaufeli 2002) and job climate (van Veldhoven 2005; Gelade and Ivery 2003; Noe, et al. 2006).

- Job security can be defined as “the perceived stability and continuance of one’s job as one knows it” (Probst 2003, p.452). Guest et al. (2003) imply that this human resource practice is related to firm performance. In this study, job security attributes, like job continuity, interorganizational promotions, redundant personnel and vacant jobs, are examined.

- Job communication can be described as “the communication transactions between individuals and/or groups at various levels and in different areas of specialization that are intended to design and redesign organizations, to implement designs and to coordinate day-to-day activities” (Frank and Brownell 1989, p.6). According to Smidts, Pruyn and van Riel (2001), employee communication is a multidimensional factor that incorporates various aspects of communication. This study adopts the “two-way” job communication, as suggested by Guest et al. (2003).

- Job satisfaction can be defined as “the magnitude to which an employee has a pleasurable or positive feeling about his job and job environment” (Locke 1976, p. 1300; Weiss 2002). According to Judge, Thoresen, Bono and Patton (2001), organizational performance is composed of employee performance, which, in turn, is related to employee’s attitude and job satisfaction. In this study, job satisfaction items, such as job environment, job promotion, workload and salary, are examined.

- Job facilities can be defined as the equipments every employee has on his disposal that can be used to assist him in accomplishing his job. As Sims et al. (1976) imply, the usage of equipments, as well as the satisfaction from equipment usage, are two of the main dimensions of job analysis. In this study, both dimensions (equipment usage and usage satisfaction) are examined.
Job design can be defined as the procedure that integrates work tasks, functions, as well as the qualifications required (skills, knowledge, abilities) for each job, in a way that meets the needs of employees and the organizations (Noe et al. 2006). According to Noe et al. (2006), there is a strong correlation between job analysis and job design. This study is focused on items like social interaction (teamwork) and capabilities usage.

Job training can be defined as “a short-term learning intervention. It is intended to build on individual knowledge, skills, and attitudes to meet present or future work requirements” (Rothwell and Sredl 2000, p. 9). Also, Jacobs and Washighton (2003, p. 344) define employee development as “an integrated set of programs, provided over a period of time, to help assure that all employees have the competence necessary to perform to their fullest potential in support of the organization’s goals”. According to Mayson and Barrett (2006), employee training is an important human resource management topic. Several studies (Bartel 1994; Oakes, Ferris, Martocchio, Buckley and Broach 2001; Jacobs and Washighton 2003) suggest that there is a positive relation between training and organizational performance. Further, McEntire et al. (2006) state that training is a part of job analysis practice. In this study, both job training and development items, such as job rotation, off-the-job and on-the-job training programs, are examined.

Career opportunities can be defined as “employee’s interpretation of a patterned sequence of jobs usually related in work content, as well as an ordered movement of employees among these jobs” (Landau and Hammer 1986, p. 385). In this study, the items of opportunities to learn, skill development, career satisfaction and extensive training are included.

Job requirements can be defined as “the competences actually required by the job” (Ellström 1997, pp. 267-268). According to Jeanneret and Strong (2003), job requirements (occupation-specific requirements, Jeanneret and Strong 2003), is a job analysis factor that provides information about the occupational requirements. In this study, occupational tasks, such as duties, team-working, knowledge and occupational pressure are examined.

The term “rewards” can be defined as “how employees are rewarded in accordance with their value to an organization and it is concerned with both financial and non-financial rewards” (Armstrong 2002, p. 3).
Moreover, some researchers (Carson and Stewart 1996; Boselie et al. 2005) consider rewards as a part of job analysis and a human resource management activity. In this study, occupation rewards, such as salary, bonuses, career development and insurance, are incorporated.

- Finally, the term job climate can be defined as “the employee’s own work environment, meaning his working conditions, his degree of management support, his job importance etc” (Morgan 1981, pp. 11-12; van Veldhoven 2005, pp.31-32). According to Noe et al. (2006), job climate is a job analysis’ parameter that needs to be included in a job analysis research. Further, Gelade and Ivery (2003) found that job climate is related to firm performance and, in fact, is a mediating link between human resource management and firm performance. In this study, some main job climate items, such as management awareness, employee importance and job climate safety are examined.

To summarize, many researches (Youndt, Snell, Dean and Lepak 1996; Becker and Gerhart 1996; Guest 1997; Wood 1999; Bjorkman and Xiucheng 2002; Boselie et al. 2003; Guest et al. 2003; Wright et al. 2003; Wright et al. 2005) have dealt with the relationship between human resource management practices and firm performance. Although, the impact of job analysis to firm performance has not been fully investigated, a number of evidences exists, implying a positive relationship between job analysis and firm performance (Siddique 2004). Supporting this view, Noe et al. (2006) state that job analysis is considered to be a valuable practise for human resource management that affects organizational performance.

To conclude, in this study job analysis is measured by incorporating 10 (non-overlapping) distinct factors, relying on the suggestions of many researchers. This way, not only a more complete picture of job analysis practice can be drawn, but also the multifaceted nature of this human resource practice can be rendered.

**H1:** There is a positive relationship between job analysis practice and firm performance.

### 2.2. The relationships between human resource involvement in firm’s strategic planning, job analysis and firm performance

The organizational human resource strategy outlines firm’s human resource practices, which, in conjunction with organizational planning, are implemented through human resource involvement. The involvement of human resources in firm’s strategic management can be defined as the extend to which human resource executives are concerned and engaged in activities that utilize their expertise (Wright et al. 1998; Siddique 2004), supporting firm’s strategic planning. In this study, the following six items...
are used to measure human resources involvement: human resource systems redesigning, human resource systems development, identifying human resource systems malfunctions, organizational meetings held to discuss human resources issues, ratio of human resources executives to total employees and the hierarchical position of human resources manager or director in firm’s organizational chart (Wright et al. 1998; Siddique 2004).

According to Wright et al. (1998), when firms regard skilled employees as their main competence, then human resource involvement is highly related to human resource effectiveness. Further, Schuler and Jackson (1996, p. 175) state that, the implementation of job analysis may aid firms to redesign their jobs, in order to be more compatible to firm’s goals and employees’ expectations. As Anthony, Kacmar and Perrewe (2002) also point out, job analysis can be successful when it incorporates firm’s strategic planning aims. In other words, job analysis practice needs to be designed and “fitted” to organizational strategic aims and planning.

H2: Human resource involvement in firm’s strategic planning is positively related to job analysis implementation.

Several studies (Wood 1999; Guest 1997; Wright et al. 2005) have examined the relationship between human resource management and firm’s performance using various firm performance measures. This study focuses on performance measures that are derived from the existing literature (e.g. Siddique 2004) and believed to be closely related to job analysis practice. In detail, firm performance is measured by the following four factors: administrative efficiency, financial performance, organizational climate and competitive performance. Administrative efficiency refers to the “degree of firm’s internal responsiveness”, meaning the degree of firm’s ability to function quickly and responsively (Siddique 2004).

Further, financial performance is estimated by the firm’s increase rate of yearly profit, firm’s liquidity level and return on investment (ROI). Organizational climate can be defined as “a set of properties of the work environment, perceived directly and indirectly by the employees who work in this environment” (Ireland, van Auken and Lewis 1978, pp. 3-4). Firm’s absenteeism level, employees’ turnover and complaints, as well as employees’ safety are used to estimate the quality of organizational climate (Siddique 2004). Items such as customer satisfaction, sales growth and market share growth are used to measure firm’s competitive performance (Siddique 2004).

Finally, some other researches (Martell and Carroll 1995; Bennett, Ketchen and Schultz 1995; Wright et al. 1998) have concluded that there is
a relationship (indirect) between human resource involvement and firm performance.

H3: Human resource involvement is related to firm performance

The proposed research model is shown in Figure 1.

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**Figure 1:** Research model and hypotheses

3. Conclusion and research limitations

3.1. Conclusion

The constantly changing nature of jobs created the need for firms to determine, in a regular basis, the needed employees’ capabilities to perform a job. A job analysis technique is developed in order to help firms to deal with human resource management problems (Doron and Marco, 1999). According to Siddique (2004), the potential contribution of the job analysis practice to firm’s performance has not been systematically examined thus, the need for a credible and reliable tool for gathering job-related data and determining the needs of a job is crucial nowadays.

This study proposes a theoretical framework that explores the relationships between human resource involvement in firm’s strategic planning, the gathering of job-related data through job analysis and firm’s performance. A causal relationship model is constructed incorporating various factors derived from the literature. This model will be empirically tested in different Greek firms and organizations in order to examine its validity and reliability through structural equation modeling.
3.2. Research Limitations

This study presents an overview of the job analysis practice, giving grasp for further research of the inter-organisational relationships of human resource involvement in strategic planning, job analysis and performance. A possible limitation is that other factors, like strategic orientation, human resource planning and other HR policies, are not examined in this research. This study can provide the basis for future research, by expanding the present research model including other constructs. Also, further research may be useful for the examination of the direction of the causality of the proposed relationships. Finally, further research on firms’ characteristics should receive more attention and, as Greer (2001) stresses, future researchers have to demonstrate that job analysis is an essential “high-performance” human resource practice.

References


The gap between the existing and the ideal Human Resource Management (HRM) system: its impact on the performance of Greek enterprises

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Abstract:
The term of Human Resource Management (HRM), which has prevailed the last years, was used in order to attribute the particular approach of management of labour relations, while it was also often used as a reaction to the term of personnel management. The HRM approaches workforce as the most important capital, which is capable of giving the enterprise a dynamic and viable competitive advantage. In the passage of years the researchers have proposed a lot of HRM practises which have the force to improve and to support the performance of the enterprise. The aim of this study is the determination of the GAP between the “ideal” and the “existing” HRM model in the Greek industrial sector. Moreover, an attempt is made in order to explore the impact of gap in the operational performance of the enterprise. For the achievement of the objectives a research, in 208 medium and large size Greek industrial enterprises, was conducted showing a negative impact of gap in the operational performance of the industry.

Keywords:
H.R.M Practices; Factor Analysis; Correlation; Paired Samples t-test.
1 Introduction

According to Armstrong (2000), the main objective of HRM is to guarantee the capability of the enterprise to acquire success through people. Sisson (1995) thinks that the starting point, for the enterprise, should be the recognition that the person is not simply a factor of production along with the capital and the equipments, but the biggest resource in order for the enterprise to acquire comparative advantages. The effective exploitation of human potential is believed to create competitive advantage for the enterprise (Pfeffer, 1994), while the methods of management of the human resources constitute a precious creative source of competitive advantage (Amit and Belcourt, 1999). The way that enterprises recruit, educate, reward, motivate and discipline their employees are of central importance for the success of the enterprise. Taking for granted that the human workforce is regarded as the most important component for the success of the enterprise, a lot of enterprises have realised that the people are the ones that can give them comparative advantages (Mathis and Jackson, 2000). The successful management of the human resources constitutes the basic element of the total strategy of growth and success of many enterprises (Mulvie and McDougall, 1990).

2 Human Resource Management Practices

The human workforce is a type of resource on which the enterprises do not have a complete control. Nevertheless, there are certain tools which allow them to practise their influence in the quality and the attribution of the human workforce on which they rely on. The HRM practices which they adopt will have great influence in the performance that is achieved by the enterprise (Moriones and Cerio, 2000). The choices of enterprises for special practices and the degree that these practices are completed in a policy connected with the strategy of the enterprise are very important for the competitiveness (Sisson, 1995). Traditionally the HRM practices drew more attention from service companies than industrial companies. Nevertheless the increase of the operational performance through the right management is equally important for both types of enterprises. It could be said that the high technology and the innovative industrial practices alone can bring a small increase in the performance if the essential practices of HRM are not in the position to create a constant social - technical framework. For this reason the industrial enterprises should evaluate carefully the existing practices of human capital and to modify them, if it is essential, so the workers can contribute satisfactorily in the improvement of the operational performance of the enterprise (Ahmad and Schroeder, 2002). Through the passage of years researchers have proposed a lot of practices for human resources who have the power to improve and to
support the performance of the enterprise. These practices emphasise on the choice of workers based on the culture of the enterprise, the behaviour, the attitude and the essential technical abilities which are required for the work, the probable compensation for the performance and the intensification of the workers for the fast incorporation to team work (Ahmad and Schroeder, 2002; Moriones and Cerio, 2000). From the literature review we can conclude that the behaviour of workers inside the enterprise has an important impact in the performance of the enterprise and that the HRM practices can influence the individual performance not only through the effect in the skills of workers and the motivation, but also through the structure of the enterprise which allows the workers to improve their work (Huselid, 1995). Various other studies look for the impact of HRM practices in the performance of the enterprise (Kathuria and Partovi, 1999; Kinnie and Staughton, 1991) in the industrial relations and in the industrial and organizational psychology (Jones and Wright, 1992; Kleiner, 1990). The literature moreover widely reports that the HRM practises can help in the creation of a source in a viable competitive advantage, specifically wherever they are aligned with the competitive strategy of the enterprise (Jackson and Schuler, 1995; Porter, 1985).

Delaney et al. (1989), in a research, which they carried out in 1986, used ten practices that refer to the fields of personnel selection, evaluation of personnel, high compensations, planning of work, complaining process, diffusion of information, evaluation of behaviour and participation of employees in the process of decision-making. Huselid (1995) in order to create a completed and modern list of high performance processes, in work added in these ten practices, three more which are widely acceptable in their affect in the performance of the enterprise: the intensive effort of recruitment, the average of annual hours of training for each worker and the criteria of promotions. Pfeffer (1994), proposed a list of 16 practises forming the opinion that one of the 16 best practices in the successful enterprises is the measurement of practices while he claimed that the seriously committed enterprises, in order to achieve the competitive advantage, through the people make the measuring of their efforts a critical component in the general process. In 1998 Pfeffer proposed seven HRM practises, decreasing the initial list by merging some of them. These practices which are expected to increase the performance of the enterprise are the following: (1) Employment security, (2) Selective hiring of new personnel, (3) Self –managed teams and decentralization of decision making as the basic principles of organizational designs, (4) High compensation, (5) Extensive training, (6) Reduced status distinctions and (7) Extensive sharing of financial and performance information throughout the organization. Each one of these practices is absolutely related to the others (Ahmad and Schroeder, 2002). The enterprises, depending on the
strategy and the capabilities that they have, give different weight in every one of the HRM practices. Formally, when an enterprise puts the biggest possible effort for the growth, establishment and application of every one of these practices it achieves the ideal HRM system. This ideal type of system is expected to produce the higher performance in the enterprise. As closer to the ideal HRM system an enterprise is, so much better its performance will be. According to Ahmad and Schroeder (2002), if the coordination among the practices is substantiated, then the performance of the enterprise will be more than if all these practices were implemented individually or by combination.

3 Research Methodology

3.1 Data Collection

Field of the research constituted the sector of Greek industry. The Greek industry, as most sectors of the Greek economy, is characterized by the small size of the enterprises as only 2% of these industries have more than 500 employees (ICAP, 2002). The target population of the research constitute by 5,964 industries which are reported in the list of S.E.V (Hellenic Federation of Enterprises). An effort was made to cover most industrial sectors, according to the classification of NACE (National Classification of Economic Activity-rev.1), from all the regions of the country.

The collection of needed information was contacted by the use of questionnaire which was send by post, fax or via e-mail in randomly selected industries. From 285 questionnaires that were sent in total, 212 returned completed. Response rate reaches 75% and is considered very satisfactory, particularly if it is compared with the average of 20% that Young (1996) reports for researches that are made in enterprises and are addressed to superior executives. In similar researches as those of Ahmad and Schroeder (2002) the response rate was 60%. In the final sample which is constituted by 208 industrial units, more than 100 are found in the list of the 500 biggest industries of our country, with an average of 270 dull time employees and average annual turnover of 82 million €.

3.2 Measurement of Variables

Pfeffer’s seven HRM practices were selected for the purpose of this research, while the questionnaire of Ahmad and Schroeder (2003), after some appropriate modifications, was the basic research instrument. In each question (statement), the personnel managers answered using the following five-point Likert scale: 1 = It never happens, 2 = It seldom happens, 3 = It happens some times, 4 = It often happens and 5 = It always happens. In
this way was estimated the degree of application of HRM practices by the Greek manufacturing companies.

Moreover, in order to determine the Greek “ideal” HRM model, according to personnel managers, it was asked by them to declare their degree of importance of each statement using the following five-point Likert scale: (1) Unimportant, (2) Of little importance, (3) Moderately important, (4) Important and (5) Very important. In order to measure operational performance 3 variables were used from the work of Hill (1989) and 2 variables from the work of Vickery et al. (1997). In each of these variables the responsible of financial departments were asked if the performance in their company is: (1) Very below average, (2) Below average, (3) On average, (4) Above average and (5) Very above average of the industry.

The content validity of the questionnaire was ensured through pre-test and structured interviews with the personnel managers and academic experts in the field. For the test of construct validity, was conducted: a) Exploratory Factor Analysis and b) Reliability Analysis with the use of S.P.S.S 17.0.

All items that did not contribute strongly to the corresponding factor (practice) or to the alpha value were removed. After the purification of the factors, was calculated the average score from all the items of the factor and the average score became the value representing the factor.

3.3 Data Analysis- Results

Thirteen factors have been created from the seven practices and their mean scores are presented in the table below.

The results of table 1, show that the enterprises, depending on the strategy and the capabilities that they have, give different weight in every one of the HRM practises. According to researchers, the extend of application of practices which are applied can differ between the sectors and/or the countries for various reasons, such as the culture and the temperament (Salk and Brannen, 2000), the governmental regulations and the policies (Morishima, 1995), the competitive priorities (Boxall and Steeneveld, 1999), and the application of different management practices (Snell and Dean, 1992). Hofstede (1980) also argued that the national culture affects in the attitude and in the behaviour of the workers. In an enterprise which is activated in different countries the culture of workers is considerably different. Consequently the choice of the practises that every enterprise will choose constitutes an important factor in the determination of the degree at which the practices will contribute in the improvement of the performance (Bailey, 1993; Guest, 1997; Huselid, 1995).
From table 1 arises also that the model that the Greek personnel managers believes as “ideal” for the Greek industrial units is fairly different from the one proposed by theory and other foreign managers. The Greek “ideal” model, in the context of this study, is the model that arised from the declarations of Greek personnel managers.

Table 2 shows a positive and in some cases strong correlations, among the different HRM practices confirming the opinion of Ahmand and Schroeder (2003) who argue that when a company increases its effort in one of the HRM practices, increases the effort in the other practices also.
In order to determine the gap and its impact on operational performance of companies, in this study defined as misfit the dissimilarity between the “ideal” and the existing HRM model and the following formula is used to calculate it.

\[
    \text{GAP}_i = \sum_{k=1}^{n} (x_{ik} - x_{ik})^2
\]

where \(x_{ik}\) is the score of \(k\)th factor of the existing HRM model of a particular unit \(i\), \(x_{ik}\) is the score of the \(k\)th factor of the “ideal” HRM model and \(k\) the factors representing the HRM model.

In this study \(i\) varies from 1 to 208 and \(k\) varies from 1 to 13. The GAP, in each company, can be ranged from 0 to 16.

It is obvious from the table 3 that there are statistically significant differences between the existing and the “ideal” HRM model, in all the factors and consequently in all the practices (\(p<0.01\)). That means that the
Greek industrial units do not apply the practices according to the manager’s desires and instructions but according to the owner’s and the economical and organizational capabilities that they have.

The relationship between the operational performance and the partial MISFIT of each factor that constitutes the HRM practices is negative as all the correlation coefficients are negative. The same is happening between the operational performance and the MISFIT of the sum of factors that constitutes the HRM model. In particular, the correlation coefficient is -0.288 and is significant at 0.001 level. Formally, when an enterprise puts the biggest possible effort for the growth, establishment and application of every one of these practices it achieves the ideal HRM system. This ideal type of system is expected to produce the higher performance in the enterprise. As closer to the ideal HRM system an enterprise is, so much better its performance will be.

### Table 3: Paired Samples t-test

<table>
<thead>
<tr>
<th>Factors</th>
<th>t-value</th>
<th>Sig. (2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Employment insecurity</td>
<td>-2.644</td>
<td>0.009</td>
</tr>
<tr>
<td>2.1 Manufacturing and human resources fit</td>
<td>-8.802</td>
<td>0.000</td>
</tr>
<tr>
<td>2.2 Behavior and attitude</td>
<td>-9.751</td>
<td>0.000</td>
</tr>
<tr>
<td>3.1 Team activities</td>
<td>-10.326</td>
<td>0.000</td>
</tr>
<tr>
<td>3.2 Interaction facilitation</td>
<td>-11.097</td>
<td>0.000</td>
</tr>
<tr>
<td>4.1 Contingent compensation</td>
<td>-13.335</td>
<td>0.000</td>
</tr>
<tr>
<td>4.2 Incentives to meet objectives</td>
<td>-12.331</td>
<td>0.000</td>
</tr>
<tr>
<td>5.1 Training on job skills</td>
<td>-10.714</td>
<td>0.000</td>
</tr>
<tr>
<td>5.2 Training in multiple functions</td>
<td>-8.390</td>
<td>0.000</td>
</tr>
<tr>
<td>6. Status differences</td>
<td>-18.346</td>
<td>0.000</td>
</tr>
<tr>
<td>7.1 Communication of strategy</td>
<td>-8.422</td>
<td>0.000</td>
</tr>
<tr>
<td>7.2 Feedback on performance</td>
<td>-12.609</td>
<td>0.000</td>
</tr>
<tr>
<td>7.3 Diagrams</td>
<td>-9.948</td>
<td>0.000</td>
</tr>
</tbody>
</table>

4. Conclusions

The Greek Industrial sector doesn’t use the HRM practices in such an extensive way. Gives priority to the employment security and to the communication of strategy while considers as less important the contingent compensation and the status difference. However, there is a strong and positive relationship among the practices. There is also, a significant difference between the HRM model that is applied and the "ideal", according to Greek personnel managers. Moreover, the Gap of each
practice is negatively related to the operational performance and the same happen more intensely between the total Gap and operational performance.

References


The impact of HRM on organizational performance: a proposed “best HRM practices system”

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Abstract:  
Over the past several years, an increasing amount of attention has been given to the role of human resource management (HRM) as a key asset in contemporary organizations. However, it seems to be a limited only amount of research attempting to explore the mechanisms through which these practices can lead to competitive advantage. This study attempts to explore the way the adoption and use of HRM practices affect organizational performance. Therefore, a new, composite model, called “best HRM practices system” is proposed. This model empirically examines the relationships between best human resource management practices, knowledge management, organization learning and organizational capabilities, as well as their impact on organizational performance. To carry out this research, a structured questionnaire was designed and distributed to Greek firms that belong to the secondary sector and employ at least 50 employees. Results indicate that manufacturing and construction firms pursuing best HRM practices achieve higher performance through the interaction of these practices with knowledge management and organisational learning capability and the creation of organisational capabilities.

Keywords:  
Human Resource Management Practices, Organizational Learning, Knowledge Management, Organizational Capabilities

1. Introduction  
Over the past several years, an increasing amount of attention has been given to the role of human resource management (HRM) in contemporary organizations. Justifying its value to the firm was the primary concern of
most academics and practitioners. The emergence of numerous empirical studies, examining the impact of different HRM practices on organizational performance, supports this claim. However, besides the quantity and variety of these studies, minimum attention has been given to the conception or understanding of the mechanisms through which HRM practices influence performance.

Reviewing the relevant literature one can notice that the approaches adopted by various researchers seem to be descriptive and confined within the limits of directly linking the HRM practices with performance. Most of them, describe what HRM practices do and their impact on performance (at various levels of the company). On the other hand, there is a limited amount of research attempting to explore how HRM practices essentially work and, hence, to identify the processes through which these practices can lead to competitive advantage.

The purpose of this paper is to examine the mediating processes between the existence and application of HRM practices and the creation of competitive advantage and increased performance. Towards this end, a new composite model, called “best HRM practices system” is proposed. This model empirically examines the relationships between best human resource management practices, knowledge management, organization learning and organizational capabilities, as well as their impact on organizational performance.


A significant body of research has suggested specific HRM practices that are expected to promote such inimitable attributes in human resources that can help an organization to obtain a competitive advantage and enhance its performance (e.g., Huselid, 1995; MacDuffie, 1995; Delaney and Huselid, 1996; Frits and MacDuffie, 1996; Guest, 1997; Michie and Sheehan, 2001; Ahmad and Schroeder, 2002; Guest et al., 2003).

During the years, all these practices that lead to superior performance were given various names by different authors: “best HRM practices” (Pfeffer, 1994), “high performance work systems or practices” (Appelbaum and Batt, 1994; Appelbaum et al., 2000), “high-involvement practices” (Lawler, 1986), “high commitment practices” (Wood, 1996) and finally, “higher productivity and product quality practices” (Ichinowski et al., 1997). All of these terms highlight the increase of employee involvement in decision making and the improvement of employee motivation and commitment (Boxall and Purcell, 2003). Within this paper the term “best HRM practices” will be preferred, referring to all those HRM practices and policies that have been identified as performance enhancers.
However, a central issue into this line of research refers to the limited understanding of the mechanisms through which HRM practices influence effectiveness (Delery, 1998). Many authors (Becker and Gerhart, 1996; Wright and Sherman, 1999; McMahan et al., 1999; Delery and Shaw, 2001) point out that there is a lack of understanding about the process (how and why) through which HRM creates organizational value and increases performance. Unfortunately, the existing empirical research has produced poor results that are unable to support organizations wishing to gain competitive advantage through human resources. Thus, the question of ‘how’ best HRM practices lead to organizational performance needs to be answered and the exact mechanics that play an important role must be identified.

The following section presents a brief theoretical background in which the authors attempt to acknowledge some of those mechanisms and integrate them into a broad conceptual framework. Subsequent sections present the research model adopted and the hypotheses tested while the research methodology and findings are following. The paper concludes with a discussion of the results, implications and research limitations.

2. Theoretical background

2.1. Knowledge Management and HRM

Many researchers (e.g. Blacker, 2000; Soliman and Spooner, 2000; Yahya and Goh, 2003; Scarbrough, 2003; Thite, 2004; Oltra, 2005; Lengnick-Hall and Lengnick-Hall, 2006, Gloet, 2006) highlight the importance of HR in implementing KM and the fact that people issues need to be moved to the centre stage of thinking about knowledge.

An important point is the idea that the success of any KM initiative is likely to be critically dependent on having suitably motivated people taking an active role in the process (Robertson and O’Malley Hammersley, 2000; Storey and Quintas, 2001). The most important factor here includes the personal nature of tacit knowledge which requires the willingness, on the part of those workers who possess it to share and communicate it (Flood et al., 2001; Empson 2001; Willman et al., 2001).

For Soliman and Spooner (2000), HRM practices play a crucial role in facilitating employees’ absorption, transfer, sharing and creation of knowledge. Similarly Oltra (2005) argues that great care has to be taken so as to increase the capability of human beings as organizational knowledge enhancers and, as a result, the strategic management of people must act as a trigger toward effective knowledge-leveraging processes.
2.2. Organizational Learning Capability and HRM

Summarizing the definitions adopted by different academics (Senge, 1990; Mills and Friesen, 1992), the learning organization (LO) is an organization which adopts specific strategies, mechanisms, and practices that encourage its members to learn continuously so that they can adapt to the changing business environment. Goh (1998) defined these strategies, mechanisms and practices as the “learning capability” of the organization. Other researchers also use this term (e.g. Ulrich et al., 1993; DiBella et al., 1996). Chiva et al., (2007: p. 225) define organizational learning capability (OLC) “as the organizational and managerial characteristics that facilitate the organizational learning process or allow an organizational to learn”.

Although the LO literature is vast and takes various forms, as Argyris (1999) argues, the central idea behind the LO includes notions of adaptability, flexibility, avoidance of stability traps, experimentation, rethinking means and ends, realization of human potential for learning in the service of business purposes and creation of human development. These same central ideas are adopted by this study. LO is conceptualized as the creation of the needed infrastructure that can accommodate the acquisition and use of knowledge and the processes towards this end are described as the organizational learning capability.

The relationship between organizational learning and HRM is emphasized by many academics (e.g. Mills and Friesen, 1992; Drucker, 1993; Pearn et al., 1995; Bennet, 1998; Reynolds and Ablett, 1998; Lennon and Wollin, 2001; Marchington and Wilkinson, 2003; Jaw and Liu, 2003; Gomez, 2004; Khandekar and Sharma, 2005).

According to Sinkoula et al., (1997) OLC is dependent upon invisible assets as knowledge. Given the fact that those assets are embodied in people, HRM practices play a unique role in organizational learning (Jaw and Liu, 2003). For Dertouzos et al., (1989) and Pettigrew and Whipp (1991), competitive advantage will occur to organization which develops HR policies that promote continuous learning, teamwork, participation and flexibility; attributes that clearly exist within the best HRM practice spectrum. As Khandekar and Sharma (2005) point out, the more specific HRM practices exist in the organizations, the stronger the learning capability of the organization.

2.3. OLC and KM

Firestone and McElroy (2004) argue that the relationship of OL and KM is close enough to be termed intimate. For Dimitriadis (2005), effective learning requires the development of a strategic learning capability by linking organizational learning and KM in and among organizations. Cavalieri (2004) proposes that those two approaches are complementary
and may be integrated into a larger framework that can offer managers a potentially better way to leverage human intellectual capital for performance.

Thus, the need for combining these two processes, OL and KM, becomes important, as they are both considered critical for organizational success. A clear understanding of the relationship between them is, therefore, necessary. Most of the authors that seem to be essentially involved within this debate (e.g. Pemberton and Stonehouse, 2000; Rowley, 2000; Loermans, 2002), argue that a LO generates new knowledge which helps sustain its competitive advantage. However, just creating knowledge alone does not mean that knowledge is being efficiently and effectively used or managed. KM takes the output from the LO (new created knowledge), manages it and ensures that an appropriate environment to perpetuate the generation and management of knowledge capital is being properly maintained.

Our view is that, indeed, successful learning organizations must create an organizational environment that combines organizational learning with KM. As Loermans (2002, p. 292) characteristically points out “*the LO and KM disciplines must become mutually self-supporting; one concept simply cannot operate without the other.*” Organizational learning capability constitutes the infrastructure of the organizational knowledge system, while KM is dealing with all those practices that are required for its development and maintenance. In other words, a LO develops a culture which emphasises the importance of learning (knowledge creation), constantly promotes it as a central idea or value within the organization and creates the right conditions for such ideas to prosper. On the other side, KM, within this environment of the LO, is primarily focusing on the accumulation, sharing, utilization and use of knowledge assets throughout the organization.

2.4. Organizational Capabilities, Knowledge Management and Organizational Learning

An early generic description by Nelson and Winter (1982) categorises capabilities as lower-order organizational knowledge and skills, and higher-order co-ordinating mechanisms. Other descriptions of capabilities view them as a set of organizing processes and principles a firm uses to deploy its resources to achieve strategic objectives (Kogut and Zander, 1992; Grant, 2002).

Literature suggests that organizational capabilities are closely related with KM initiatives. Based on the knowledge based view of the firm (KBV), competitive success is governed by the capability of organizations to develop new knowledge-based assets that create core competencies or organizational capabilities (Narasimha, 2000; Miller 2002). Similarly,
Pemberton and Stonehouse (2000) argue that the creation of knowledge through learning processes is seen to be critical to the development of capabilities. The impact of organizational learning capability in the development of organizational capabilities is also evident throughout the literature. As Chaston et al., (1999) have noted, organizational learning functions as an antecedent of organizational capabilities. It brings employees and other resources together, firms develop the processes on which capabilities are built, and employees continuously apply their knowledge and skills to operational or strategic problems so that a deeper knowledge base is developed, which will also enhance capabilities. Wang and Lo (2003) add to this view by noting that competence building and upgrading can only be achieved by organizational learning.

2.5. Organizational Capabilities and Performance

The relationship between organizational capabilities and performance is well established in the literature.

The resource based view (RBV) suggests that competitive advantage and performance results are a consequence of firm-specific resources and capabilities that are costly for competitors to imitate (Wernerfelt, 1984; Barney, 1986; Rumelt, 1987; Barney, 1991). Based on knowledge based view (KBV), firms that possess stocks of organizational knowledge, characterized as uncommon or idiosyncratic, stand a good chance of generating and sustaining high returns (Raft and Lord, 2002). In the organizational learning theory, these stocks of knowledge develop dynamic learning processes which are capabilities that are described as organizational learning (Shrivastava, 1983; Lopez, 2005). Finally, under the dynamic capabilities perspective, dynamic capabilities are the drivers behind creation, evolution and recombination of other resources into new sources of competitive advantage and performance (Teece et al., 1997).

3. Proposed research model

Considering today’s corporate environment, the conceptual framework presented in Figure 1, views performance primarily as a product of strategic human resource management (SHRM) through the exercise of best HRM practices at both strategic and operational levels of any company (with one or multiple business). The main value provided by this framework lies in the reflection of factors and their relationships that seem to play their own unique roles, as mediating processes, into the HRM practices-performance relationship.

Best HRM practices are expected to enhance organizational performance (Arthur, 1994; Huselid, 1995; Delery and Doty, 1996; Pfeffer, 1998; Aplinebaum et al., 2000; Guest et al., 2003) by promoting inimitable

Those inimitable attributes are mainly the end products (outcomes) of the KM and OL processes (Hislop, 2003; Jaw and Liu, 2003; Khandekar and Sharma, 2005) which are mutually self-supporting (Pemberton and Stonehouse, 2000; Loermans, 2002; Gorelick and Tantawy-Monsou, 2005; Dimitriades, 2005). Our view is that OL constitutes the infrastructure of the organizational knowledge base creation, while KM is concerned with all needed strategies to maintain and leverage it (Loermans, 2002).

These two processes lead to the production (creation) of knowledge-based assets which, in turn, develop organizational capabilities (Nonaka and Takeuchi, 1995; Wang and Lo, 2003; Real et al., 2006; Nielsen, 2006) that could drive a company to superior and sustainable performance (Williamson, 1999; Caloghirou et al., 2004; Regan and Ghobadian, 2004).

\begin{figure}
\centering
\includegraphics[width=\textwidth]{diagram.png}
\caption{Proposed “Best HR Practices’ system}
\end{figure}

Based on the proposed research model, 6 main research hypotheses can be extracted and empirically tested:

\textit{Hypothesis 1: Best HRM practices have a positive influence on KM processes.}
Hypothesis 2: Best HRM practices have a positive influence on OLC processes.

Hypothesis 3: OLC processes have a positive influence on KM processes.

Hypothesis 4: KM processes have a positive influence on OC.

Hypothesis 5: OLC processes have a positive influence on OC.

Hypothesis 6: OC have a positive influence on organizational performance.

4. Methodology

4.1. Sample and data Selection

To test the hypotheses empirically, a questionnaire survey methodology was chosen. The target population consisted of all 930 manufacturing firms in Greece, employing at least 50 employees, in order to achieve sufficient sample size and generalizability of the results. The population was taken from a database compiled by ICAP, a reliable source for data of Greek companies.

The size limitation was necessary since small-scale companies in general do not employ a big range of formal HRM practices (Miner and Crane, 1995) and is in line with other similar HR studies (e.g. Guest et al., 2003).

A pre-test was performed to establish content validity (Zikmund, 2003). The instrument was pre-tested through in depth discussions with academics and professionals. After some modifications the questionnaire was finalised. To ensure that the HR managers of the sample firms were willing to answer the questionnaire and maximize response rate, two research assistants spent two weeks telephoning these 930 firms. It should be noted that many HR managers declined to participate due to time constrains or company privacy concerns. The questionnaires were sent only to the 212 HR managers who accepted to participate in the survey (mailed or e-mailed according to their preference). A cover letter explaining the study objectives was attached, while a stamped return envelope was also enclosed. Follow up letters were sent approximately three weeks after the initial mailing.

Finally, only 142 questionnaires were returned. Out of these a total of 4 questionnaires were found invalid due to insufficiently completed

1 A large percentage of the sample firms were lacking an HR manager due to their small size. In that case a representative top manager most familiar with HR issues was conducted.
questions. A total of 138 responses were appraised as suitable for our
analysis giving, a gross response rate of 15%.

4.2. Measures

4.2.1. Best HRM practices

Taking into consideration previous empirical contributions (Jones and
Wright, 1992; Arthur, 1994; Pfeffer, 1994; Jackson and Schuler, 1995;
MacDuffie, 1995; Marchington, 1995; Milgrom and Roberts, 1995; Delery
and Doty, 1996; Becker and Huselid, 1998; Pfeffer, 1998; Bowers and
Akhlaghi, 1999; Wiesner and McDonald, 2001; Bowen et al., 2002; Guest
et al., 2003; Michie and Sheehan, 2005; De Kok et al., 2006; Sels et al.,
2006), the authors concluded that the testing of the proposed framework
should be sufficient with the integration of the following practices: 1)
employment security, 2) selective hiring, 3) high levels of teamwork and
decentralization, 4) compensation and incentives contingent on
performance, 5) extensive training, 6) employee involvement and internal
communication arrangements, 7) internal career opportunities, 8) broadly
defined job descriptions and 9) harmonisation. In addition, responding to
Rodwell’s et al. (2000) suggestion, ‘health and safety’ policies were
incorporated into the list as a tenth practice. Table 1 summarises the
variables used, the methods employed to measure the best HRM practices
and the related literature\(^1\). Some of those HRM constructs are measured as
a two-dimensional construct as determined by the scope of the HRM
practice. Each item of a construct was measured using a seven-point scale
from strongly agree (7) to strongly disagree (1).

4.2.2. OLC and KM

To measure OLC four constructs were used, based on previous well known
empirical contributions (Galer and Heijden, 1992; Goh and Rechards,
1997; Sinkoula et al., 1997; Hult and Ferrell, 1997; Hult et al., 2000;
Calantone et al., 2002; Hult et al., 2003; Tippins and Sohi, 2003; Gomez
et al., 2005): 1) commitment to learning and empowerment, 2) systems
perspective and clarity of purpose and mission, 3) openness and
experimentation and 4) organizational memory. Organizational memory
was measured as a two-dimensional construct as determined by the scope
of this concept.

Similarly, to measure KM three constructs were used, adapted from a
combination of other studies (Wiseman, 1988; Weber et al., 1990;
Blanning and David, 1995; Sviokla, 1996; Ruggles, 1998; Leary 1998;
Zack 1999; Chang Lee et al., 2005; Shih and Chiang, 2005): 1) Knowledge

\(^1\) Full details on the measurement are available on request
accumulation, 2) Knowledge sharing and 3) Knowledge utilization. The construct of “knowledge creation” was not included into the measurement of KM (as it is common in many KM studies) because, according to the above discussion, is considered an outcome of OLC. Tables 2 and 3 summarise the variables used, the methods employed to measure OLC and KM and the related literature. Each item of a construct was measured using a seven-point scale from strongly agree (7) to strongly disagree (1).

Table 1
Summary of the ‘best HRM practices’ measures

<table>
<thead>
<tr>
<th>Practice (construct)</th>
<th>Dimension</th>
<th>Description of measurement</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment Security</td>
<td>Employment security</td>
<td>4 items are used to measure the degree to which an employee could expect to stay in his or her job over an extended period of time</td>
<td>Delery and Doty, 1996; Pfeffer, 1998; Ahmad and Schroeder, 2003; Guest et al., 2003; Michie and Sheehan, 2005</td>
</tr>
<tr>
<td>Selective hiring</td>
<td>Selective hiring</td>
<td>7 items are used to measure the degree to which the organization uses sophisticated hiring procedures and the importance given towards specific characteristics of the prospective employee’s attitude and behaviour</td>
<td>Huselid, 1995; Becker and Huselid, 1998; Pfeffer, 1998; Wiescher and McDonald, 2001; Bowen et al., 2002; Guest et al., 2003; Ahmad and Schroeder 2003; Michie and Sheehan, 2005; De Kok et al., 2006; Sels et al., 2006</td>
</tr>
<tr>
<td>Use of teams and decentralisation</td>
<td>a) Team activities b) Interaction facilitation</td>
<td>a) 5 items are used to assess the effective use of teams on the shop floor b) 5 items are used to assess the extent to which supervisors encourage and facilitate workers to work as a team</td>
<td>Pfeffer, 1998; Bowers and Akhlaghi, 1999; Ahmad and Schroeder, 2003</td>
</tr>
<tr>
<td>Compensation and incentives contingent on performance</td>
<td>a) Incentives to meet objectives b) Recognition and rewards contingent on performance</td>
<td>a) 4 items are used to measure whether the organization’s reward system is consistent with its objectives and goals b) 5 items are used to measure the recognition of employee performance and its connection with proper rewards</td>
<td>Huselid, 1995; Delery and Doty 1996; Becker and Huselid, 1998; Pfeffer, 1998; Bowers and Akhlaghi, 1999; Wiescher and McDonald, 2001; Bowen et al., 2002; Guest et al., 2003; Ahmad and Schroeder 2003; Michie and Sheehan, 2005; De Kok et al., 2006; Sels et al., 2006</td>
</tr>
<tr>
<td>Extensive training</td>
<td>a) Training on job skills b) Training in multiple functions</td>
<td>a) 5 items are used to measure if employees’ on the job skills and knowledge are being upgraded in order to maintain a work force with up to date skills b) 5 items are used to measure the extent to which employees receive cross training, to be able to perform multiple tasks</td>
<td>Huselid, 1995; Delery and Doty 1996; Becker and Huselid, 1998; Pfeffer, 1998; Bowers and Akhlaghi, 1999; Wiescher and McDonald, 2001; Bowen et al., 2002; Guest et al., 2003; Ahmad and Schroeder 2003; Michie and Sheehan, 2005; De Kok et al., 2006; Sels et al., 2006</td>
</tr>
<tr>
<td>Employee involvement and internal communication arrangements</td>
<td>a) Employee involvement and communicati on of strategy</td>
<td>a) 6 items are used to measure the existence of employee voice into the organization and efforts made by management to communicate the organization’s strategy to all employees b) 5 items are used to measure the extent to</td>
<td>Huselid, 1995; Delery and Doty 1996; Becker and Huselid, 1998; Pfeffer, 1998; Bowers and Akhlaghi, 1999; Guest et al., 2003; Ahmad and Schroeder 2003; Michie and Sheehan, 2005;</td>
</tr>
</tbody>
</table>
b) Feedback on performance which management provides shop floor employees with information regarding their own performance and total organizational performance Sels et al., 2006

<table>
<thead>
<tr>
<th>OLC construct</th>
<th>Dimension</th>
<th>Description of measurement</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commitment to learning and empowerment</td>
<td>Commitment to learning and empowerment</td>
<td>5 items are used to measure the role of management with respect to helping employees learn and elicit behaviors that are consistent with an experimenting and changing culture.</td>
<td>Galer and Heijden 1992; Goh and Rechards, 1997; Hult and Ferrell, 1997; Jerez-Gomez et al., 2005; Hult et al., 2000; Calantone et al., 2002; Hult et al., 2003</td>
</tr>
<tr>
<td>Systems perspective and clarity of purpose and mission</td>
<td>Systems perspective and clarity of purpose and mission</td>
<td>5 items are used to measure the degree to which employees have a clear vision/mission of the organization and the existence of a common understanding that enables the firm to be seen as a system made up of different parts, each of which has its own function but acts in a coordinated way to obtain a satisfactory result.</td>
<td>Goh and Rechards, 1997; Sinkoula et al., 1997; Hult and Ferrell, 1997; Jerez-Gomez et al., 2005; Hult et al., 2000; Calantone et al., 2002; Hult et al., 2003</td>
</tr>
<tr>
<td>Openness and experimentation</td>
<td>Openness and experimentation</td>
<td>5 items are used to measure the degree of independence employees enjoy in the pursuit of new ways of getting the job done and freedom to take risks</td>
<td>Goh and Rechards, 1997; Hult and Ferrell, 1997; Jerez-Gomez et al., 2005; Calantone et al., 2002; Calantone et al., 2002</td>
</tr>
<tr>
<td>Organizational memory</td>
<td>a) Declarative memory</td>
<td>Organizational memory refers to the amount of stored information or experience an organization has about a particular phenomenon. a) 4 items are used to measure the knowledge of facts and events</td>
<td>Hult, 1998; Hult et al., 2000; Tippins and Sohi, 2003; Hult et al., 2003</td>
</tr>
<tr>
<td>Organizational memory</td>
<td>b) Procedural memory</td>
<td>b) 4 items are used to measure the knowledge about routines, processes and procedures</td>
<td></td>
</tr>
</tbody>
</table>
### Table 3
**Summary of KM measures**

<table>
<thead>
<tr>
<th>KM construct</th>
<th>Description of measurement</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge accumulation</td>
<td>A scale of 5 items to measure the employees’ access to databases to obtain the relevant knowledge to aid in their work and decision making</td>
<td>Leary, 1998; Chang et al., 2005; Shih and Chiang, 2005</td>
</tr>
<tr>
<td>Knowledge sharing</td>
<td>A scale of 5 items to measure the extent to which diffusion of knowledge is promoted</td>
<td>Sviokla, 1996; Ruggles, 1998; Chang Lee et al., 2005; Shih and Chiang, 2005</td>
</tr>
<tr>
<td>Knowledge utilization</td>
<td>A scale of 4 items to measure the degree employees retrieve information, process them and apply them.</td>
<td>Wiseman, 1988; Weber et al., 1990; Blanning and David, 1995; Chang Lee et al., 2005</td>
</tr>
</tbody>
</table>

### 4.2.3. OC

Empirical research on resources and capabilities has not yet reached maturity (Miller and Shamsie, 1996) and each research attempt, seems to adapt a diverse approach. In this study OC were measured using a list adapted by King and Zeithaml (2001). King and Zeithaml (2001) recognised eight different groups of capabilities in the textile industry. Based on theoretical contributions, as well as from in depth discussions with academics and professionals it was decided that this scale could be used for the whole manufacturing sector with some minor modifications. Table 4 summarises the variables used and the methods employed to measure OC. Each item of a construct was measured using a seven-point scale from strongly agree (7) to strongly disagree (1).

### Table 4
**Summary of measurements of OC**

<table>
<thead>
<tr>
<th>Types of manufacturing capabilities</th>
<th>Description of measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing innovativeness</td>
<td>3 items are used to measure the ability to innovate</td>
</tr>
<tr>
<td>Marketing capabilities</td>
<td>2 items are used to measure the capability to acquire marketing skills</td>
</tr>
<tr>
<td>Stakeholder responsiveness</td>
<td>3 items are used to measure the capability to meet the customer needs</td>
</tr>
<tr>
<td>Capability to compete in a global marketplace</td>
<td>5 items are used to measure the development of knowledge and skills regarding international competition and markets</td>
</tr>
<tr>
<td>Internal integration capabilities</td>
<td>6 items are used to measure the ability to manage the organizational structure to integrate knowledge throughout the organization</td>
</tr>
<tr>
<td>HR capabilities</td>
<td>3 items are used to measure the capability to manage human resources</td>
</tr>
<tr>
<td>Finance/ detail orientation</td>
<td>4 items are used to measure the financial knowledge and skills and the ability to manage details and technicalities within an organization</td>
</tr>
<tr>
<td>Capabilities of external constituencies</td>
<td>3 items are used, reflecting the capability to understand the needs and cost structures of customers and suppliers</td>
</tr>
</tbody>
</table>
4.2.4. Organizational performance

In this study, organizational performance was separated in two sets of measures, the non-financial and the financial ones. According to Banerjee and Kane (1996), for organizational performance measurement there is a need for integration of financial and non-financial measures.

Financial performance was operationalized as a two-dimensional construct, including corporate profitability and market performance (Venkatraman and Ramanujam, 1986), similarly to Spanos and Lioukas (2001). Corporate profitability was measured with three perceptual items, reflecting return on equity, profit margin and net profits whereas market performance was measured with four perceptual items reflecting market share, absolute sales volume, increase in market share and sales.

For all of these items, HRM managers were asked to indicate their firm’s performance relative to competition. Besides the fact that subjective performance measures are extensively common in similar studies (e.g. Guest et al., 2003; Ahmad and Schroeder, 2003), since the sample includes mostly SMEs, it was anticipated that it would be difficult to extract adequate and reliable financial information. Moreover, financial data for SMEs are also criticized for being unreliable and subject to varying accounting conventions or even to managerial manipulation (Dess and Robinson, 1984).

The non-financial measure of organizational commitment was also used. The construct was based on Mowday and Steers (1979) instrument and was measured with eight items. An employee with strong organizational commitment will be highly motivated to expend energy on organizational tasks (Anderson et al., 1994). Organizational commitment is an indicator that confirms whether the HRM practices employed in an organization are able to foster psychological links between organizational and employee goals (Ahmad and Schroeder, 2003).

5. Data analysis and results

Exploratory factor analysis

All theoretical concepts used in the present research were taken from prior studies which provided a theoretical rationale for the existence of these concepts and also the items measuring these concepts. However, due to the fact that (a) for the measurement of each construct, except that of organizational capabilities-OC, we used items from many researchers (see tables 1-4) and (b) we were obliged to modify some of the items of the construct of OC to suit the secondary sector, we used exploratory factor analysis-EFA to redefine the theoretical constructs according to the new established factors. Thus, principal component analysis was conducted on the scaled responses to aggregate managers’ perceptions of each separate
theoretical construct (HR practices, KM, OLC, OC and OP) into categories or factors (dimensions). Bartlett’s test of sphericity for each construct/dimension displayed levels of correlations indicating that a factor model was appropriate (p<0.001) (Norusis, 1994:50). In addition, each construct/dimension exceeded the acceptable level (0.6) on the Kaiser-Meyer-Olkin (KMO) test of sampling adequacy, except very few cases where the KMO was just below the cut-off point of 0.6. Varimax rotation was used to identify a set of factors that were uncorrelated with each other. The survey revealed categories (dimensions) for each theoretical concept that were logical and fit with past categorizations (see table in appendix A).

It can also be noted that the loadings for all individual items, incorporated into each of the constructs examined, are high. Selective hiring was divided into two factors: (1) importance for employee attitude and behaviour and (2) emphasis on hiring procedures. One item was dropped from “emphasis on hiring procedures” (EHP1), one from “interaction facilitation” (IF5) and another from “incentives to meet objectives” (ITMO4) due to insufficient low loadings. One item was also dropped from “training on job skills” (TOJS1) dimension.

Confirmatory factor analysis

In this study, confirmatory factor analysis (CFA) was employed to test the construct validity of the measures used, using both SPSS and AMOS. Appendix A (last column) presents the model fit results for all (34) constructs or dimensions. As shown, four fit measures were used to evaluate the model fit in AMOS: chi-square/degree of freedom ($\chi^2$/d.f.), goodness-of-fit index (GFI), comparative fit index (CFI) and root mean square residual (RMR). Some important SPSS measures (KMO, Bartlett’s Test Significance and TVA) are also presented in this appendix.

Overall, the results demonstrate that the validation measures for all constructs measured are at acceptable levels. Almost all CMIN/DF scores are below the accepted threshold score 5 (Harrison and Rainer, 1996), while GFI and CFI are above the 0.9 threshold (Bollen and Long, 1993) and RMR scores are close to the accepted threshold score 0.1 (Hair et al., 1992).

Structural Modeling

Structural Equation Modelling (AMOS) was used to empirically test the proposed model. An initial step included the calculation of the mean value of all composite measures, best HRM practices, OLC, KM, OC and organizational performance by summing up the individual item scores in each dimension and then dividing by the number of items.
Subsequently, each of these composite measures was tested independently for model fit (second-order confirmatory factor analysis). From a total of 14 dimensions that compose best HRM practices, 6 were dropped due to inappropriate CMIN/DF fit values. The final best HRM practices construct included the following dimensions: 1) team activities, 2) interaction facilitation, 3) incentives to meet objectives, 4) recognition and rewards contingent on performance, 5) training on job skills, 6) employee involvement and communication of strategy, 7) feedback on performance, 8) internal career opportunities and 9) job descriptions. The fit values of all other composite measures (OLC, KM, OC and organizational performance) were within the acceptable levels.

The overall metric model was then appraised. As it is shown in table 5, all extracted fit values are within acceptable levels.

Table 5. Overall Fit of the Model

<table>
<thead>
<tr>
<th>Model-fit Index</th>
<th>Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum sample discrepancy divided by degrees of freedom (CMIN/DF)</td>
<td>3.791</td>
</tr>
<tr>
<td>Goodness-of-fit Index (GFI)</td>
<td>.960</td>
</tr>
<tr>
<td>Comparative Fit Index (CFI)</td>
<td>.976</td>
</tr>
<tr>
<td>Root Mean square Residual (RMR)</td>
<td>.047</td>
</tr>
<tr>
<td>Normed fit index (NFI)</td>
<td>.969</td>
</tr>
<tr>
<td>Tucker-Lewis coefficient (TLI)</td>
<td>.941</td>
</tr>
</tbody>
</table>

Figure 2 demonstrates the structural model with the extracted path coefficients and the adjusted R2 scores while table 6 presents the overall findings as far as the hypotheses tested are concerned.
Table 6. Hypotheses Testing Results

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Path</th>
<th>Path Coefficient</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>Best HRM practices → KM processes</td>
<td>0.38***</td>
<td>Accepted</td>
</tr>
<tr>
<td>H2</td>
<td>Best HRM practices → OLC processes</td>
<td>0.69***</td>
<td>Accepted</td>
</tr>
<tr>
<td>H3</td>
<td>OLC processes → KM processes</td>
<td>0.54***</td>
<td>Accepted</td>
</tr>
<tr>
<td>H4</td>
<td>KM processes → OC</td>
<td>0.42***</td>
<td>Accepted</td>
</tr>
<tr>
<td>H5</td>
<td>OLC → OC</td>
<td>—</td>
<td>Dropped</td>
</tr>
<tr>
<td>H6</td>
<td>OC → Organizational Performance</td>
<td>0.63***</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

Proposed Causal Relationships

<table>
<thead>
<tr>
<th>Path</th>
<th>Coefficient</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best HRM practices → OC</td>
<td>0.44***</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

*** $p < 0.01$ level, ** $p < 0.05$ level
Hypotheses 1 and 2 are both supported because a significant positive relationship is shown between best HRM practices and KM and OLC processes. Manufacturing firms that invest on best human resource practices achieve higher levels of knowledge and learning, while their KM and learning initiatives are more likely to succeed, than firms that do not invest in HRM practices. In the literature, prior empirical evidences support these results, although there have been no prior studies testing the relationship of HRM with OLC and KM simultaneously, especially in the manufacturing sector. For example, Yahya and Goh (2002) examined the association between four practices of human resource management with five areas of knowledge management in different types of organizations. Their results point out the importance of HRM in creating a knowledge organization and suggest a positive relationship between KM dimensions and training, performance appraisal and compensation and reward practices. Khandekar and Sharma (2005) investigated the role of organizational learning and strategic human resource management in sustainable competitive advantage. Their study reveals a positive relation between organizational learning and specific HRM practices as HRM planning, recruitment and selection processes, performance appraisal, compensation and rewards and organizational exit.

Hypothesis 3 is also supported since a positive relationship between OLC and KM is demonstrated. Manufacturing firms which adopt organizational characteristics that facilitate learning create an organizational base where new knowledge can be created and KM initiatives are more likely to foster. In the literature there is very little empirical research on this relationship, probably due to the ambiguity that surrounds those concepts. Prior research seems to concentrate either in KM or OLC or into their relationship to other organizational factors such as innovation, strategy and performance.

Hypothesis 4 is acceptable as KM is positively related to OC. Manufacturing organizations with the ability to create knowledge-based assets develop manufacturing specific capabilities. Empirical studies that test similar relationships in the manufacturing sector have been to minimum. However, this relationship is confirmed on studies which have concentrated on all economic sectors. For example, Sher and Lee’s (2004) empirical findings in major Taiwanese firms suggest that the use of KM significantly enhances dynamic capabilities.

Hypothesis 5 is not supported by the results, as the relationship between OLC and OC found to be statistically insignificant. In the literature, empirical evidence shows that OLC is associated with the development of OC (Moingeon et al., 1998; Chaston et al., 1999) and, therefore, those results seem a bit surprising in first sight. However, this study tests both effects of KM and OLC on OC. As it is suggested, OLC
creates the infrastructure of the organizational knowledge base creation and, then, KM processes, effectively maintain and enlarge that base. OC are products deriving from valuable inimitable attributes developed by those two processes. Consequently one could argue that OLC has an indirect effect on OC through KM.

Finally hypothesis 6 is supported as well, since a significant positive relationship is shown between OC and organizational performance. Firms in the manufacturing sector that build specific capabilities, which are uncommon and costly for competitors to imitate gain competitive advantage and increased performance results. Similar results can be found in previous studies. A notable one is that of Spanos and Lioukas (2001) who propose a composite model that combines the Porter framework of competitive advantage and the RBV of the firm. Their findings indicate the existence of firm specific effects (capabilities) on performance.

Moreover, modification indexes indicated a strong positive relationship between best HRM practices and OC (presented in figure 2 with dotted lines). This direct relationship, recommended by modification indexes, pinpoints an important issue. Those HRM practices can also develop certain OC that are not directly influenced by knowledge based assets. Examples of such capabilities include the “stakeholder responsiveness capability” of managing customer partnerships or the “HR capability” of maintaining an organizational culture of personal dependability, reliability and integrity. Those capabilities are more likely to be bonded into the social fabrics of an organizational environment and could be characterized as employee based resources. Thus, they are more directly influenced by HRM practices. Similarly, Collins and Clark (2003) argue that HRM practices lead to higher firm performance through developing and reinforcing employee-based resources that are valuable in a particular competitive environment. Their results indicate that a set of network building HR practices can lead to higher firm performance through the practices’ effect on the external and internal social networks of top management teams. The authors (Collins and Clark, 2003) suggest that future HR research should continue to examine employee-based and other firm capabilities that may act as mediating links between HR practices and performance.

6. Discussion and conclusions

This paper contributes to the better understanding of the way HRM practices influence organizational performance. The tested ‘best HRM practices’ system combines five concepts that in conjunction have previously been little examined. The system can help organizations in the manufacturing sector to become aware of the relationship between these
concepts and understand the necessity to integrate their HRM initiatives in organizational learning and knowledge management, in order to create organizational capabilities and, finally, achieve increased performance.

The results of the structural equation modelling approach provide some empirical evidence to support all hypotheses in the Greek manufacturing sector except one. Even though the direct relationship of OLC with OC is not supported, it is argued that OLC functions as an antecedent of organizational capabilities through KM (indirect effect). Those HRM practices form a highly skilled, committed and motivated workforce that exhibits productive behaviour and is willing to create, share or explore those invisible assets. This kind of workforce can foster knowledge base creation through a culture of continuous learning provided by OLC. Of course, an organizational knowledge base cannot survive or progress effectively on its own. It is powered and maintained through KM by means of accumulating, sharing and utilizing those knowledge assets throughout the organization. Those complementary effects of KM and OLC processes effectively generate valuable, rare and inimitable OC. Those capabilities that can usually help to perform a task or activity in an integrated manner are the sources for achieving a sustainable competitive advantage and enhanced performance.

However, the findings of this study are subject to a number of limitations. The main limitation includes the measurement of OC. Reviewing previous empirical studies on OC, one can notice that most of them follow different measurement approaches. This phenomenon might be justified due to the ambiguous nature of OC, hence their difficulty to be defined or measured (Williamson, 1999). A different OC measurement, like for example measuring “generic” OC (e.g. Regan and Ghobadian, 2004) instead of “manufacturing” specific, could have provided different results. Another important limitation includes the use of subjective performance indicators. The respondent’s perceptions regarding their company’s performance might not necessarily coincide exactly with objective reality. According to Spanos and Lioukas (2001) this could result in potential biases as respondents may tend to rationalize their firms’ competitive behaviour based on received wisdom about what constitutes effective management praxis.

**Bibliography**


**Note**

This paper is a smaller version of a paper submitted for publication consideration in a Journal (Emerald).

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## APPENDIX A

Means, St. deviations, EFA statistics (loadings, KMO, Bartlett’s sig. and TVA), Cronbach’s Alpha, and CFA fit indexes.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Dimension</th>
<th>Items</th>
<th>Mean</th>
<th>St. Deviation</th>
<th>Loadings</th>
<th>KMO Bartlett’s Test Sig.</th>
<th>CFA fit indexes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ES1</td>
<td>5.86</td>
<td>1.349</td>
<td>.603</td>
<td>.616</td>
<td>.967</td>
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<tr>
<td></td>
<td></td>
<td>ES2</td>
<td>6.78</td>
<td>.669</td>
<td>.799</td>
<td>.000</td>
<td>.870</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES3</td>
<td>5.14</td>
<td>1.596</td>
<td>.700</td>
<td>.457</td>
<td>.124</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES4</td>
<td>6.23</td>
<td>1.055</td>
<td>.607</td>
<td>.547</td>
<td>.870</td>
</tr>
<tr>
<td>Employment security</td>
<td></td>
<td>IEAB1</td>
<td>5.76</td>
<td>1.179</td>
<td>.810</td>
<td>.662</td>
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<tr>
<td></td>
<td></td>
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<td>5.52</td>
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<td>.754</td>
<td>.000</td>
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</tr>
<tr>
<td></td>
<td></td>
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<td>5.85</td>
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<tr>
<td>Selective hiring</td>
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<td></td>
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<td>5.23</td>
<td>1.524</td>
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<td>.914</td>
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<td></td>
<td></td>
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<td>5.21</td>
<td>1.619</td>
<td>.857</td>
<td>.973</td>
<td>.894</td>
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<tr>
<td>Use of teams and decentralisation</td>
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<td>TA1</td>
<td>5.02</td>
<td>1.771</td>
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<td>.834</td>
<td>4.026</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>TA3</td>
<td>5.13</td>
<td>1.590</td>
<td>.911</td>
<td>.000</td>
<td>.978</td>
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<td></td>
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<td>5.13</td>
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<td>.749</td>
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<td></td>
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<tr>
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<td>.978</td>
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<tr>
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<td>4.52</td>
<td>1.669</td>
<td>.601</td>
<td>.832</td>
<td>.978</td>
</tr>
<tr>
<td>Incentives to meet objectives</td>
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<td>3.912</td>
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<tr>
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<td>ORGCOM5</td>
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<td>ORGCOM8</td>
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Systems of recruitment of auxiliary personnel in the small to medium-sized enterprises in the Greek manufacturing industries

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Abstract:  
Selecting the appropriate personnel is one of the greatest problems small to medium-sized contemporary businesses deal with. This selection is of critical importance due to the fact that it is strongly connected with the smooth functioning of every business. Scientific bibliography refers to a series of factors that determine the personnel selection. All of these factors play a significant role, but their importance differs among the industries thus they affect the choice in a different level, some at a higher and some at a lower one. Work experience, knowledge and personality are considered to be substantial while selecting personnel. In the present research some of the factors that contribute in the selection process of auxiliary personnel and workforce in the Greek manufacturing industries, are examined. This study aims in detecting the fundamental axis of the strategic choice made by Greek manufacturing industries concerning the appropriate auxiliary personnel. The purpose of this paper is to examine which of the authorized services are qualified to select the needed personnel, what process is followed during the selection and finally to examine the perception of these authorized services regarding the qualifications and capabilities of
the chosen staff. The findings enable researchers to better understand what factors determine the auxiliary personnel selection in manufacturing industries. The research was conducted, by questionnaire, in small to medium-sized businesses in Northern Greece. The questionnaire was referred to a sample of 220 employees of the manufacturing industries in Northern Greece and a series of questions relating to the understanding of the need for hiring personnel, the required and important qualifications, the process followed as well as the appropriate executive for selecting personnel, were asked. The first results indicate that the selection process is indeed very complicated and that the factors affecting the choice of auxiliary personnel are a lot more than the ones studied in this paper. Furthermore the results show that there are factors that are considered to be of great importance for most of the manufacturing enterprises.

Keywords: manufacturing industries, auxiliary personnel, selection, important factors

1. Introduction

Since the middle 19th century, when the term Human Resources Administration appeared, up to now, this concept has developed within all sectors and it henceforth constitutes an integral operation of any enterprise. This operation gathers, depending on the size and the object of the enterprise, a series of significant activities which focus on the human factor management (Papalexandris & Mpourantas 2003). The modern Greek enterprises, comprehending the significance of human resources administration, are adopting proportional practices and methods for the most optimal attraction, selection, development, assessment and integration of their manpower.

The importance of human resources for an enterprise and the issue regarding their suitable selection are highlighted not only by the executives of enterprises themselves but also by various personalities in this sector. Jack Welch, CEO of the General Electric Company, characteristically mentions: ‘The best enterprises are now aware, with no doubt, of the fact that real and unlimited productivity springs from the existence of human teams that respond to challenges, are enthusiastic, devotional and duly rewarded. Progress comes if each worker is utilised by the organisation, if s/he is included in its action and if s/he is allowed to have a voice-role in the success of the enterprise. This increases productivity not only numerically but also geometrically’.

The hereby paper is interested in detecting the recruitment systems in small and mid-sized enterprises throughout the Greek manufacturing industry. The present article is outlined as follows: Initially, what will be
presented are the main axes for approaching the human resources administration and how it deals with recruitment systems as well as how these are approached by the bibliography. Subsequently, the research subject and methodology will be presented. Finally, the statistical analysis of results will be mentioned aiming at the deduction of conclusions with regard to the detection of the principal bodies in personnel selection.

2. Theoretical Support

Small and mid-sized enterprises play a dominant role in the Greek economy. ‘The small and mid-sized enterprises constitute the cornerstone of the Greek economic sector. Their multitude, their flexible form, their variety, the new inventions and innovations which come from them constitute the main characteristics of their role as well as their offer in the economic and social growth of the country’ (Kanellopoulos 1994)

In Greece, the enterprises characterized as small and mid-sized are the ones that employ personnel up to 50 individuals. Regardless of the number of individuals they employ, in order for a company to be characterized as a small to mid-sized one, it should meet the following prerequisites:
1. Each one must possess a small share of the domestic market.
2. Each business unit must be economically independent and flexible.
3. The owner ought to practise control and administration of the enterprise.

Small and mid-sized enterprises are extended to all the sectors of the economy, to the primary, the secondary as well as services (tertiary sector).

Small and mid-sized enterprises play a key role in the international and domestic economy, since they constitute almost the total of enterprises and employ 2/3 of workers.

More specifically, these enterprises aim at satisfying the end consumer and they can achieve this objective by adapting their production to the current consuming needs. ‘Their role is crucial for national economies because they represent a high percentage in the business community; they are flexible and are adapted to altering conditions; they create new forms of production and devise new services and products; they strengthen employment; they contribute to the national income and to the maintenance of social cohesion’. (Hellenic Federation of Enterprises 2003)

Having analyzed the environment in which processing industries take action and develop and after the full understanding of their importance for the Greek market, the issue regarding the proper personnel selection emerges. ‘Personnel selection, both personnel that will staff an enterprise and personnel that will be promoted to superior hierarchical levels, constitutes or, at least, should constitute one of the core tasks of the administration, since the proper or improper selection directly influences
the efficient behaviour of an individual’ (Xiroturi 1995). This effect is not only limited to an individual level but extends to intrabusiness and collective levels as well.

The basic strategies of personnel administration deal with the selection, recruitment, wage policy, training and performance control and assessment on the part of the personnel.

The main bodies of the above basic strategies are considered to be the following:

- the owners, who practise control and administration of their enterprises, provided that these are small to mid-sized ones
- the Board of Directors which manages the issues of the enterprise and is the superior corporate authority
- the Chief Executive Officer, who organises and plans activities in the company
- the personnel director manages those needs of the enterprise that concern personnel administration and management issues
- the competent department director and, finally,
- the conference of directors on personnel issues.

Personnel selection is one of the key and most important operations of personnel administration. The selection process, according to the bibliography, follows specific stages and is based on a series of testing criteria. The stages of this process are the initial selection of personnel through applications and resumes, the preliminary interviews, the professional tests, the background and reference reviews, the diagnostics interviews and/or evaluation centres, examinations of natural conditions and, finally, decision (Mpourantas & Papalexandri 2003).

Depending on the type and the nature of the enterprise, there are cases in which some of the above stages are omitted or even combined, a fact which is legitimate since each enterprise individualises this selection process.

The recruitment application form, the references, the interview (structured, free, individual or group one, conducted by a committee or via a video conferencing), the selection tests (psychometric, knowledge and skills ones), C.V, practical training, the evaluation centres and handwriting analysis are the methods used for personnel selection.

The recruitment application is a predetermined form that is completed in the same way by all candidates and, thus, it can be easily processed by the enterprise.

References have the form of either a reference letter or an oral confirmation and they may influence the selection process considerably, because they provide data for the candidate and his/her performance from previous employers. Sometimes, however, this is questioned since it may contain biased data.
Interviews constitute the most common method of personnel selection since their aim is to investigate how suitable a candidate is for a job.

Selection tests aim at investigating those competencies of an individual which are not likely to arise from the other methods.

The available information from curriculum and recruitment applications is used by the enterprises in the initial stage of the selection process. Based on the demographic data and the formal qualifications of candidates, those candidates that are considered to be suitable for further contact will be selected.

Practical training is a method which is used because it provides the enterprises with the ability to understand the candidate’s behaviour within the working environment. The candidates are usually hired for a small time period (from three to six months). This tentative period of work gives the opportunity to both the candidate to be trained, and to the enterprise to examine whether the candidate meets the preconditions required for the particular job.

A typical evaluation centre consists of many and different processes in order to determine the applicants competences, such as oral communication, leadership and decision-making. The assessors are usually employers of companies and organisations who are observing the behaviour of the candidate in question.

Through handwriting analysis, the graphological portrait of the candidate is produced. The conclusions drawn are related to the candidate’s personality.

The main goal from every selection method is for the company to verify that the candidate has the demanded qualifications for the job. In order for an applicant to be selected some skills are considered essential. Work experience, ability to cooperate with colleagues and management and passion for work are required when referring to auxiliary staff and workers. Other qualifications such as high I.Q and E.Q, knowledge of the market and personality seem to be less important due to the nature of work.

3. Methodology

Based on scientific bibliography, in small medium industries in the area of Greek manufacturing arise questions relatively to the ways and practices of auxiliary personnel recruitment.

Do the candidates selection methods that the business chooses in order to hire auxiliary staff relate with the person that takes the final decision on recruitment process?
Are the required qualifications of candidates that the business desires in order to hire auxiliary staff influenced by the person who takes the final decision about the candidates selection?

To be able to respond to these questions we will examine through a closed questionnaire, the ways that specific industries modulate the hiring systems they use. More specifically, we will examine the methods of recruitment preferred by businesses and organizations responsible for this choice. The survey will take place in small medium industries in Northern Greece, where the industry is more developed.

After the explanations, and based on scientific literature we expect that the methods of CVs, personal interviews and trial working period are the most popular procedures among those selecting candidates and in particular auxiliary staff. Trial working period expected and probably is the most popular of all methods because we refer to workers, so is very important to have the real impression about the job performance of each candidate, and the person who is responsible to take the final decision obtains a complete view of the efficiency of workers.

Regarding the qualifications that the support staff must have, we expect that the most basic would be the cooperation with their colleagues, the cooperation with the administration, the passion for work and working experience.

For the acceptance or rejection of these cases, we used the statistical test method X2 with the index which will interpret whether a variable affects the other. The indicator is the Chi-square and its values determine whether the samples are dependent or independent.

4. Presentation of research results

The sample of present research is constituted by 220 small to medium-sized enterprises, that responded in the questionnaire. The questions that were used for the particular questioning are:
1) Who undertakes mainly the process of recruitment of workers and auxiliary personnel?

![Pie chart showing the percentages of recruitment process undertaken by different roles.]

The 16.75% of the asking companies answered that the responsible director undertakes mainly the recruitment process of workers and auxiliary personnel. The same percentage (16.75%) possesses also the director of personnel.

The directing advisor comes in second place (13.71%) with no, statistically, important difference from the responsible director and the director of personnel. The responsible director with the director of personnel from the one side and the person in charge of personnel with employees of his department from the other side assemble the percentages 8.63% and 7.11% respectively.
2) Who takes the final decision for the selection of workers and auxiliary personnel?

The directing advisor takes mainly the final decision with a percentage of 26.13%. With a large difference (approximately 9%) follows the responsible director with the director of personnel with a percentage of 15.08%. Third comes the director of personnel with 14.07%. The responsible director comes in fourth place with 11.06%. Both the administrative council and all the directors together assemble the same percentages (8.04%).

3) Which of the selection methods are mostly used by the company in order to employ workers and auxiliary personnel?

Curriculum and personal interviews are the most used selection methods, among all companies. Curriculums are used by 42.0% of the companies and another 11.5% not only uses this method but also considers it to be the most important one, in order to select the appropriate auxiliary personnel (image 1). A personal interview on the other hand, is the method that accumulates the highest percent of all other methods (63%) and an additional 22% considers this method of utmost importance. (image 2)
Image 1

Image 2
The third most used method is the trial period of work. It scores a percent equal to 26.5 and 7.5% of the companies, rate this method of selection as the most effective

Image3

The rest of the possible selection methods appear to be rarely used by the companies, such as graphological analysis, assessment centers and group interviews and psychological tests, as they are almost never used.

What are the most important qualifications, for hiring auxiliary personnel and workers?

In order for an applicant to be selected for the job, some qualifications are considered essential from most companies. The results from the conducted research indicate that applicants who have work experience, can co-operate both with management and their co-workers, that are highly energetic, with passion for their work, and can inspire trust are most likely to be hired than others. The results are presented in the following table.
Qualifications table

Other qualifications such as high intelligence, high emotional intelligence, knowledge of the company’s market and personality are, as the results indicate, not regarded as important factors by the companies during the selection of auxiliary personnel hence they score low in percentage (table 2) comparing to the other qualifications.

<table>
<thead>
<tr>
<th>Most important</th>
<th>important</th>
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<tbody>
<tr>
<td>Personality</td>
<td>32.3%</td>
</tr>
<tr>
<td>Knowledge of the market</td>
<td>12.7%</td>
</tr>
<tr>
<td>High E.Q</td>
<td>18.6%</td>
</tr>
<tr>
<td>High I.Q</td>
<td>28.2%</td>
</tr>
<tr>
<td>Discretion</td>
<td>24.1%</td>
</tr>
<tr>
<td>Low salary demands</td>
<td>15%</td>
</tr>
<tr>
<td>Fight for ones rights</td>
<td>6.4%</td>
</tr>
</tbody>
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Table 2

The research also aimed in testing whether the person responsible for the final decision about hiring auxiliary personnel, affects the systems of recruiting this personnel in any way. Therefore it was necessary to conduct a correlation check between the qualified head-manager to make the selection with the used methods and the demanded qualifications. In all
following correlation checks, only the factors with the highest percentages are used, because the others are less important.

In regard to whether the head-manager who makes the final decision about which of the candidates will be selected and hired correlates with the demanded qualifications, a chi-square test was conducted with the SPSS program.

In this case the null assumption is

H0: the variables are independent

And the alternative one

H1: the variables are dependent

The null assumption stands when the value sig in the Chi-Square table is higher than 0.05 and if otherwise the alternative case is the one to be accepted which means that the two variables are dependent.

The following tables prove that all the tested variables are independent (in all cases the sig value is higher than 0.05), meaning that there is no alteration in the usage of each method according to the head-manager qualified to make the selection of personnel.

<table>
<thead>
<tr>
<th>Chi-Square Tests</th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>8.944</td>
<td>4</td>
<td>.063</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>9.040</td>
<td>4</td>
<td>.060</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>2.685</td>
<td>1</td>
<td>.101</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>100</td>
<td></td>
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</table>

*final decision-passion for work

<table>
<thead>
<tr>
<th>Chi-Square Tests</th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>2.611</td>
<td>4</td>
<td>.734</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>2.009</td>
<td>4</td>
<td>.734</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>.489</td>
<td>1</td>
<td>.480</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>100</td>
<td></td>
<td></td>
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</tbody>
</table>

*final decision-energetic employee
Regarding the variables methods of selecting auxiliary personnel and the person that takes the final decision, the same Chi-Square test was conducted with the SPSS program and the assumptions are again as follows:

H0: the variables are independent
H1: the variables are dependent

The results from the test show, that also in this case the selection methods that are used are independent from the person qualified to make the final selection. This results from the value sig in the following tables of
After the field research conducted in small-medium manufacturing companies in Northern Greece, the issue of strategic choice of auxiliary personnel is based on the proper method of recruitment, the responsible person for that choice and the qualifications required for the job. Each of these variables influence to different degree the Systems of recruitment of auxiliary personnel in the small to medium-sized enterprises in the Greek manufacturing industries.

5. Conclusions

After the field research conducted in small-medium manufacturing companies in Northern Greece, the issue of strategic choice of auxiliary personnel is based on the proper method of recruitment, the responsible person for that choice and the qualifications required for the job. Each of these variables influence to different degree the Systems of recruitment of auxiliary personnel in the small to medium-sized enterprises in the Greek manufacturing industries.
The conducted checks confirm the initial assumptions of the investigation. More specifically, the method of personal interviews is the most popular among the selection methods and is independent of the qualified person for the recruitment process. The CV is also one of the most important methods along with the trial working period.

Regardless of the person responsible for the final decision, the qualifications required remain the same.

The explanation of this result lies in the fact that small-medium sized businesses need energetic and cooperative people as auxiliary personnel. These characteristics are essential for this kind of job and therefore it is difficult to be changed by the person who takes the final decision.

The conclusions are justified by Greek and foreign literature and the current status of domestic enterprises. This research represents the beginning of the investigation of those dimensions that influence the selection of personnel, but because of the multiplicity of such variables is left for further research should be held.

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In unity is strength: A critical evaluation of the training programmes adopted to support a merger

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Abstract:
The socioeconomical realignments taking place in a wide spectrum of the global scenery during the past decades have created a completely new economic arena. Key players in the economic scenery are banks which try, through mergers and acquisitions, to remain powerful and play leading role in the ‘universal chessboard’. The purpose of this paper was to critically analyze and evaluate the training programs adopted to support a merger using the case study of two Greek banks (Bank A and Bank B). Furthermore, it was also attempted to identify the extent to which the training programs adopted during or after the merger formed a part of the coherent package of HR policies. It also examined the role of social partners in a merger. A selected variety of literature was chosen to form the primary structure of the research. Diverse sources associated to the topic were employed in order to form the theoretical part of the research and assisted in the analysis of the data gathered. As responses to external changes and internal changes, Bank A adopted several programs related to both technical and behavioral issues. However, the transition from the previous organizations to the new one was not completely smooth. Employees and social partners reacted to the change. The fact that the merger sought to be materialized in short time put pressure to the managers who tried to set in order of precedence the goals of the bank. A strategic plan was designed in which training played a critical role as it was the vehicle that could lead to an easier convergence of the populations and at the same offered more quality customer services. Nonetheless, years after some parts of the merger remain under question and despite the success, there were several omissions that if were taken into account could have made the merger more successful. The paper is divided into five parts. In the first part a background of the study is introduced while part two involves the research’s literature review where the basic concepts that form the theoretical framework of the study are established. The third part includes the methodology that the researcher followed during the design of research and the collection and analysis
of data. In part four, lays the analysis and interpretation of the data collected during the research and the core findings. Finally, part five is the conclusion of the study that includes a summary of the implications emerging from the findings of the research.

Keywords:
Merger in greek banking sector; role of training in merger; merger; training

1. Introduction

During the last decades the global economic scenery seems to have changed dramatically. Worldwide phenomena such as globalization and the emergence of new strong economies have shaped a new scheme of things.

One of the major players in the economic arena are banks. Nowadays, an increasing number of banks merge in order to form economic colossus which will be able to play a leading role in the global and local economic arena.

Hence, the Greek banking sector could not remain uninfluenced by the rapid changes. The period 1993-1999 was characterized by fundamental changes in the banking sector which were the outcome of gradual financial deregulation (Bank of Greece, 2007). While the Greek banking industry until the early 1990s operated under bureaucratic rules and regulation that limited the competition and the market development, convergence to European standards, privatization and competition have initiated a reshape of the industry (Bryant, Garganas and Tavlas, 2001). Interbank competition has increased after the entrance of Greece in the EU and privatization of public bans has additionally reformed the Greek banking sector (Mylonidis and Kel nikola, 2005).

But why is it so important for banks and organizations in general to merge? Mergers and acquisitions are a response to the contemporary competitive marketplace, economies of scale, technological enhancement and deregulation (Bleeke et al., 1993). Schuler and Jackson (2001) also identify reasons that lead organizations to merge or form strategic alliances such as market dominance and economies of scale or control of distribution channels. Moreover, except for economic growth that brings world-class leadership, many organizations merge in order to survive. Adding a core competence in order to improve flexibility, financial profits and a larger asset base are also reasons that lead organizations to merger and acquisition activities (Schuler and Jackson, 2001).

2. Literature Review

Paton and MacCalman (2000) characterized change as one of the few constants of history.
In the 21st century, according to Jones, Palmer, Osterweil and Whitehead (1996), worldwide phenomena such as global competition, the advance of knowledge etc created the imperative for constant change and the adoption by organizations of a new, more dynamic model of structure which will be more human-centered. Organizations consist of both formal and informal elements (Senior, 2006). French and Bell (1990, 1999) attempted to explain those elements of organizations using the ‘organizational iceberg’ metaphor which portrays two contradictory aspects of organizational life. The first is the visible part which consists of formal elements of the organization such as structure, goals, strategies, systems, services and management. The second part of the iceberg includes more covert elements of the organization such as values, norms, beliefs, the organizational culture, the power and politics of organizational life and the leadership style and behavior.

Bate (1994) identified four generic approaches to change: the Aggressive, the Conciliative, the Corrosive and the Indoctrinative. Despite the fact that these four approaches are often used in cases of cultural change, Bate (1994) stressed that they were not designed having cultural change in mind. Hence, they couldn’t be characterized as ‘culture-specific’ (Bate, 1994).

The rapid technological developments in modern societies and the changes in modern production methods call for more skilled workforce and training at all levels of the organizational hierarchy (Patrick, 1992; Rainbird, 1994). At the same time, the competitive global market, the need for large economies of scale, globalization and the need for rapid familiarization to the contemporary market conditions have increased the merger and acquisition activity worldwide especially in the banking industry (Schuler and Jackson, 2001; Waight, 2004).

Burke (1996) argued that changes emerging from the external environment strongly influence the culture, the behavior and the skills of the employees in the organization. Employees are expected to be more flexible, able to handle a variety of situations (Glaveli and Kufidu, 2005) and at the same time the employers become more demanding as they shift towards a more elastic supervision (Sappay and Sappay, 1999). The workforce is required to be sociable, flexible, creative, with autonomous thought and developed communication and negotiation skills (Sappay and Sappay, 1999; Melidu, 1999; Dench, 1997).

Waight (2004) stressed the importance of training in both the investigation and the implementation phase of a merger and argued that training is viewed as a mechanism in communicating changes and strengthening employees. Moreover, it is believed that the existence of training programs and their coalition with the overall HR strategies were essential during a merger. The analysis of the training and development
programs plays a determining role in the design of the training strategies that will follow the merger due to the fact that they form a beneficial training framework for the employees and the organization.

Greek banks adopted more active HRM practices and paid attention to the training and development of their employees (Glaveli and Kufidu, 2005). It was essential for human resources to be strategically developed in order to assist banking organizations control, change and maintain performance (Fonda, 1989; Penn et al., 1994). Moreover, employee training was viewed as a means to assist banks overcome their skill and capability inefficiency (Reeve, 1994) by keeping their workforce up to date and flexible (Pollitt, 1999). The advantageous outcomes of training were expected in terms of skills, motivation, employee commitment, employment relationships and customer satisfaction (Lingg, 1996; Weaver, 1996; Wilson, 1994).

Training was also portrayed by many researchers as the criterion that influenced employee satisfaction, customer satisfaction and the business results (Bloemer et al., 1998; De Ruyter et al., 1997). Therefore, employee training and development was necessary to be carefully designed and realized and directly connected to the organizational aims and strategy (Glaveli and Kufidu, 2005).

Glaveli and Kufidu (2005) analyzed the impact of change in the Greek banking sector and the relationship between the employees training and the implementation and success of changing strategy. They suggested that banks in order to respond to the changing environment adopted training programs for the employees that had a beneficial influence on motivation, commitment, homogenization and customers’ satisfaction.

Reed and Vakola (2006) studied how the design of a training needs analysis tool could affect organizational change. They proposed that in a multifaceted, bureaucratic organization the dynamics of hierarchy directly influence the way employees understand change and can play a fundamental role on the shifting of the organization towards something more up to date and dynamic (Reed and Vakola, 2006).

Understanding the fundamental role of training in a merger or acquisition process can also come through the study of failure. Harper and Cormeraie (1995) argued that the reason why a high percentage of organizations involved in mergers fail is the inability to offer sufficient training activity that will familiarize employees with their new partners.

Very often the managers meet the resistance of the employees or their representatives who are not willing to accept the change. Mabey et al. (2005) argued that organizational change when implemented by others looks threatening and includes very often loss of face as the employees are not able to change rapidly. Brown (1998) suggested that resistance to change comes both from the individual and the organization. Individuals
are possible to resist when they feel that the change does not satisfy their standards of fairness and security. On the organizational level resistance may be caused by powerful groups such as employee unions that might feel that through the change their power and influence will be lost (Brown, 1998).

The social partners are often a powerful group within the organization, which might resist change. Heyes (2000) attempted to explain how training in the workplace was connected to industrial relations and how the social partners can influence training within an organization. He claimed that training is likely to have positive relationship with trade union representatives especially in organizations where unionism is recognized.

3. Methodology

Whipp (1998) characterized case study as the flagship of qualitative research. And as qualitative data were gathered and analyzed in this research, the most appropriate research strategy to follow is the case study. The research methods employed during the gathering of data in this research were semi-structured one-to-one interviews and analysis of secondary data.

Semi-structured interviews were considered the most suitable research method to use as it gave through the responses of the interviewees the opportunity to probe meanings that add value and depth to the data (Saunders et al., 2007). Furthermore, due to the fact that the respondents built and explained their answers, the discussion ended up in fields that were not taken into consideration but were of major importance for the research objectives (Saunders et al., 2007).

All the interviews were recorded so that the expressions of the interviewees and other non verbal elements would be carefully observed (Saunders et al., 2007).

Documentary secondary data were also used in this research. This term involved written materials such as reports to shareholders, public records, journals, magazine articles etc. This kind of data were used in order to offer qualitative data such as reasons that lead managers to certain decisions and assisted in triangulating findings based on other information (Saunders et al., 2007).

A case study research in one organization in the banking sector was undertaken in order to identify the role of training during a merger process. In order to accomplish the research aims and objectives, a non-probability, purposive sampling strategy was adopted. Fifteen individuals were interviewed: the current Head of Training and HR Departments of the organization who belonged to the workforce of Bank A before the merger,

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1 As secondary data will be used the annual reports of Bank A from 1999 to 2007
the Head of Training and HR Departments of the organization during the merger who are now retired or work for other organizations, the current IT manager who held the exact position in Bank A during the merger, the manager in charge of a business process reengineering who now work for another organization but was an employee of Bank A and the representatives of the employee unions from the merging Banks. Most of the interviewees belonged to the workforce of Banks A and B for a long time and the majority of them kept their positions after the merger. Due to limited access in the organization it was not possible to have the view of the employees individually. Therefore, as the entire workforce is unionized, it was decided to have the employees’ view collectively through the employee unions.

A grounded theory approach was taken towards data analysis. Coding began after primary data were collected. In this procedure, the data were split into constituent parts which were given names (Bryman and Bell, 2007). Charmaz (1983) argues that codes give the opportunity to separate, label and organize the data and at the same time they form a primary step in the development of theory (Bryman and Bell, 2007). Moreover, in this type of analysis, data are always in potential fluidity or revision (Bryman and Bell, 2007).

4. Findings

The primary target of the merger between Bank A and Bank B was the creation of a financial organization with human resources properly trained in contemporary techniques of financial sector, devoted and highly committed to the organization who emphasize on qualitative customer services and enhancement of competitiveness (Bank A annual report, 2000).

Building a financial group that could become competitive in the Balkans and at the same time able to play a protagonistic role in the Greek banking market was not an easy goal for the managers and the employees. The fact that the two banks differed substantially in many levels, created the imperative for a strategic plan in which all the departments of the organization would participate.

The training strategy which was designed played an important role in the merger and contributed at the utmost in a smoother transition from the previous organizations to the new one. The Training Department in cooperation with the HR and IT Departments undertook the responsibility of materializing the merger—as long as the human resources side is concerned.
4.1 Change in the IT

In the case of the merger between Bank A and Bank B, merging the IT systems was complicated due to the fact that the two banks had fundamental differences in their systems and the way they handled the products and services.

The primary target set by the management was the recently unified network to offer the exact services regardless of the bank that the client belonged to before the merger. Within three months a new platform was created which gave the opportunity to the clients to go to any branch either of Bank A or Bank B and do any kind of transaction.

At the beginning of the merger the management decided to follow the already existing platform of Bank A which was more up-to-date. In this case, the IT Department had to have a close cooperation with the Training Center of Bank A in order to help the employees who belonged to Bank B align themselves with the new systems.

The IT manager of the united bank attempted to explain why it was chosen to use the IT system of Bank A instead of the one Bank B had or a completely new designed. Firstly, the creation of a new IT system would be time-consuming and expensive. Moreover, it would demand a double amount of training as they would have to train the entire workforce. Another drawback was that until the design of the new system, the two banks would be obliged to work separately for a long period and the message of the unified bank would be delivered neither to the customers nor to the employees. In addition, keeping both IT systems would not serve the targets of the merger.

4.2 The role of training in the merger

Catalytic in the success of the merger was the contribution of the Training Department. It was the one that had to collaborate with most of the departments in order to help the employees of the merging banks experience a smooth transition and enhance their technical skills according to the needs of the new bank. As the structure of Bank A and Bank B had major differences, training managers had to design a plan and complete the coalescence of the two workforces in rather brief time.

The training managers of the new Bank created a strategic plan with horizon of one and a half year. Its main targets were the consolidation of an amalgamated culture, the unification of IT systems and the learning of products and services of the new bank. Under this strategic plan, the training program concerning the merger was created which involved training programs related to both technical and behavioral issues and employees of all levels of hierarchy were involved. The Training managers of Bank A argued that most of the employees trained belonged to the
workforce of Bank B. This phenomenon was a consequence of the management’s decision to follow the structures, products and services of Bank A.

The strategic plan of training in this particular merger involved two types of programs. The short-term programs were more concerned with technical issues and the learning of the products of the new Bank while the long-term touched upon behavioral issues and the establishment of a new culture in the bank.

The short-term training programs were focused on IT services, new products and customer services. Through this technical training the employees of the two banks were able to serve clients regardless of the bank they belonged before the merger.

The long-term programs were more difficult to achieve as they involved behavioral and managerial issues and aimed at the creation of a new organizational culture. However, managers had to confront several problems regarding the change of cultures due to the fact that the two banks differed significantly in their organizational cultures and the way they confronted the clients. Bank A was a private bank and its culture was shaped to those kinds of principles whereas Bank B was public and its culture was completely diverse.

Despite the fact that the majority of the training programs focused on the technical enhancement of the workforces, it would be inept to argue that the human factor was neglected. The Training Department of the new Bank used various technical programs as a Trojan Horse in order to train the employees of both banks on behavioral issues too and assist in the formation of the new organizational culture.

In order to achieve cultural change without major loses or resistance, training managers adopted a more educative approach (Bate, 1994). They attempted, through training, to introduce the new culture which was more close to this of Bank A and show them that this would be more beneficial. In the training programs specializing on behavioral issues and cultural change employees of all levels of organizational hierarchy were involved. The senior training manager of A and the HR manager of Bank B organized training programs and toured the whole network where they familiarized the employees with the cultures of both banks and introduced the new culture they wanted to create. Moreover, most of the training programs running at this period of time were mixed in order to help the new colleagues feel closer, united and adopt a common culture. Despite the fact that the culture of Bank A was dominant, several values of the Bank B were introduced and formed the culture of the new Bank.

All the training programs that run during the merger were specially designed on a no discrimination basis. The unity of workforces that the training programs promoted was of major importance, according to the
Training manager, for the smooth transition to the new culture. In all the programs, both the behavioral and the ones related to enhancement of technical skills employees of both banks participated. The Head of Training Department of the new Bank argued that ‘basic principle of the training department was the avoidance of any kind of discrimination’. This policy helped the employees of Bank B feel equal to their colleagues even if they were the ones ‘acquired’. A different point of view had the training manager of Bank who believed that there was not a strong effort from the side of Bank A to approach the employees of Bank B while training gave a wrong impression of equality between employees of the two banks.

In their critical evaluation of the merger and the role of training in its success, the training managers of Bank A argued that most of the training programs adopted were successful and contributed to the creation of the new, stronger Bank.

Several limitations and behaviors restricted the faster unification in cultural level of the two banks. The training managers had to face the anachronistic perception of some employees and managers of Bank A who viewed their new colleagues as losers on whom they had to dominate. This kind of behavior combined with the fear of the employees from the acquired Bank B made the work of training harder. Therefore, one of the priorities in the strategic plan of Training Department was the elimination of a ‘we and you’ culture and the establishment of a new perception where all the colleagues, united would fight for a common target which was the development of the new Bank.

The training strategy adopted during the merger can be characterized unique as it was both human and technology centered. From the beginning of the merger, training was strategically planned and managers had specified their priorities and aims.

4.3 How did a business reengineering process serve the merger?

One year before the merger, Bank A had initiated a business process reengineering with main target the transformation of the regular banking branch into a modern branch offering banking services.

The role of this pioneer business process reengineering was not only to assist the bank in becoming more competitive and enter a market segment where previously had minor presence. It was also used as the vehicle that training managers employed in order to unite the workforces of the two banks and help them adopt the new organizational culture that was formed after the merger.

In the training programs designed to support the business process reengineering participated employees belonging to the workforces of both the merging banks. Hence, the training groups formed were mixed and the new colleagues were introduced to each other’s culture and idiosyncrasy.
Moreover, the fact that the reengineering project was new for both banks meant that all employees had to adapt themselves in the new environment. This was a major chance for the managers to unify the two workforces and help them start collaborating under the same organization with common aims and a common culture.

4.4 HR Department: the closest partner in the merger

If the human resources are the most valuable asset of an organization, no change plan can be successful if they are not strategically managed (Mabey et al., 1998). In the case of the merger between Bank A and Bank B, the Human Resources Department was responsible for the successful utilization of the employees and its managers formed the needs according to which the training programs were designed and materialized.

The fact that the two banks differed substantially in their culture and the way they perceived the banking operations were the major problems which had to be solved in order to accomplish the strategic goals of the merger. A further problem was the fear of the employees who perceived the merger as a battle which they lost and this would have consequences on their jobs.

In order to overcome those problems, the HR department collaborated with the Training Department in both technical and cultural level. The first step as the HR managers of Bank A noted was to mix the two workforces. Through the concentration of branches, they initiated the formation of economies of scale, the decrease of operation costs and the unification of the workforce. To further reinforce this strategy of the HR department, the training managers designed their programs to operate in mixed groups in which the employees could introduce themselves to their new colleagues and start collaborating with them.

Equality was another basic principle on which Bank A structured its HR strategy. Hence, the non discrimination policies implemented by the HR Department were transferred to the Training Department too.

4.5 Time: a major opponent

According to Johnson and Scholes’s (2004) change kaleidoscope time could be a critical factor influencing the management style adopted during change. In the case of the merger between Bank A and Bank B the pressure of time was of major importance. Despite the fact that it was not a matter of survival, (Johnson and Scholes, 2004) other external factors forced the management of the new Bank to follow an already existing management style, this of Bank A and sacrifice several valuable features found in Bank B. Moreover, a plan lasting 1 ½ year was designed and the managers could not stray from it.
4.6 Resistance to change

Mergers do not always involve a peaceful transition from the previous organizations to the new one. The feeling of fear for the unknown was the major challenge that HR and Training managers had to face in the merger between Bank A and Bank B, as the vast majority of the employees viewed it suspiciously. In order to fight this kind of phenomena and eliminate the feeling of fear from the employees, the Training Department in cooperation with the HR Department organized programs that involved training in behavioral issues.

Another major challenge the managers confronted was changing the cultures. According to Seo and Hill (2005), the mixture of different cultures is one of the unique problems identified in mergers. After the acquisition and the merger a new private bank was formed. The new culture that would supposedly be formed was this of a private bank. Bank A already had a relative culture. However, this was a complicated procedure for the employees of Bank B who were used to a completely different way of thinking and behaving. Hence, the resistance from the employees -especially those with many years of service- was high.

4.7 Social Partners: ministrant or hindrance in the merger?

In Bank A and Bank B employee unions played a protagonistic role. Due to the fact that both banks were highly unionized, the employees’ representatives were involved in the important decisions of the banks playing either a positive or a negative role.

Bank A’s unionists supported that during the merger they played the role that the Training and the HR Department were supposed to play. They admit that the IT systems and cultures of the two banks were substantially different and hard to unite and the attempt to mix the populations rapidly defeatured the basic principles in the culture of Bank A causing corrosion in the quality of work of the employees. In addition, management did not pay proper attention to behavioral issues and the whole burden of the cultural change was put in the arms of the unionists. This was against the employees of Bank A who felt ‘abandoned’ by their representatives whereas the employees of Bank B were favored by the unionists who were trying to integrate them.

A completely different point of view though came from the unionists of Bank B who believe that their colleagues had to fit in into the already existing system and culture of Bank A without keeping the values and behaviors that they had in the previous organization. For this incident, unionists also blame their representatives during the merger who only tried to resist without attempting to negotiate the rights of the ‘acquired’ employees. Loss of valuable time combined with the lack of a strategic
plan, concerning training for the new environment lead to a devaluation of the employees who were forced to retire earlier or resign.

Despite the fact that training is further enhanced when employee unions participate in the training decisions (Heyes, 2000), this positive relationship between training and unionism cannot be proved in this particular merger due to the fact that training was not a first priority in the agenda of the employees’ representatives.

5. The merger between Bank A and Bank B: A critical commentary

It was characterized as the ‘bloodless’ and one of the most successful mergers in the history of the Greek banking sector. It was the merger with the least resistance to change, without massive job losses that formed a powerful private bank in Greece and the Balkans. However, years after the merger and despite the indubitable success, there are still some issues that remain under question.

Most of the managers, especially those coming from Bank A, viewed the merger as completely successful that accomplished most of its strategic goals. The same managers stressed the catalytic role that training played in materializing a rather difficult unification of two completely different cultures and technological systems. However, as it could be observed, it was the culture and IT of Bank A that dominated even if slightly changed with elements of Bank B.

Moving towards training, both Training and HR managers agreed on the protagonistic role it played in the success of the merger. They argued that it was designed on the principle of no discrimination and helped the employees come together, collaborate and learn the culture of the new bank. All the programs were designed to enhance their technical and behavioral skills in order to achieve better quality of customer services as quickly as possible.

However, a totally different point of view existed in a minority of managers of Bank B. They thought that there was no strategic design for the merger and the employees and managers of Bank B had to fit within Bank A without anyone taking into consideration their needs. For them equality promised was not materialized and Bank A’s employees were promoted in all levels. Hence they perceived the merger as unsuccessful to achieve its strategic goals.

The current Head of Training Department attempted to evaluate the overall results of the merger. He argued that the success of the merger can be proved by the fact that the training policy followed appeals to the employees of the new formed Bank. Neither of Bank A nor of Bank B.

On the other hand, the unionists of both banks do not share the same point of view with the management. Employees representatives from Bank A argued that the merger put a further burden on them as because had to
support an integration between two completely different cultures which were not matching. At the same time unionists of Bank B supported the view that the merger caused fear and uncertainty to them and the employees of their bank while racism and discrimination were a common problem.

In conclusion, it should be stated that this merger was completely successful and employees training played a basic role in it. However, the fact that in the beginning of the merger more attention was paid to the technical skills and the quick response to customers’ need had several costs to the employees. The first years after the merger, the employees had accomplished to work as one machine but they did not feel united.

Years after the merger, with reasonable amount of time spent on managerial and behavioral skills and after the recruitment of new employees such phenomena have been eliminated and the new Bank continues its dynamic presence in the Greek banking sector.

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Factors affecting motivation of employees in public sector: the case of the prefecture of Drama-Kavala-Xanthi

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Abstract:
This study aims to identify the factors that affect the motivation of employees in the Greek public sector and particularly in the Prefecture of Drama – Kavala – Xanthi as well as to classify the employees in strategic groups according the factors that affect their motivation. The survey was conducted through a postal survey based on a questionnaire that was designed by the researchers. The survey took place in spring of 2008 and was based on a random sample of 161 employees. The productive response rate was 68% (110 questionnaires). The factors that affect personnel motivation derive from Principal Component Analysis are: (a) Economic rewards, (b) Differentiation from colleagues, (c) Moral rewards, (d) Working environment and (e) Personal improvement. Furthermore, the employees in the Prefecture of Drama – Kavala – Xanthi can be classified according their motivation in three strategic groups: (i) Differentiators, (b) Money orientated and (c) Interested in personal improvement. A chi-square analysis was performed to profile the employees of each group of motivation regarding their job and personal characteristics. Many job and employees’ characteristics such as working status, working experience, responsible position, computer qualification, education, affect their motivation at work.

Keywords:
Work Motivation, Public Administration, Motivation in Public Sector, Human Resources Management in Public Sector

1. Introduction
Public servants have bad reputation regarding their ineffictivity and fear of responsibility. There are many reports by citizents regarding bureaucrats laziness and bureaucratic errors abound. The lack of monetary incentives at public organizations is supposed to attract workers who are most averse to exerting effort. This pessimistic view is prominent according to Delfgaauw and Dur (2004) in economic literature.
On the other hand, when citizens are asked to state their opinion about public services based on personal experience, they tend to be satisfied with the performance of the agency (Delfgaauw and Dur 2004). Citizens’ evaluation of a specific agency or civil servants is significantly better than the evaluation of the public sector in general (Katz et. al. 1997, Goodsell 1985). Hence, there are some public servants that do not clash with the stereotype mentioned above. It is also in line, with a number of researches that have been published and highlighted the importance of “personnel motivation” on public sector (Francois 2000; Delfgaauw and Dur 2002; Dixit 2002; Besley and Maitreesh 2003; Prentergast 2003; Glazer 2004). Incentives’ policy, working conditions, promotion prespectives, personnel’s contribution to decision making process and the general behaviour framework are some important factors affecting the employees’ satisfaction within an organization (Karamfillidis 2006).

According to Brewer (2003) people choose to work in the public sector because they want to serve the society. They are motivated by a strong desire to serve the public interest, service to others and self sacrifice (Perry 2000; Boyne 2002; Houston 2005). Furthermore, public servants show a stronger service ethic, than private sector employees (Wittmer 1991). Some other factors that affect personnel motivation in public sector are: the opportunity to have an impact on public affairs, commitment to serve the public interest and the interest in achieving social justice (Perry 1996; Naff and Crum 1999; Brewer 2003 and Houston 2005).

Several studies indicated that private sector employees and managers value economic rewards higher that public sector employees and managers (Crewson 1997; Karl and Sutton 1998; Houston 2000). Some other researchers argued that public sector employees are less extrinsically and more intrinsically motivated; this means that they are more motivated by job content, self-development, recognition, autonomy, interesting work and opportunity to learn new things (Crewson 1997; Jurkiewicz et.al. 1998; Karl and Sutton 1998; Houston 2000; Houston 2005). Needs for self development and recognition are also important factors that motivate workers in private sector (Rainey 1982; Wittmer 1991; Jurkiewicz et.al. 1998). Job security and stability have an impact on public servants’ motivation according to Jurkiewicz et. al. (1998). Furthermore, factors including age, gender, education, hierarchical administration level found to be significant related to personnel motivation in public sector (Wittmer 1991; Crewson 1997; Karl and Sutton 1998; Kacmar et. al. 1999; Jurkiewicz 2000; Moon 2000).

On the other hand, according to Manolopoulos (2008) the public sector in Greece is more likely to provide extrinsic than intrinsic rewards, however the latter seems to be related to better organizational outcomes. Moreover, a supportive context as expressed by encouragement of
initiatives and access to managerial information motivate employees in public sector to develop entrepreneurial behaviour which until recently remains restricted to top and middle managers and elected politicians and focuses on policy promotion and initiatives concerning public sector transformation (Zampetakis and Moustakis, 2007). Individuals’ ability and demographic characteristics are core determinants of employees’ motivational preferences (Manolopoulos 2008).

Although few studies took place concerning the examination of the motivational behaviour of public servants in Greece, there is no study that aimed to identify the factors that affect the motivation of the Greek public servants and to classify them according to their motivational patterns. As most of the knowledge regarding the motivation of public servants’ is derived from international studies, the examination of the factors that affect the motivation of employees in the Greek public sector is extremely important because different organizational and national cultures affect the personnel’s motivation in a different way (Kline and Peters 1991; Cho and Lee 2001). Hence, this study examines which of the factors presented in the literature review affect the personnel motivation in the Prefecture of Drama – Kavala – Xanthi, that is a complex organization consisting of three Prefectures (Drama, Kavala and Xanthi) and one Central Office; and comprises a kind of precursor of the elected Regions the Greek state plans to establish.

2. Methodology

2.1 The Conceptual Model

In this study, a conceptual model aims to place the key concepts outlined in the literature review into an identifiable framework, which is illustrated in the Figure 1 below. In particular, it tries to investigate the relationships between aspects of the internal and external environment of an organisation and the development of key dimensions (factors) that may influence employees’ motivation as well as to examine the association between the job and employees’ characteristics and a particular motivational behaviour.
2.2 Hypotheses and Operationalisation

The aims of a research should be turned into operationalised aims, which are the hypotheses to be investigated (Oppenheim 2000). Thus, when a conceptual model is operationalising, the hypothesis asserts the relationships between the setting variables. In the conceptual level of this research the hypotheses that are investigated are the followings:

![Conceptual Model Diagram]

**Figure 1: The Conceptual Model**

**Factors affecting personnel motivation**
- Economic Rewards
- In Kind rewards (e.g. days off, travels)
- Prestige
- Promotion Perspectives
- Recognition by colleagues and supervisors
- Power of position
- Working environment
- Working relations with other colleagues
- Opportunities for self development

**Job characteristics** (subject of work, indoor working activities or ...)

**Classification of employees to groups according to their motivational**

**H1**

**Employees’ characteristics** (age, education, previous working experience)

**H2**
H1: Employees of the Prefecture of Drama – Kavala – Xanthi can be classified into groups according to the factors that affect their motivation at work.

H2: The job and employees’ characteristics are significant related to a particular motivational behaviour.

The operationalisation of the conceptual model of this study is presented in the Figure 2.

Operationalizing the Conceptual Model, the concepts transformed to the variables presented in Appendix I.
Figure 2. Operationalisation Model
2.3 Survey Procedure

The researchers undertook a survey of sample employees to gather data necessary to identify the factors that affect the motivation of personnel in the Prefecture of Drama – Kavala – Xanthi.

Information were gathered through a postal survey as the employees in the Prefecture of Drama – Kavala - Xanthi are familiar with this kind of research and their educational level is suitable to use this kind of survey method. Additionally, the cost of conducting large interview survey sample to develop a typology was considered prohibitive. Furthermore, the postal method was more confidential as the researchers should not have access to the personal protected data of the workers.

In order to generalize their findings to a larger population than the sample from which the data have been collected, researchers should ensure that the sample is representative of the population. The databases of the human resources departments of the Prefectures of Drama, Kavala, Xanthi and Central Office were used as sample frameworks. Moreover, the problem with the protection of the sensible personal data was overcome by sending the questionnaires to the employees through the human resources departments of each prefecture (Drama, Kavala, Xanhi) and Central Office.

In this survey, a random selection of employees was made to form the sample due to the fact that the authors wished to generalize their findings beyond the sample of workers covered by the survey. As errington (1985) argued the only way in which this can be achieved is to ensure that the units for survey are selected at random from the larger population about which generalization are to be made. The sample that was selected consists of 161 employees which would be reasonably representative of some larger population about which useful generalization could be made. The size of the sample is detailed Table 1:

<table>
<thead>
<tr>
<th>Prefecture</th>
<th>Number of employees</th>
<th>Sample</th>
<th>Productive Sample¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drama</td>
<td>385</td>
<td>50</td>
<td>41</td>
</tr>
<tr>
<td>Xanthi</td>
<td>273</td>
<td>50</td>
<td>22</td>
</tr>
<tr>
<td>Kavala</td>
<td>286</td>
<td>50</td>
<td>39</td>
</tr>
<tr>
<td>Central Office</td>
<td>11</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>955</strong></td>
<td><strong>161</strong></td>
<td><strong>110</strong></td>
</tr>
</tbody>
</table>
The productive sample consists of the employees that have answered all the questions of the questionnaires and therefore the questionnaire was possible to be subject of statistical analysis.

It is a stratified random sample, with each prefecture being represented in the sample in the same proportion as it appears in the main population. Hence, a more efficient estimation of some population characteristics that might exist in each prefecture will take place rather than sampling from the population at large (Barnett 1991; Fink 1995). In order to check that this sample was reasonably representative, the researchers compared the characteristics of the sample with those of the total population following the methodology that Errington (1984), Tsourgiannis et. al. (2006), Tsourgiannis (2007) and Tsourgiannis et. al. (2008) used in their studies. The characteristics of the selected sample with those of total population are compared in Table 2. The sample comprises the 11.5% of the total population and is reasonable representative of them as all the characteristics (as described in Table 2) do not differ from those of the total population.

Table 2: Evaluation of the sample

<table>
<thead>
<tr>
<th>Number Employees</th>
<th>Total number of employees</th>
<th>Percentage Composition of the total population</th>
<th>Productive Sample</th>
<th>Percentage Composition of the productive sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>561</td>
<td>58.7</td>
<td>59</td>
<td>53.6</td>
</tr>
<tr>
<td>Female</td>
<td>394</td>
<td>41.3</td>
<td>51</td>
<td>46.4</td>
</tr>
<tr>
<td>No of employees &lt;=40 years old</td>
<td>201</td>
<td>21.0</td>
<td>33</td>
<td>30.0</td>
</tr>
<tr>
<td>No of employees 41-60 years old</td>
<td>699</td>
<td>73.2</td>
<td>75</td>
<td>68.2</td>
</tr>
<tr>
<td>No of employees &gt;=61 years old</td>
<td>57</td>
<td>6.0</td>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td>No of employees with working experience in public sector &lt;=10 years</td>
<td>258</td>
<td>27.0</td>
<td>41</td>
<td>37.3</td>
</tr>
<tr>
<td>No of employees with working experience in public sector 11-30 years</td>
<td>606</td>
<td>63.5</td>
<td>51.8</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------------------------</td>
<td>-----</td>
<td>------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>No of employees with working experience in public sector &gt;=31 years</td>
<td>91</td>
<td>9.5</td>
<td>10.9</td>
<td></td>
</tr>
</tbody>
</table>

1Data provided by the Human Resources Departments of Prefecture of Drama, Prefecture of Kavala, Prefecture of Xanthi and Central Office.

The survey was conducted in spring of 2008. The response rate achieved was 95% but the productive response rate was 68% as some employees refused to answer the questionnaire due to lack of time or because they thought that their sensitive personal data are not protected enough.

2.4 Questionnaire design

Factors that affect the motivation of employees mainly in public sector were identified by the researchers after searching the public administration and human resources literature. Furthermore, they designed a questionnaire in order to meet the research objectives and pre-tested it in academics, public administration experts and public servants. In the next stage the questionnaire was piloted in January and February of 2008 to 20 employees of the Prefecture of Drama – Kavala – Xanthi. The pilot survey indicated that the questionnaire did not need any modification and therefore the main survey was conducted in spring of 2008 as mentioned above.

The questionnaires were designed in three parts:
Part 1 – Working environment: this consisted of 5 questions regarding the description of the working environment.
Part 2 – Motivation attitudes at work: this consisted of 42 attitudinal statements on a 5 point Likert scale relating to their motivational behaviour. These questions covered areas such as rewards, prestige, promotion perspectives, working environment, power, interpersonal relations.
Part 3 – Job and personal characteristics: this consisted of 17 questions related to characteristics such as age, education, income, responsible position, working experience, marital status, computer skills.
2.5 Statistical Methodology

Multivariate analysis techniques were used to reveal the key information contained in the responses, and these analyses were applied to three stages. First, principal component analysis (PCA) was used to identify the variables that accounted for the maximum amount of variance within the data in terms of the smallest number of uncorrelated variables (components). In this study, PCA reduced the 20 key attitude variables (listed in Appendix I), which relate to various aspects of employees motivation, to a smaller number of underlying factors (or strategic dimensions). An orthogonal rotation (varimax method) was conducted and the standard criteria of eigenvalue = 1, scree test and percentage of variance were used in order to determine the factors in the first rotation (Hair et al. 1998). Different trial rotations followed where factor interpretability was compared. Factor analysis enables scores to be calculated for each underlying factor, and these are substituted for the original variables.

These factor scores were then subjected to cluster analysis to group employees with similar patterns of scores into similar clusters based on their motivational behaviour. In this study, both hierarchical and non-hierarchical methods were used according to the recommendations of Hair et al. (1998), Siardos (1999), Punj and Stewart (1983), Mc Intyre and Blashfield (1980), Tsourgiannis et. al. (2006), Tsourgiannis (2007) and Tsourgiannis et. al. (2008) in order to develop a typology regarding the motivation of employees in the Prefecture of Drama-Kavala –Xanthi.

Quadratic discriminant analysis was performed to assess how accurately the identified factors that affect personnel motivation, which were derived from the factor analysis, could predict and discriminate group membership. Bivariate statistical tests including chi-square analysis performed to develop the profile of each group of employees.

3. Results

3.1 Description of employees’ motivation patterns.

Principal components and factor analysis (through a varimax rotation) were conducted, and the latent root criterion (eigenvalue =1), the scree plot test and the percentage of variance were used to determine the number of factors. All three criteria suggested that there were five factors in the first rotation.
Results of Principal Components Analysis of Strategy Variables.

<table>
<thead>
<tr>
<th>Components</th>
<th>Eigenvalues</th>
<th>% of Variance</th>
<th>Cumulative Variance %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.612</td>
<td>33.060</td>
<td>33.060</td>
</tr>
<tr>
<td>2</td>
<td>2.395</td>
<td>11.973</td>
<td>45.033</td>
</tr>
<tr>
<td>3</td>
<td>2.029</td>
<td>10.147</td>
<td>55.179</td>
</tr>
<tr>
<td>4</td>
<td>1.243</td>
<td>6.215</td>
<td>61.395</td>
</tr>
<tr>
<td>5</td>
<td>1.004</td>
<td>5.021</td>
<td>66.416</td>
</tr>
<tr>
<td>6</td>
<td>0.884</td>
<td>4.421</td>
<td>70.837</td>
</tr>
<tr>
<td>7</td>
<td>0.726</td>
<td>3.631</td>
<td>74.468</td>
</tr>
<tr>
<td>8</td>
<td>0.646</td>
<td>3.232</td>
<td>77.700</td>
</tr>
<tr>
<td>9</td>
<td>0.628</td>
<td>3.140</td>
<td>80.841</td>
</tr>
<tr>
<td>10</td>
<td>0.603</td>
<td>3.015</td>
<td>83.855</td>
</tr>
<tr>
<td>11</td>
<td>0.526</td>
<td>2.630</td>
<td>86.485</td>
</tr>
<tr>
<td>12</td>
<td>0.477</td>
<td>2.383</td>
<td>88.868</td>
</tr>
<tr>
<td>13</td>
<td>0.403</td>
<td>2.013</td>
<td>90.881</td>
</tr>
<tr>
<td>14</td>
<td>0.364</td>
<td>1.821</td>
<td>92.702</td>
</tr>
<tr>
<td>15</td>
<td>0.345</td>
<td>1.725</td>
<td>94.427</td>
</tr>
<tr>
<td>16</td>
<td>0.286</td>
<td>1.429</td>
<td>95.856</td>
</tr>
<tr>
<td>17</td>
<td>0.254</td>
<td>1.272</td>
<td>97.127</td>
</tr>
<tr>
<td>18</td>
<td>0.238</td>
<td>1.188</td>
<td>98.316</td>
</tr>
<tr>
<td>19</td>
<td>0.182</td>
<td>0.909</td>
<td>99.224</td>
</tr>
<tr>
<td>20</td>
<td>0.155</td>
<td>0.776</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Several different trial rotations were conducted to compare factor interpretability as suggested by Tabachnick and Fiddell 1989, Child 1990, Malhotra 1996, Hair et al 1998.

Factor analysis identified five factors which explained the 66.416 % of the total variance (Table 3). The factor loading scores of the twenty variables onto the five factors are presented in Table 4. The cut-off point for interpretation of loading scores was 0.54 according to Hair et al. (1998) and Tabachnick and Fiddell (1989) suggestions.
Table 4. Key Factors Derived from Principal Component Analysis.

<table>
<thead>
<tr>
<th>PRINCIPAL MOTIVATION FACTORS</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economic Rewards</strong></td>
<td></td>
</tr>
<tr>
<td>V14 Extra economic rewards</td>
<td>0.85</td>
</tr>
<tr>
<td>V15 Extra days off</td>
<td>0.78</td>
</tr>
<tr>
<td>V13 Salary</td>
<td>0.78</td>
</tr>
<tr>
<td>V18 Business trips</td>
<td>0.64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Differentiation from colleagues</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>V3 The fact that the employee desires to be better than his colleagues</td>
<td>0.75</td>
</tr>
<tr>
<td>V6 Power</td>
<td>0.74</td>
</tr>
<tr>
<td>V20 Prestige</td>
<td>0.73</td>
</tr>
<tr>
<td>V19 Valuable acquaintances</td>
<td>0.57</td>
</tr>
<tr>
<td>V1 The feeling that the employee is valuable to his/her organization</td>
<td>0.54</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moral rewards</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>V17 Moral rewards (e.g. thanking by supervisors)</td>
<td>0.76</td>
</tr>
<tr>
<td>V16 Evaluation reports</td>
<td>0.69</td>
</tr>
<tr>
<td>V10 The fact that he/she is considered as a loyal cooperator by his/her supervisors</td>
<td>0.69</td>
</tr>
<tr>
<td>V11 Support by his/her supervisor</td>
<td>0.68</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Working environment</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>V4 Support by his/her colleagues</td>
<td>0.84</td>
</tr>
<tr>
<td>V2 Team work</td>
<td>0.81</td>
</tr>
<tr>
<td>V5 Working environment</td>
<td>0.57</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Personal improvement</th>
<th>Factor Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>V9 Freedom of creativity</td>
<td>0.79</td>
</tr>
<tr>
<td>V12 Opportunities for personal improvement</td>
<td>0.68</td>
</tr>
</tbody>
</table>

Determinant of Correlation Matrix: 0.00004 ,
KMO MSA = 0.827
Bartlett test of Sphericity = 1,030.613  P <0.001

In the next stage, hierarchical and non-hierarchical clustering methods were used to develop a typology of the motivation patterns that personnel of the Prefecture of Drama- Kavala - Xanthi follow (Harrigan 1985; Helsen and Green 1991; Hair et al. 1998; and Siardos 1999). Cluster analysis differs from factor analysis in that the former groups objects (in this case employees), whereas the latter is concerned with grouping variables. Factor scores are standardised (mean = 0, standard deviation =1). Cluster analysis was conducted on the 110 observations, as there were no outliers.
It identified three clusters of employees that were named according to their motivational behaviour strategy (Table 5). These are: (a) “Differentiators”, (b) “Interested in Personal Improvement” and (c) “Money Orientated”.

**Table 5.** Characteristics of the Three Strategic Groups

<table>
<thead>
<tr>
<th>Principal Motivation Factors</th>
<th>Clusters (Groups of Employees)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>“Differentiators”</td>
<td>“Interested in Personal Improvement”</td>
</tr>
<tr>
<td>Economic Rewards</td>
<td>0.018&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.403&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>0.747</td>
<td>1.013</td>
</tr>
<tr>
<td>Differentiation from colleagues</td>
<td>0.652&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.557&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>0.904</td>
<td>0.672</td>
</tr>
<tr>
<td>Moral Rewards</td>
<td>0.140&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.141&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>0.834</td>
<td>0.942</td>
</tr>
<tr>
<td>Working Environment</td>
<td>0.173&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.155&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>0.761</td>
<td>0.967</td>
</tr>
<tr>
<td>Personal Improvement</td>
<td>-0.440&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.685&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>0.904</td>
<td>0.711</td>
</tr>
<tr>
<td>Number of employees (n=110)</td>
<td>52</td>
<td>43</td>
</tr>
</tbody>
</table>

**NB:** Within rows, means with different superscript differ significantly at P<0.05 according to Tukey’s post hoc test. Means are reported in standard text and standard deviations in *italics.*

Employees of the first group named “Differentiators” are very interested in being differentiated by their colleagues and comprise the 47.3% of the sample. These employees are mainly motivated by the factor “differentiation from colleagues” and in a lesser extent by the factors “working environment” and “moral rewards” (Figure 3). Moreover they are little influenced by the factor “economic rewards” whilst they are not interested in the factor “personal improvement”. In particular, employees of this group are mainly motivated in their work by the fact that they want to be better than their colleagues, the feeling of power, prestige and acquaintances that might be valuable for them. They also desire to considered to be valuable to their organization. Support by their colleagues, team work, working environment, moral rewards, good marks in the annual valuation system, loyalty and support by supervisors are some factors that affect the personnel motivation but it a smaller degree than the above mentioned factors. Economic rewards including bonus, extra days off, salary and business trips are not particular important for the
motivation of these employees. On the other hand, they are not affected by factors such as freedom of creativity and opportunities for personal improvement.

Factors affect the motivation of the group of employees named “Differentiators”.

![Bar chart showing factors affecting motivation](Figure 3. Factors affect the motivation the group of employees named “Differentiators”.

The second group of employees named “Interested in Personal Improvement” is interested in their personal improvement through their job and is the 39% of the sample. These employees are mainly motivated in their work by the factor “personal improvement” and in a smaller degree by the factors “working environment” and “moral rewards”(Figure 4). On the other hand, they are not interested in the factors “differentiation from their colleagues” and “economic rewards”. More specifically, employees of this group are very interested in the freedom of creativity that their job provides as well as in the opportunities for personal development. Significant impact in their motivation at work has the support of their colleagues, team work and the working environment. Furthermore, moral rewards including thanking by supervisors, good marks in the evaluation system, the fact that they considered valuable cooperators by their supervisors as well as supervisors’ support, are some other factors that affect the motivation at work of this group of employees. On the other hand, factors such as, differentiation from the other colleagues, power, prestige, acquaintances that might be valuable for the employees, are not significantly related to the motivation of this group of employees at work.
Economic rewards like bonus, business trips, salary do not affect personnel motivation of this group.

Figure 4. Factors affect the motivation the group of employees named “Interested in Personal Development”

Employees of the third group named “Money Orientated” are very interested in economic rewards such as extra bonus, extra days off, salary and business trips (Figure 5). On the other hand, employees’ differentiation, ethic rewards, working environment and personal improvements have no impact on the motivation of this group of employees.
Factors affect the motivation of the group of employees named “Money Orientated”

The predictive accuracy of the discriminant model was evaluated using the cross validation technique that Minitab 12 provided. The analysis indicated that 97.3% of the examined employees were classified correctly. More specifically, the proportion of personnel that were classified correctly in the group “Differentiators” 96.2%, 97.7% were classified correctly in the group “Interested in Personal Improvement”, while the 100% of the workers that appeared to be interested in economic rewards (Money Orientated) were correctly classified. The summary of the cross validation classification is shown in Table 6.
3.2 Profiling each group of employees according to their job and personal characteristics.

A one-sample chi-square test was performed for each group of employees in order to develop the profile of their motivation regarding their job and personal characteristics.

The profiles of the three motivation groups regarding their job and personal characteristics is illustrated in Tables 7.
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>“Differentiators”</th>
<th>“Interested in Personal Improvement”</th>
<th>“Money Orientated”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>χ²</td>
<td>% employees</td>
<td>Standardized Residuals</td>
</tr>
<tr>
<td><strong>Employment Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenure Long term contracts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x²=71.715, df=2, P&lt;0.01</td>
<td>88.5%</td>
<td>6.90</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short term contracts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x²=24.085, df=2, P&lt;0.01</td>
<td>65.4%</td>
<td>4.02</td>
</tr>
<tr>
<td><strong>Kind of job</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indoor activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outdoor activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Both indoor and outdoor activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x²=37.231, df=1, P&lt;0.01</td>
<td>7.7%</td>
<td>-4.31</td>
</tr>
<tr>
<td><strong>Occupation with many different subjects of the same scientific sector</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td>x²=9.33, df=1, P&lt;0.01</td>
<td>28.8%</td>
<td>-2.16</td>
</tr>
<tr>
<td><strong>Occupation with many different subjects of different scientific sectors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td>x²=7.92, df=1, P&lt;0.01</td>
<td>69.2%</td>
<td>1.96</td>
</tr>
<tr>
<td><strong>Hold of responsible position</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td>x²=7.69, df=1, P&lt;0.01</td>
<td>65.1%</td>
<td>1.40</td>
</tr>
<tr>
<td><strong>Previous Working Experience in the private sector on the same working area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td>x²=3.930, df=1, P&lt;0.01</td>
<td>16.3%</td>
<td>-3.13</td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td>506, df=1, P&lt;0.01</td>
<td>78.8%</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----</td>
<td>-------------------</td>
<td>-------</td>
</tr>
<tr>
<td><strong>Computer Skills</strong></td>
<td>NO</td>
<td>x²=17, 308, df=1, P=0.001</td>
<td>21.2%</td>
</tr>
<tr>
<td><strong>Use of PC at work</strong></td>
<td>NO</td>
<td>x²=15, 077, df=1, P=0.001</td>
<td>23.1%</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Country of Academic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Working experience</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>in private and public</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>sector</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Country that working</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>experience has been</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>obtained</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P<0.05, **P<0.01, ***P<0.001
As Table 7 illustrated, the three groups of employees have similar profiles regarding their job and personal characteristics. More particularly, the majority employees of the three motivation groups are public servants that have tenure and they are involved in a large number of duties of the same scientific areas. Moreover, they do not possess any responsible position but they can speak at least one foreign language and have computer skills. Their academic studies have been completed in Greece and they have obtained their previous working experience in the same country.

On the other hand, most of the “differentiators” were involved in indoor jobs, hold a postgraduate degree, are married and have long working experience mainly in civil services. They are involved in many different subjects of different scientific areas and they have long working experience in private and public sector. Moreover, the majority of the “interested in personal improvement” has indoor working activities, has a university degree, and is also married. Besides, most of the “money orientated” employees hold a university degree.

Therefore the hypothesis \( H_2 \): The job and employees’ characteristics are significant related to a particular motivational behaviour.

### 3. Discussion - Conclusion

This study identified five main factors which affect the motivation of employees in Prefecture of Drama – Kavala – Xanthi. These factors are: (a) Economic Rewards, (b) Differentiation from colleagues, (c) Moral Rewards, (d) Working Environment and (e) Personal Improvement. Furthermore, the current research indicated that employees in the Prefecture of Drama – Kavala – Xanthi can be classified into the following three groups according to their motivational behaviour: (a) Differentiators, (b) Interested in Personal Improvement, and (c) Money Orientated. Employees of the first group want to be differentiated by their colleagues while the group “Interested in personal improvement” are interested in their personal development. Finally employees of the third group are motivated by the economic rewards that they receive.
Findings of this research are in accordance with those of other researches that have been undertaken world wide and have been presented in the literature review. The personnel of the Prefecture of Drama – Kavala – Xanthi is mainly affected by internal motives such as differentiation from colleagues, prestige, power, moral rewards, trust and support by supervisors and colleagues, team work, freedom of creativity and good evaluation reports. Besides, there are some employees that are motivated by economic rewards including bonus, salary, business trips and extra days off. Therefore, the outcome of this study is in accordance with the results of Karamfilidis (2006), Crewson (1997), Houston (2000), Karl and Sutton (1998), Jurkiewicz et. al. (1998).

This research also indicates that factors such as employment status, job description, hold of responsible position, foreign language and computer skills, educational level, working experience, country of academic studies, country where working experience has been obtained and marital status, significantly affect personnel motivation. Hence, the results of the current study agree with the arguments of Jurkiewicz (2000), Kacmar et. al. (1999), Moon (2000).

In particular, this study identified that “differentiators” hold a postgraduate degree contrary to the employees of the other two groups that hold only a bachelor degree. This means that civil servants, who are interested in being differentiated from their colleagues, as Table 5 indicates, are influenced by their high education and scientific specialisation and are motivated by power. They are also affected by psychological factors such as prestige while they are not interested in moral rewards as they possibly consider themselves better than others. Furthermore, economic rewards have not an impact on their motivation as they presumably already have high family income.

This research also showed that motives that have been stated by the State such as the salary, performance bonus, hold of responsible position and evaluation reports, do not affect the working performance of most of the personnel working in the Prefecture of Drama – Kavala – Xanthi. Hence these motives are not so important for the public servants as other factors including extra bonus (overtimes), days off, differentiation, moral rewards. This happened because the state motives as presented above have been scorned as the employees in the Prefectural Authority of Drama – Kavala – Xanthi have tenure, their salary and its increase is given according to the years of working experience. Furthermore, the total salary of the public servants in Greece is consisted of the basic salary, which is low, and some other allowances such as the performance bonus and the family severances. Moreover, the current evaluation system does not motivate the public servants as it is characterised to a great extent by the
subjectivity of the referees and the evaluation criteria. Besides, the selection procedure for the supervisors and directors is given, since the main criterion is the working experience in the public sector (without recognition of any possible working experience in responsible positions in the private sector). Only when the employee has the required working experience in the public sector the typical qualifications such as the mark of the University degree, postgraduate studies, professional training, are taken into consideration in order to be promoted.

The last decade the public sector in Greece recruits the best available personnel from typical qualification points of view, mainly due to the criteria of A.S.E.P. (Highest Council for Personnel Recruitment in Public Sector). Hence, in order the desire of employees for work and offer to remain undiminished the Greek State should examine the factors which affect the motivation of employees in the public sector and adapt the economic reward system as well as the evaluation and promotion system to them. In particular economic rewards such as the performance bonus or the extra days off could motivate employees in the public sector but they should be linked with and should be depended on the effort and the responsibilities employees undertake. Moreover, employees should be evaluated by their supervisors, colleagues and subordinates in order motivational factors such as moral rewards, working environment and personnel improvement to be taken into consideration in the evaluation system. Supervisors should provide moral rewards. Furthermore, public servants are motivated by the support of their colleagues and the team work. Hence, supervisors should work towards those aims. Public sector should also provide freedom of creativity and opportunities of personal improvement to public servants. Finally, as promotion perspectives is not a significant factor that motivate employees working in a public organisation, the promotion system should work subjectively and reward people who have qualifications and abilities to rise the hierarchy. Thus, motives such holding of position with responsibilities, power, prestige and differentiation from the colleagues will be satisfying.

The current study is a useful and valuable tool for this purpose but a more comprehensive study based on the same methodology and on data collected from all Prefectures operated in Greece will have a significant contribution on personnel motivation in the Greek civil services and local authorities. Employees’ satisfaction in the public sector and mainly in the Prefectures is quite important factor for their better and unobstructed operation because their personnel is involved actively in activities aiming to citizens’ life quality improvement, management of projects funded by the E.U. and the implementation of modern management tools including Management by Objectives and Common Assessment Framework.
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APPENDIX

Factors affect personnel motivation at work
V1. The feeling that employee is valuable in the organization where he/she works for.
V2. Team work
V3. The fact that employee desires to be better than his/her colleagues
V4. Support by his/her colleagues
V5. Working environment
V6. Power
V7. Position of responsibility
V8. Promotion perspectives
V9. Freedom of creativity
V10. The fact that he/she is considered as loyal cooperator by his/her supervisors
V11. Support by his/her supervisor
V12. Opportunities for personal improvement
V13. Salary
V14. Extra economic rewards
V15. Extra days off
V16. Evaluation reports
V17. Moral rewards (e.g., thanking by supervisors)
V18. Business trips
V19. Valuable acquaintances
V20. Prestige

Job and Employees’ characteristics
V21. Employment status
V22. Subject of job
V23. Kind of job (indoor activities, outdoor activities)
V24. Occupation with many different subjects of the same scientific sector
V25. Occupation with many different subjects of the different scientific sectors
V26. Age
V27. Education
V28. Hold of responsible position
V29. Family Income
V30. Country of academic studies
V31. Previous working experience on the same working area in the private sector
V32. Previous working experience on the area of employee’s studies in the private sector
V33. Working experience in the private and public sector
V34. Working experience in the public sector
V35. Country where the working experience was obtained
V36. Sex
V37. Marital status
V38. Foreign Language
V39. Computer Skills
V40. Use of PC at work
The possibility and, effectiveness of design type thinking in managing change in the Human resources function in Omani Government

Abdul Majeed Al-Sawafi

Abstract:
The importance and objectives of this paper are as following. Firstly, following Morecroft et al (2002), we assess the so called “processes of attrition”, (phenomena associated with human resource turnover, e.g. retirement, obsolescence, and employee turnover). These challenge organizations and have enormous impact on resources and are particularly poignant in certain sectors and contexts. Secondly, we take the “process of attrition”, and outline the limitations of dominant orthodoxy and thinking in both the conceptualisation of the phenomenon, and in how it is dealt with in practice. We argue that there are alternative (systemic) ideas that can help to improve current approaches. Thirdly, in order to demonstrate the application of our proposed approach, we take an example of a key ‘attrition indicator’ and to establish a better understanding of the causal factors of high employee turnover rate (in our case, in the Omani Government sector), their multifarious relationships and systemic interconnections, the implications for policy to address the turnover phenomenon. Fourthly, and finally, we abstract the lessons learned, and consider the use of systemic thinking in the HR function, and its potential use as a method to generate effective design type thinking in managing intervention in improving human resource functions, associated processes and practices.

Motivation:
To assess the efficacy, efficiency and effectiveness of design type thinking in HR management.

Approach:
The rigor of this paper emphasizes three major steps. First, it starts with conducting a general diagnosis of the human resources function system by using the One, two, Three analysis. These kinds of analysis aim basically and respectively to identify the problem stakeholders, social issues within a system, and the political perspective that emphasize on the distribution of power within a system. Since the researcher believes the hidden problem/s cannot be seen with the abstract eyes, he would use three metaphorical glasses that are; process structure glasses, human behaviours glasses, and psychological glasses, to analyze the HR system in the government sector. The outcomes of the three glasses can
then be synchronized to allow a better understanding of the situation along with potential solutions. Finally, the researcher would apply some of cybernetics conventions to assess how solid and dependant is the control structure of the system.

The paper is presented as follows. The first section introduces systems, general system theory, and demonstrates their relevance and (importance) to the Human Resources functions in the public sector. The second section outlines an approach designed from system thinking, which provides a set of principles for designing organizations. This is termed “design type thinking” for organizations, and flowingly provides the empirical and case example, which reflects an insight to the importance of the “design type thinking”. The fourth section presents an evaluation of the use of the “design type thinking”. The fifth section outlines the implications and learning from the whole cycle.

1. Introduction:

Hereby a brief introduction about the systems, general system theory, system thinking and their relevance to management is given. First of all, According to management scientist a system defined to be set of subsystems or components that are matched to achieve several objectives (Churchman, 1968). System approach is so different from other disciplines. It is a meta-discipline and, interestingly, it can talk about other disciplines (Checkland, 1981). Furthermore, Checkland (1981) asserted that the applicability of its subject matter can be exerted in other knowledge fields. Beer (1959) described the definition of particular system as arbitrary. At his argument one can read that there is a difficulty in defining a system since it can be expanded into a wider system or cut down into small version of dependant systems. The definition in his literatures could be deduced as set of interrelated elements that have relationship between them that is meant to deliver a specific pattern. Checkland (1981), introduced system as an approach which, technically, means a way of solving a problem by taking the broad view of problem by considering all aspects and parts with their interactions and involvements to the major problem according to him.

Churchman (1968), argued that when thinking about the meaning of a system, anyone should take to his consideration five basic things that can be considered as component and they are; (i) the total objectives, performance measures of the whole system, (ii) the fixed constraints that form the system’s environment, (iii) System resources, (iv) the system’s components, their activities, objectives, and measures of performance, and finally (v) system management (Churchman, 1968).

Second, General systems theory this particular theory provides the framework of systems in which to hang the flesh and blood of particular
disciplines and particular subject matter in an orderly and coherent corpus of knowledge (Boulding, 1956). Third, System thinking is about the usage of conscious to order its thoughts by looking at certain concepts from the angle of wholeness (Checkland, 1981). System thinkers normally distinguish between systems ideas used in obtaining ‘case records’ within another discipline and its usage as a vehicle for developing itself. Davidz & Others (2004), argued that the understanding of the term “system thinking” is highly linked to one’s definition of the term “system”.

To consolidate that, they laid out how others from theorists and academics define system thinking. For example, Jay Forrester and Barry Richmond use the term interchangeably with system dynamics, Ludwig von Bertalanffy introduce it within the open system theory, Peter Checkland used it in his soft system approach, Peter Senge considered it as one of the five disciplines,...etc.

Fourth, Beer (1959), desperately introduced the cybernetics as a new science. He asserted on that by exploring it from three basic points. They are; being organised since it has a well built theoretical backbone that is capable of holding the contents of knowledge, reflect knowledge that helped in constructing various operational models, and it has a practical applications in the real life. Moreover, Beer mentioned three basic characteristics of a cybernetic. They are; (i) exceedingly complex, (ii) probabilistic, and (iii) systems of homeostatic character. The third character indicates that the cybernetic has a critical variable that is held at favourable level. In other words, a cybernetic has a self regulatory mechanism. On the epistemological level Beer suggested that a cybernetic is like a mind and body, where communication and control in exceedingly multifaceted systems and can be considered as a mean of conducting operation research.

Cybernetics is not following the classic way, represented in observation and codification, of conducting useful works. This part of science is concerned with the study of system in all contexts. That is why one can obviously find its participation in flourishing some other fields of sciences like; mathematics, biology, physics, engineering, psychology, anatomy, anthropology, ecology, thermodynamics and management.

Control, which is the main factor normally mentioned when discussing cybernetics, is a practice exerted by some strongest party upon weak party to manipulate its behaviour by using coercion (Beer, 1959). Beer (1959) stressed on the importance of homeostasis, which is an apparatus or mechanism designed to hold and control a variable within considered necessary limits, and the entropy, the propensity and ability of an organization to design, assess, apply, and watch a best way of it energy distribution targeted to accomplishing its own missions, as system self regulator in deterministic systems. It is almost like the Adam Smith’s
introduction of the invisible hand. Such terms accompanied by related issues kept emerging while talking about the control in systems. For example, the usage of theory of control in biological systems by Quastler (1952) discovered the feedback mechanism. That, somehow, led to the new term servomechanism theory, and the pathology of control systems.

After laying down a brief literature review about the system a shift now to complete what researcher started with will take place. In his worthy contribution to management system thinking field in public sector, Seddon (2003), asserted that organizations have adopted a constitution of command-control management. This constitution reflects practices and thoughts within organization as; (i) organizations have top-down hierarchies, (ii) decision making is separated from the work, (iii) decision makers take their decision based on budgets, targets, activities...etc, (iv) managers roles are confined to managing people and budgets. He described this as a problem of management thinking.

Seddon (2003) raised some interesting and very important issues when he suggested a system thinking to help organizations to make their work work. First, he asserted the strong cultural cohesion between purposes, the real reason of existence of an organization, measures; this is about the indices that let people know how they are doing, and the methods, which are the tools, patterns, and guidelines of how people do in their organizations. Second, he stated that organizations errors and failures are basically the natural consequences of wrong design of the work flow within their contexts. Actually, one of the most vital errors mentioned above is what this paper is trying to address and that is the failure to keep human resources within an organizations. This problem can be attributed, in this context, to the way senior managers see their problems at work. It is very wrong according to Seddon (2003), to try addressing problems by working on people and neglecting the system in which they are involved. The managers would naturally gain so much if they managed to apply a culture change. Basically, this change could increase employees’ beneficial morale, enable them to simply experience decision making and greater control at their work.

The fact that when considering organizations as systems, one should start viewing, analysing it from the outside in was introduced by Seddon (2003). The analysis as mentioned above should include both people and the system where they involved. Seddon thought that problems with people are part and parcel of the old system. He introduced some guidelines, as questions, that would help a leader in determining if they think they have problems with people. The guidelines are resourcefully constructed to include a revision of the system design and its measurements. They also include information related to the performance required by an entity and willingness of the people achieving it.
Morecroft et al (2002), proposed that in order to be able to make a corrective action regarding the human resources, the organization as a system has to have basically (i) a clear and communicable goal for the resources accumulation, and (ii) aptitude to keep an eye on the existing level and state of a given resource. Moreover, they continued by arguing that this is very difficult to be formulated for intangible resources like employee motivation as it lacks any defined accepted metric.

Seddon (2006) argued that public sector cannot just be managed with theories. To depict that he introduced some examples showing the incapability of any of theories like; the Keynesian theory that encourage governments to increase its expenditures in the public services, or the monetarism theory of Milton Friedman which focus more on controlling the amount of monetary liquidity in the market and deal with public sector as a quasi-market, the Game theory principals, and ubiquitous use of “choice” as a central way for political attraction, used in the past by managers and politicians to solve the public sector problems and improve the economies. Hyense (2003) stipulated that one of the major reasons why these theories had fallen in helping managing properly is their weak roots in the theory of science that depends on reductionism, which is going to be shed afterwards.

The application of such theories along with stating targets caused serious problems to the whole economy in general and all sectors applied them exactly as they were laid down. Among the control problems accompanied the applications of above mentioned theories are; worsening service, creating waste, destroying morale and driving the costs up.

2. Methodology and the Design Type Thinking

The researcher is going to use the triangulation approach in this study. This means both quantitative and qualitative methods are going to be utilized in conducting this research.

The way in which this study is conducted is unique. That is because the researcher has followed two different approaches in this study, which are the deductive approach and the inductive approach. In the early stages of the study, researcher has proposed the following model to control the employee turnover in the government properly. See figure 1

The researcher has deduced this model from the intensive exploration and examination of literatures written, and models presented by scholars and governmental statistics, and reports in the last century about the employee turnover. From this model a set of different kinds of questions that are going to test variables are deduced.

In the second stage, an inductive approach was tracked by the researcher. In this approach the proposed model is going to be tested using
the questionnaire that was generated deductively. Finally, there would be a second consolidation for the feedback by conducting some interviews.

![Controlling the Governmental turnover rate through assessing:](image)

**Figure 1:** The first proposed model for controlling employee turnover in government sector by the researcher

### 3. Collection of Quantitative Data (Questionnaire)

The questionnaire method was used in this study to gather information quantitatively. The researcher consider, while designing the questionnaire, the major objectives and purposes of the study mentioned in the first chapter.

The best community members who are going to be the study respondents are coming from different governmental bodies, governmental companies and Public Authorities. There targeted positions of the respondents, who would be the best and more trusted sources of wanted information for this study because they have authority and power, from those organizations are; directors of human resources departments, recruiting officers, directors of financial departments, academics, MPs, consultants in human resources departments, and researchers in human resources departments. The potential respondents are characterized with...
highly experienced officers in the human resources field, well educated, come from both genders (Males and Females), and work directly or indirectly with employees.

The questionnaire focused on three vital dimensions which are; (i) social psychology dimension, (ii) law & labour relations dimension, and (iii) metrology dimension. It consists of different kind of questions starting from objective questions (open-ended), going through subjective questions (closed-ended), and ending by an open space for a respondent to put any remarks regarding the issue. The researcher used the likert scale with responses as follow;

<table>
<thead>
<tr>
<th>St Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>St Disagree</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

It was pilot studied among five respondents. This move was to test its readability and to settle on an optimum layout of the questionnaire by assuring its quality and efficiency. Respondents gave some valuable comments about the questionnaire. For example, (i) some technical terms or jargons used in the first version were amended to assure a better understanding among potential respondents, (ii) wording on some questions was improved, and (iii) some statements that were involving more than one variable were divided to separate statements to ensure that each statement is testing only one variable (this would help researcher to avoid some analytical dilemma while testing the variables). An identical Arabic version of the questionnaire was developed to cope with the problem that not all of respondents could communicate easily using English language. The final and amended version of the questionnaire was sent after that to about fifty respondents using the email service and a third person to hand a hard copy to respondents, since it is geographically difficult for the researcher to distribute the hard copy personally to respondents. Twenty-five respondents gave their participations to the study. This number represent (50%) of response rate since the researcher distributed fifty questionnaires.

4. Collection of qualitative Data (Interview)

As mentioned above the researcher is triangulating the study. Thus, he used the qualitative approach represented in semi-structured interviews beside the quantitative approach. They were mainly to give a description about the problematic situation, uncover and identify the problem stakeholders, social issues within a system, the political perspective that
emphasize on the distribution of power within a system, communication, and control. A set of five interviews were transcribed as a benchmarking for the rest. The rest of interviews were analysed by hearing and comparing with the transcribed ones.

5. Design Type Thinking (DTT)

The knowledge of methods that researcher used in developing the query conducting method stems from three major branches, in which two are consumed and used before by others and one is brand new. The first two branches are the Action Research (AR), and the Soft System Methodology (SSM). The new branch is the one considered by researcher to be a contribution to knowledge by the researcher and shall be called Design Type Thinking (DTT). Further details of these methods’ knowledge tributaries are going to be unfolded in the following paragraphs.

Action research can be considered as a powerful and liberating form of professional learning where all stakeholders of a situation can inspect and appraise their work (McNiff, 2006). In brief the action research cycle looks like: Action is taken, then reflection on the action yield insights or appreciation, these appreciation are taken to improve the action again. And the process continues (Flood, 2000). It is powerful according to McNiff, because stakeholders themselves are investigating and appraising their tasks using their stream of educational and social values. What distinguishes this kind of research is that while the primary task is seeking change, development or improvement of the situation, the whole work is conducted by practitioner and involved parties not by a professional researcher (Kember, 2000).

Kurt Lewin suggested six major features of action research (Lewin, 1946). They are respectively; it is a problem-driven, client-centered, challenges the current status, concerned with producing empirically disconfirm-able propositions, these propositions could be systematically interrelated into a theory organised, and usable in everyday life (Lewin, 1946; Argyris, 1983).

Checkland and Holwell (1997), revisited the work of Chris Argyris about the action research and came to conclude it as: (i) a collaborative process between researchers and people in the situation, (ii) process of critical inquiry, (iii) It places a focus on social practice and finally, (vi) a deliberate process of reflective learning (Checkland & Holwell, 1997; Flood, 2000). They realised that at their conclusion that action research lacks intellectual framework.

Systems approach is the main methodology for conducting this paper. The foundation and shape of this knowledge, or its epistemology, is seeking a derivation of knowledge from a strategic point of view as Haynes stated (2001). Jackson (2006) added another dimension to this
epistemology which is making sense of causality from different and contradictory perspectives to that derivation. System epistemology depends on several elements, or hallmarks as described by Houghton (2008), that assure its effectiveness as knowledge. Synthesise considered one of the most important element since it involves, according to Schultz and Hatch (1996), a concrete and instantaneous perceptive of the dialectical tension of ideas. A concurrent awareness of how the problem spheres can be solved and improved is needed with that understanding. Since the synthesis is nonlinear concept, it enhances Jackson (2006) addition above if and only if he is not asserting a simple causality concept. Being nonlinear allows a bigger picture appearance of the conflicts along with solutions and concerns that evolve. That led to consider synthesis as the central idea in systems concept (Houghton, 2008; Ackoff, 2000).

The second element of system epistemology is the variegation. This reflects the aptitude of altering the appearance of an issue to examine it from various angles. This feature allows a comprehension view of all subsystems involved in the system being under focus (Houghton, 2008). The final element of system epistemology is the perspectivalism. This element allows examining the strategic point of view of subsystems within a system. By doing that, a researcher could identify and realize the similarities and contradictions between the different frames and learn to shift these perspectives efficiently (Houghton, 2008). If one can accept and articulate the ideas through applying the precedent three hallmarks then s/he will be able to generalise findings based on systemic epistemology. Generalization in system means seeking more holistic interpretations of an observed issue which leads to rich insights about it.

The researcher will be using systems ideas in conducting this study and not the pure sciences because of several reasons. First of all, and beside what has just been mentioned immediately above this paragraph, there is no field in sciences showed an efficient ability in dealing with complexity except systems approach (Checkland, 1981). Most of sciences approaches are applying a reductionist method, where a whole system is broken down into separate parts to allow separate examination for each area. In defending this scientific approach Checkland (1981) introduced three main reasons explaining that. They are; (i) the world is so messy and to generate a cohesive investigation about it, it must be reduced or simplified into items that can be individually experimented, (ii) reductionism is far better way in giving a logical coherent explanation, and (iii) it goes along with Descarte's advice in problems' solving.

Secondly, pure sciences methods failed in social sciences because; (i) generalisation in social sciences findings is not similar in natural sciences and specifically on human beings, (ii) the component of social sciences, that is individual, is far complex, and (iii) it is unpredictable and as is
known whatever take place in social sciences is composed of a blend of wished-for and unintentional effects. Thirdly, System approach helps in creating an adaptive organization (Seddon, 2003).

The motivation factors of this paper are considered when developing the new methodology of conducting system approach in management. For the efficiency matter the researcher combined the political in social aspect in one, two, three analysis. That is because distribution of power within an organization is involved in social constructs with defined boundaries. The researcher thinks that considering it as sole dimension in analysis is complicating the analysis and distorting some other issues like the environmental boundaries. In the new approach it would be called One, Two analysis.

The efficacy and effectiveness in the new model are going to be met respectively by satisfying two major pillars, and what they consequently involve, they are; (i) system thinking approach, and (ii) cybernetic convention of the problematic situation. In these two pillars doing right things will be through assessing what the researcher thinks that are involved system’s epistemology of synthesis, variegation, and perspectivalism in management. This shall be done through examining all of the possible subsystems and issues involved in organizational processes’ structures, organizational human systems’ behaviours, and organizational psychology matters. After that, a researcher does debating between the actual situation and ideal situation; propose some actions that are culturally and logically accepted, and advice decision taker to adopt them.
Intervention is not a stage but it is a continual activity throughout the whole process.

Figure 2: The first proposed model for the design type thinking DTT by researcher.
Figure 3: The second proposed model for the design type thinking DTT by researcher
The third proposed model for the design type thinking DTT by researcher

**Figure 4:** The third proposed model for the design type thinking DTT by researcher.
6. Findings and Discussion:
Before starting examining the proposed model elements, a case introduction and description is to be provided. This preface is based on feedback the researcher acquired from his respondents who can be described as the existing human resources specialists in the governmental entities of Sultanate of Oman.

Respondents were asked to value statements that measure issues like the percentage of employee turnover, the human resources role in dealing with people who wanted to quit, the nature of quitters, the consequences of employee turnover to an organization, and their upcoming positions with their new employer.

Statistics

Table 2: Statistics Summary about the responses to the case preface statements

<table>
<thead>
<tr>
<th>Statements</th>
<th>N Valid</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>the ETR is abnormally high in this firm</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>HRD convinced many staff not 2 quit this firm</td>
<td>23</td>
<td>2</td>
</tr>
<tr>
<td>the quitting process is very flexible in this firm</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>finding substitutes for quitters is easy</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Hiring costs concern for this firm</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>quitters reflect positive image about this firm</td>
<td>21</td>
<td>0</td>
</tr>
<tr>
<td>quitters reflect negative image about this firm</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>normally the quitters are high performers</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>quitters have appointed in better positions</td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Table (4.1) illustrates the valid and missing values for each statement was asked. It is obvious that statements 3, 7, and 8 scored the best since they have no missing values which mean that all participants responded to these statements. On the other hand we can see that some statements have some missing values. For example, the first, fourth, fifth and sixth statements have respectively six, four, four, four missing values.
Table 3: Table of frequencies shows the participants responses to the case preface statements

<table>
<thead>
<tr>
<th>N</th>
<th>Statements</th>
<th>strongly disagree</th>
<th>disagree</th>
<th>neutral</th>
<th>agree</th>
<th>strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>the ETR is abnormally high in this organization</td>
<td>36.8%</td>
<td>31.6%</td>
<td>31.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>HRD convinced many staff not to quit this organization</td>
<td>8.7%</td>
<td>17.4%</td>
<td>21.7%</td>
<td>43.5%</td>
<td>8.7%</td>
</tr>
<tr>
<td>3</td>
<td>the quitting process is very flexible in this firm</td>
<td>12.0%</td>
<td>20.0%</td>
<td>8.0%</td>
<td>48.0%</td>
<td>12.0%</td>
</tr>
<tr>
<td>4</td>
<td>finding substitutes for quitters is easy</td>
<td>4.8%</td>
<td>57.1%</td>
<td>28.6%</td>
<td>4.8%</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hiring costs concerns this organization</td>
<td>9.5%</td>
<td>19.0%</td>
<td>19.0%</td>
<td>47.6%</td>
<td>4.8%</td>
</tr>
<tr>
<td>6</td>
<td>quitters reflect positive image about this organization</td>
<td>38.1%</td>
<td>23.8%</td>
<td>19.0%</td>
<td></td>
<td>19.0%</td>
</tr>
<tr>
<td>7</td>
<td>quitters reflect negative image about this organization</td>
<td>16.0%</td>
<td>12.0%</td>
<td>32.0%</td>
<td></td>
<td>24.0%</td>
</tr>
<tr>
<td>8</td>
<td>normally the quitters are high performers</td>
<td>4.0%</td>
<td>20.0%</td>
<td>36.0%</td>
<td></td>
<td>40.0%</td>
</tr>
<tr>
<td>9</td>
<td>quitters have appointed in better positions</td>
<td>18.2%</td>
<td>45.5%</td>
<td></td>
<td></td>
<td>36.4%</td>
</tr>
</tbody>
</table>

Frankly speaking, if one count the ratios in the (neutral) column and divide that by the total percentage, that is (900) since the number of statement measured in this part are nine statements with (100%) scale for each statement, the finding would be shocking. It is about (20%) in average where managers are neutral. It seems that respondents were following some diplomatic methods in responding to these statements. Maybe because they think these kinds of information have to be high classified and revealing them would negatively affect their organization. The other possibility is that they might not have insufficient skills of managing the human resource departments. That, of course, can be attributed to different things like: (i) incompatible qualification with existing position as a consequence of managers' rotation policy within an organization, (ii) the blind decentralization where HR manager is to sign only on papers regardless of knowing the circumstances and (iii) carelessness of managers because of the high bureaucracy in governmental bodies. In fact, this issue would emerge several times throughout this paper and researcher would consider it as one of the paper's limitations.

In sum, the case of employee turnover shall be treated as a national case and traced seriously since shockingly (31%) of respondents consider it
as "abnormally" high in their organization. That goes simultaneously with unpretentious efforts paid by concerned governmental bodies to resolve this quiet crisis. Furthermore, they are flexible in terminating process. Here one should notice that flexibility is favoured in the labour market, but this flexibility should be considering the public interest as it is not neglecting the personal or private interest. To consolidate this, the assessed bodies are confronting, at least for this matter, the negative consequences of employee turnover that are represented in financial costs according to (52%) of respondents, staffing costs which is in turn time consuming, and the difficulty of finding substitutes for those quitters as (60%) of respondents said. In addition, the staff that quit reflect negative image about their ex-employer.

Regarding the nature of employee turnover from employee and employer perspectives, which is the second objective, the researcher has found the following. First of all, the nature of employee turnover is very controversial and especially from the employee standpoint. It seems to be there is no standardized explanation for this phenomenon, see tables 2.1 & 2.2 and figure 1. But factors as remuneration, job satisfaction, unemployment rate, gender issues and such factors mentioned in the chapter two can be used as signs or predictors of employee turnover.

The model that is to be introduced by researcher is to concentrate more on the win-win principle, where both organization and staff get the ever best from their interaction. Generally that is because firms do not want to lose their key staff or the high performers as the case with assessed entities in this paper where more than (75%) of respondents avowed that quitters are high performers. On the other hand, the organization should consider the pivotal dimensions that lie behind why people left them and accordingly respond positively. The coming parts would shed this.

The researcher used the content analyses to analyse the semi-structured interviews feedback. Almost 70% of interviewees described it as a healthy phenomenon. None of them could argue how mature and satisfied is the public sector’s human resources and competencies and consequently this would refute their statements about the phenomenon healthiness. Almost 85% of them agreed on defining; management competencies, current work frame, staff, financial aspects, global factors, society and policy makers as the stakeholders of the problem (see figure).
About the social issues like values beliefs, respondents were equivalently categorized into; old values, values have nothing to do with workforce actions, and mechanistic values respectively. This was very odd since it is known –at least in management field- that values inform workforce actions.

Regarding the distribution of power; respondents were unsure about power because according to them decision making is a power and being a president of staff union involves a power. This assures the researcher view

**Figure 5**: A diagram showing the stakeholders of the human resources problematic situation in Oman
of the great need of applying system ideas in addressing such problematic issues. The case was almost the same while analysing the communication, control and their role in employee turnover.

6. Conclusion

The purpose of this paper is to find out the possibility and, effectiveness of design type thinking in managing change in the Human resources function in Omani Government. It started with giving a brief introduction about the kind of knowledge the researcher would ultimately use in developing the Design Type Thinking (DTT). This knowledge includes system ideas and schools. A demonstration of their relevance and (importance) to the Human Resources functions in the public sector was established after that.

Then, in the methodology section, that involved using a triangulation approach, the researcher consolidate the view of using the system ideas in developing such method by giving the epistemological background of the field and its strong relation to the problematic situation. Following to that were the action plan of the study empirical and the revelation of the DTT.

Finally, a discussion of the empirical was done. This discussion showed the necessity and possibility of using the DTT. DDT in managing the human resources in public sector embraces the systems ideas, and meet the epistemological factors that are; synthesis, variegation, perspectivalism.

References:


The decision to share: a conceptual model of the knowledge sharing behaviour of health care professionals in public hospital wards

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Abstract:
In recognition of the failure of knowledge management initiatives and the reluctance of employees to fully utilise knowledge management systems, regardless of their usefulness and level of sophistication, research attention is turned toward investigating the barriers blocking the sharing of knowledge among individuals. Moreover, the value of sharing tacit knowledge, especially through face-to-face interactions, has always been acknowledged as an important prerequisite for achieving fruitful cooperation, within an organisation, and on-the-job problem solving, especially in the health services sector. With an aim to understand the drivers of sharing behaviour, this paper develops an extensive model, based on the social psychological theory of planned behaviour (TPB), to examine actual knowledge sharing behaviour of physicians and nurses at the ward level. The objective of this model is to integrate the influence of various factors, including extensions to the TPB (past behaviour, perceived moral obligation and self-efficacy), expected reciprocal relationships and commitment. The understanding of the sharing behaviour of individuals can assist the design and utilisation of such managerial interventions that can effectively support and enhance inter-organisational knowledge sharing.

Keywords:
Knowledge sharing behaviour, theory of planned behaviour, multidiscipline health teams, Greek public hospitals
1. Introduction

In the recent years, literature has focused its interest in examining the factors that influence the sharing of knowledge among individuals in the organisational level, either through face-to-face interactions or dedicated information systems. This sifting of attention was driven by the realisation that knowledge management (KM) initiatives cannot be successful unless employees are willing to share their individual knowledge. Although the failure of KM has been commonly attributed to the inability of organisations to “…align their incentive systems with their ambition of creating corporate value through knowledge-sharing” and their heavy reliance on KM technology (Husted and Michailova, 2002, p. 61), it has become apparent that the individual still remains the main drive of success. There are two reasons for this; first, because individuals are intrinsically hostile to sharing their knowledge, and it mainly depends on individuals’ motivation to share it (Husted and Michailova, 2002) and second, due to the very nature of knowledge. Dixon (2002) explains that some organisations believe that knowledge will be primary shared through information systems; however, what is true, especially for complex knowledge, is that it “…requires face-to-face conversations rather than just reading an e-mail or examining an item in a database” (p. 39). “Efficient knowledge-sharing is a “contact sport,” involving direct contact and commitment on both sides of the exchange (Husted and Michailova, 2002, p. 63). Hence, understanding individuals involved in the human activity of sharing is the most essential step in effectively supporting it (Robertson, 2002).

Knowledge management has been argued to be essential in achieved the ever desired competitive advantage, for all businesses, healthcare organisations included. This is because healthcare organisations are knowledge-intensive and their proficiency and capabilities highly depend upon well developed and flexible knowledge networks (Lin and Chang, 2008). However, effective cooperation achieved by the sharing of knowledge among healthcare professionals should not be taken for granted, as there is evidence in the literature suggesting otherwise. Even though “common goals and complementary, supportive roles make physicians and nurses natural colleagues” (Gianakos, 1997, p. 57), studies report that nurses are reluctant to recommend patient treatments (Leonard and Sensiper, 1998) or share expertise and advice (Edmonson, 2000), mainly due to the hierarchy and status conditions prevailing in such environments. However, healthcare organisations need to consistently dedicate their efforts in enhancing the sharing of knowledge among healthcare professionals as it has been argued to significantly improve medical decision-making quality (Lin and Chang, 2008).
This paper presents a model (Figure 1) developed based upon the social psychology theory of planned behaviour (TPB – Ajzen, 1991), integrating also other factors from the relevant literature, in order to examine the actual knowledge sharing of physicians and nurses in public hospitals at the ward level. The factors incorporated in the TPB, so as to improve its explanatory power and predictive validity are: some of the most highly cited extensions to the TPB (past behaviour, perceived moral obligation and self-efficacy), expected reciprocal relationships and commitment. The factors are not only discussed in relation to knowledge sharing, but also examples of their impact on other behaviours in the healthcare environment are presented.

2. Theoretical Framework and Propositions

2.1. The Theory of Planned Behaviour (TPB)

The TPB (Ajzen, 1991) is perhaps one of the most widely used social psychology models (Armitage and Conner, 2001), which aimed at producing an integrated framework for explaining and predicting social behaviour. According to the TPB, “…human action is guided by three kinds of considerations: beliefs about the likely consequences of the behaviour (behavioural beliefs), beliefs about the normative expectations of others (normative beliefs), and beliefs about the presence of factors that may facilitate or impede performance of the behaviour (control beliefs)” (Ajzen, 2002, p.107).

The central concept of the theory is behavioural intention (INT), which is assumed to encapsulate the motivational factors influencing an individual’s behaviour and “as a general rule, the stronger an intention to engage in a behaviour, the more likely should be its performance”, with the condition that the behaviour in question is under full volitional control (Ajzen, 1991, p.181). According to the TPB, there are three conceptually independent predictors of intentions. The first, attitudes (ATT) toward the behaviour, refers to the level at which an individual has a favourable or unfavourable evaluation or appraisal of a given behaviour. The second predictor of behaviour is subjective norms (SN) and, as a social factor, refers to the perceived social pressure to perform or not to perform the behaviour. Finally, the third is perceived behavioural control (PBC), which “…refers to the perceived ease or difficulty of performing the behavior and it is assumed to reflect past experience as well as anticipated impediments or obstacles” (Ajzen, 1991, p.188). The TPB proposes that PBC along with INT can be used directly to predict behavioural achievement. As regards to the effect of each of the constructs on behaviour, Ajzen (1991, p. 188) states that “…it is expected to vary across behaviors and situations”.
The TPB and its predecessor, the Theory of Reasoned Action (TRA), have been successfully utilized by past research to explain and/or predict a large number of diverse behaviours. As Ajzen (1991) advocates, the TPB offers a useful framework for dealing with the complexities of human social behaviour, assimilating some of the central concepts of social and behaviour sciences. Moreover, the way these concepts are defined, allows for the prediction and understanding of particular behaviours in specific contexts. Both theories have also been proposed and/or used in the past for the examination of knowledge sharing behaviours of various professional groups and in diverse settings (see Bock and Kim, 2002; Bock et al., 2005; Chatzoglou and Vraimaki, 2009; Hansen and Avital, 2005; Kun, 2007; Lin and Lee, 2004; Ryu et al., 2008; Vuong et al., 2008; Wei et al., 2008;).

In the proposed model, actual knowledge sharing behaviour is the dependent variable and is conceptualised as the degree to which individuals (healthcare team members) share their knowledge (tacit and explicit) with other members in the ward. It is suggested that when examining knowledge sharing behaviours in the organisational contexts, especially in the cases where subjective measures are obtained, either due to lacking information technology mediated exchanges, or because the focus is mainly placed on face-to-face interactions, the TPB can be utilized and actual knowledge sharing could be used as the dependent variable.

Based on the above, the following propositions are made:

**Proposition 1:** Individuals’ intention to share knowledge positively influences their knowledge sharing behaviour.

**Proposition 2:** Individuals’ attitude toward knowledge sharing positively influences intentions to share knowledge.

**Proposition 3:** Individuals’ subjective norms about knowledge sharing positively influence intentions to share knowledge.

**Proposition 4:** Individuals’ perceived behavioural control about knowledge sharing positively influences intentions to share knowledge.

**Proposition 5:** Individuals’ perceived behavioural control about knowledge sharing positively influences knowledge sharing behaviour.

2.2. Extensions to the TPB

Both the TRA and TBP have received a large amount of criticism regarding their applicability and predictive power and there have been many suggestions in the literature for model extensions and additional causal paths that have been found to improve model fit (see for example Chang, 1998 and Ryu et al., 2003). As a matter of fact, Ajzen (1991)
advocates that, in principle, TPB is open to the inclusion of additional constructs, provided that they can capture a significant variance in either intention or behaviour, after the original model constructs have been considered.

2.2.1. Self-efficacy
As stated above, PBC is the construct that differentiates TPB from TRA, and is proposed to influence behaviour both directly and indirectly through intention. Ajzen (1991) argues that, compared to other conceptualisations of control, PBC is most congruent with Bandura’s (1986) concept of perceived self-efficacy. However, several authors have put forward that PBC and self-efficacy are not completely synonymous (Armitage and Conner, 2001). Bandura (1986, p.361) defined self-efficacy as “people’s judgements of their capabilities to organize and execute courses of actions required to attain designated types of performance”. Armitage and Conner (2001 p. 476) explained that it “…is more concerned with cognitive perceptions of control based on internal control factors, whereas PBC also reflects more general, external factors”.

The concept of self-efficacy has been widely applied to the knowledge sharing context, as a motivational factor (e.g. Cheun and Lee, 2007; Kankanhalli et al., 2005; Endres et al., 2007; Hsu et al., 2007; Cabrera et al., 2006). Based on the social cognitive theory’s self-efficacy concept, the “expected contribution” idea has been integrated to the TRA (Bock and Kim, 2002; Bock et al., 2005). According to Bock and Kim (2002, p.16), “expected contribution refers to the idea that if employees believe that they could make contributions to the organisation’s performance, they would develop a more positive attitude toward knowledge sharing”. Bock et al., (2005) conceptualise expected contribution as an individual’s sense of self-worth, which is formed by the feedback people receive regarding the correctness of their thinking and behaviour and propose that it influences both attitude and subjective norms. The later is based on the assumption that if an individual is characterised by a high self-worth perceptions, resulting from their knowledge sharing, he/she will be more likely to be aware of the knowledge-sharing-related expectations of significant others and also comply with these expectations. Based on the above, two propositions are made:

Proposition 6: Individuals’ expected contributions positively influence attitudes toward knowledge sharing.

Proposition 7: Individuals’ expected contributions positively influence subjective norms about knowledge sharing.
2.2.2. Past Behaviour

One of the issues that has attracted considerable attention in social behaviour research is the influence of past on later behaviour (Conner and Armitage, 1998). It has been argued that past behaviour is a stronger determinant of behaviour compared to cognitions, like the ones described in the TRA and TPB (Sutton, 1994). Such claims are founded in past research findings that give evidence to past behaviour being the best predictor of future behaviour and, when incorporated into the TPB, to significantly and directly influence intentions and behaviour (e.g. Norman and Smith, 1995; Norman et al., 2000; Millar and Shevlin, 2003). Ouellette and Wood (1998) explain that there are two processes by which past behaviour guides future processes. For well-practice behaviours in constant contexts, frequency of past behaviour reflects habit and, thus, directly influences future behaviour. For behaviours that are not well learned and frequency of practice is not stable or takes place in difficult contexts, “…conscious decision making is likely to be necessary to initiate and carry out the behaviour” (p. 54). In this case, past behaviour may contribute to the prediction of intentions.

Conner and Armitage (1998) advocate the inclusion of habit (frequency of past behaviour) in the TPB, alongside with intention and PBC. Ouellette and Wood (1998) point out that past behaviour should not only be considered for the successful prediction of behaviour; they highlight that it is important for practitioners, looking to change habitual behaviours, to understand “…the factors that maintain routinized responses”, for successfully implementing intervention strategies (p. 54). The latter is of great importance when looking for ways to effectively enhance knowledge sharing. Finally, Sole and Applegate (2000) argue that habitual sharing behaviour can be established through the development of appropriate knowledge sharing practices. At this point, it should be noted that, to the best of the authors’ knowledge, no past research has been identified to have examined the role of habit or frequency of past behaviour on knowledge sharing, on either theoretical or empirical basis.

Based on the above, the following is proposed:

**Proposition 8:** Individuals’ past (frequency of) sharing behaviour positively influences intentions to share knowledge.

2.2.3. Moral Norms

Beck and Ajzen (1991, p. 289) define moral norms as “…personal feelings of moral obligation or responsibility to perform, or to refuse to perform, a certain behaviour”, whereas, based on Manstead’s (2000) work, Conner and Armitage (1998, p. 1442) define them as “…one’s own socially determined and socially validated values attached to a behaviour”. Maybe
to a greater relevance to knowledge sharing, at least for operationasilation purposes, is the definition offered by Kurland (1995, p. 299) “…duty or obligation to the client (i.e. and identified other) that is sanctioned by one’s conscience”.

Normative influence was originally dropped from the TRA model, for parsimony and measurement issues (Raats et al., 1995), although moral norms are conceptually independent from all other model constructs (Manstead, 2000). Latter, Ajzen (1991) acknowledged that personal feelings of moral obligation need to be considered, along with social pressure. The inclusion of moral norms in the TPB has been proposed to be a useful addition, to the very least when examining behaviours where moral considerations are likely to be salient (Conner and Armitage, 1998) and are expected to exert significant influence on intentions (Ajzen, 1991; Conner and Armitage, 1998; Gorsuch and Ortberg, 1983). The questions that therefore arise are a) whether the decision to share can be regarded as a moral situation and b) which could be the significance of the feelings of moral obligation in the knowledge-sharing context.

Constant’s et al. (1996) study was one of the first to examine the role of feelings of obligation in relation to knowledge sharing. They found that posting valuable advice in an organisational electronic network is motivated by a sense of obligation to the organisation. Wasko and Faraj (2000) also attest that moral obligations are motivational factors for the sharing of knowledge, as knowledge can be exchanged “…due to moral obligation resulting in pro-social and altruistic behaviour” (p. 168). Michailova and Hutchings (2006) explain that especially in collectivist cultures individuals commonly feel obliged toward their in-group members. An ethical dimension to the decision to share has also been proposed by Wang (2004), who argues that employees, who regard knowledge sharing as an ethical workplace requirement, are the ones who will share their knowledge with colleagues. However, no studies have been identified to examine knowledge sharing utilising either the TRA or TPB and also include moral obligation in their research models. In healthcare settings, research has shown that moral obligation can explain a number of different employee behaviours (see for example Lane et al., 1988; 1990). In fact, work responsibilities and moral obligations are believed to be complementary dimensions of the nursing profession (Cronqvist et al., 2004). Based on the above, the following is proposed:

**Proposition 9:** Individuals’ perceived moral obligation to share knowledge positively influences intentions to share knowledge.
2.3. Other Personal Factors Influencing Knowledge Sharing

2.3.1. Expected Reciprocal Relationships

Knowledge sharing has been argued to be governed by social exchange, in which people participate to uphold future relationships, balance of power and image (Jarvenpaa and Staples, 2001). Such expected intrinsic benefits have been proposed by several studies to affect the provision of information and knowledge (e.g. Käser and Miles, 2001; Jarvenpaa and Staples, 2001; Bock and Kim, 2002; Bock et al., 2005; Kankanhalli et al., 2005; Huang et al., 2008; Ipe, 2003; Julibert, 2008; Vuong and Staples, 2008). “Social exchange… refers to voluntary actions of individuals that are motivated by the returns they are expected to bring and typically do in fact bring from others” (Blau, 1967, p. 91). As Blau (1967) explains, social exchange differs from economic exchange in that it does not entail any specified obligations; while the latter is based on specified contracts that stipulate the exact quantities to be exchanged, in the former there is an expectation of return, but its exact nature is definitely not specified in advance. In other words, people are involved in social exchanges motivated by expected reciprocity, which in the knowledge sharing context “…is the expectation that those involved in sharing knowledge will be able to acquire or benefit from some of the value created by their involvement” (Ipe, 2003). However, individuals are mainly interested in the relationships established by social exchange, and not necessarily any extrinsic benefit that might directly follow (Blau 1967). Hence, the expected associations resulting from sharing one’s knowledge assume that employees are expected to develop a more favourable attitude toward sharing their knowledge if they believe that doing so can help them improve their relationship with other organisational members (Huber, 2001; Bock and Kim, 2002; Bock et al., 2005). Based on the above, the following proposition is made:

Proposition 10: Individuals’ expected reciprocal relationships to share knowledge positively influences intentions to share knowledge.

2.3.2. Commitment to the Ward

Organisational commitment has been both theoretically (e.g. Kelloway and Barling, 2000; Brooks, 2002; Hislop, 2002; 2003; Skyrme; 2002; Wei et al., 2008) and empirically associated with knowledge sharing, as well as with other processes of knowledge work in various contexts, including virtual teams and technology mediated learning environment (see discussion below). From a theoretical perspective, Kelloway and Barling (2000, p. 295) suggest that “the ‘rate of return’ on employees’ investment of knowledge in the organization is reflected in employees’ sense of
affective commitment to the organization”. The authors ground their argument on the fact that this commitment dimension is rooted in exchange-based and reciprocal relationships between an individual and the employing organisation, i.e. “the individual offers his/ her talents to the organization in exchange for the rewards of organizational membership” (p. 295), while this is not the case for continuance and normative commitment.

Hislop (2002) argues that low commitment levels, partially resulting from changes in contemporary nature of employment and the character of organisations, pose a significant barrier for the involvement of employees in knowledge sharing initiatives. The author adapted Guest and Conway’s (2001) psychological contract model in the context of knowledge sharing (see Hislop, 2003, Figure 3, p. 194). According to their conceptualisation, organisational commitment is assumed to influence a number of knowledge sharing and knowledge management related attitudes and behaviours, including attitudes toward the sharing of knowledge and actual participation in knowledge sharing activities. As regards to the empirical evidence on the relationship between knowledge sharing and organisational commitment, several studies have been identified in the literature (Wasko and Faraj, 2005; van den Hooff and de Leeuw van Ween, 2004; van den Hooff and de Ridder, 2004; Cabrera et al., 2006; Vuong and Staples, 2008), which have been mostly concerned with the sharing of knowledge through a knowledge management system, or some electronic medium in collaborative databases, and with sharing that takes place in the context of virtual teams. Overall, the aforementioned studies have yielded mixed results.

However, when examining knowledge sharing in certain contexts, turning the attention to a more proximal focus would be more appropriate for accurately assessing the impact of commitment on the sharing behaviour; that is especially true when health care professionals are considered. For example, Prestholdt et al. (1987) suggested that nurses tend to identify themselves more closely to their wards, than to hospital, showing signs of greater loyalty and commitment to their area of work than to the hospital as a whole. Lok and Crawford’s (2001) study indicated statistically significant impact of ward culture on nurse’s commitment, while no significant impact was indicated between the latter and some hospital culture-related variables. Lok et al. (2005) also argue on the significance of the value of analysis at the subcultural level, when behaviours and attitudes are examined. Their study also indicated that commitment is more significantly affected by organisational subcultures than by the main organisational culture. Finally, Baruch and Wilkelmann-Gleed (2002) investigated the impact of different work-related commitment foci on intention to leave, among employees and managers in
the British health-service sector. The results of their study showed low commitment levels among clinical employees in both the NHS and the employing organisation (Trust). Baruch and Wilkelmann-Gleed’s (2002, p. 349) study results also provide support for the claim that “individuals may identify with their immediate group, but not with their organization”. In the context of the psychological contract theory, Marks (2001, p. 464) suggests that “…the more proximal, collective, psychological contract that occurs in workgroups has a grater effect on employee behaviour than any contract employees have with other organizational entities”.

One of the most popular approaches to commitment is the three-dimensional model proposed by Meyer and Allen (Allen and Meyer, 1990; Meyer and Allen, 1984; 1991). Meyer and Allen (1984) initially proposed a two-dimensional model of commitment, consisting of the “affective” and “continuance commitment” facets, while in 1990, Allen and Meyer, further developed their conceptualisation of commitment and proposed a three-component model of commitment, adding the normative dimension. Affective commitment is defined as “…employee’s emotional attachment to, identification with, and involvement in the organization” and as the authors explain individuals who are affectively committed remain in the organisation because they “want to do so” (Meyer and Allen, 1991, p. 67). Continuance commitment, on the other hand, “… refers to an awareness of the costs associated with leaving the organization” (p. 67). Under this light, continuance committed employees remain with their current employer because they “need to do so”. Finally, employees who are normatively committed feel that they ought to remain in the organisation; in that sense, continuance commitment “…reflects a feeling of obligation to continue employment” (p. 67). This form of commitment is mainly shaped by social and/or cultural influences before an individual becomes a member of the organisation (Cohen, 2007). The common element of the three dimensions, as Meyer and Allen (1991) indicate, is that commitment constitutes a “psychological state” that characterises the relationship between the individual and the organisation and also plays its part on the person’s decision to remain or leave his/her employment. According to Allen and Meyer (1990, p. 3-4), the dimensions of their “three-component conceptualization of organizational commitment… [are] best viewed as distinguishable components, rather than types of attitudinal commitment; that is, employees can experience each of these psychological states to varying degrees”.

Regarding the relative effect of the three-dimensions of organisational commitment, Meyer et al. (2002), proposed that while affective and normative commitment are expected to have positive effects on the focal behaviour, continuance commitment is expected to be either unrelated, or negatively related. In general, affective commitment is expected to predict
a wider range of behaviours, as the probability of an individual engaging in a focal or discretionary behaviour is greater for “pure” cases of affective, followed by normative and then continuance commitment (Meyer and Herscovitch, 2001, p. 313). Although the majority of the literature was concerned with the impact of affective dimensions of commitment, regardless of the measures utilised, Burr and Girardi (2002, p. 81) suggest that “affective, continuance and normative commitment should all be included when valuing intellectual capital”, as past research has not managed to fully capture the differential impact of each dimension. Based on the propositions of Meyer and Herscovitch (2001) model regarding the impact of the commitment dimensions on discretionary behaviour (see analysis above) and the aforementioned studies regarding the proximity of the commitment target, the following are proposed, in the context of the TPB, for a knowledge sharing in a hospital setting:

**Proposition 11a.1:** Individuals’ affective commitment to the ward (department) will have a positive influence on attitude toward knowledge sharing.

**Proposition 11b.1:** Individuals’ normative commitment to the ward (department) will have a positive influence on attitude toward knowledge sharing.

**Proposition 11c.1:** Individuals’ continuance commitment to the ward (department) will have a negative influence on attitude toward knowledge sharing.

Moreover, evidence in the literature suggests that commitment may also influence behavioural intention (e.g. Abrams et al. 1998; Korzaan, 2006; Spitzmüller and Stanton, 2006), therefore the following are also proposed:

**Proposition 11a.2:** Individuals’ affective commitment to the ward (department) will have a positive influence on intention to share knowledge.

**Proposition 11b.2:** Individuals’ normative commitment to the ward (department) will have a positive influence on intention to share knowledge.

**Proposition 11c.3:** Individuals’ continuance commitment to the ward (department) will have a negative influence on intention to share knowledge.

### 2.3.3. Occupational Commitment

Evidence from the multiple commitments literature suggests that “…commitments to multiple foci predict employee attitudes and behaviour independently of global organizational commitment” (p. 304); moreover,
commitment to different foci has demonstrated inferences regarding which specific attitudes and behaviours each predicts (Redman and Snape, 2005). Hislop (2003, p. 196) suggests that commitment to multiple foci should also be examined in relation to knowledge sharing behaviour, as “…literature has focused narrowly on organisational commitment”. Tam et al. (2002, p. 776) advocate that “organizations compete with work teams or occupational groupings for the commitment of knowledge workers”. Literature also suggests the presence of multiple and most of the time conflicting commitments and studying them “adds distinctive value in the concept of commitment” (Baruch and Wilkelmann-Gleed, 2002, p. 340). The results of the 1987 multinational “Meaning of Working” survey (MOW International Research Team, 1987), indicated that employees showed high levels of commitment to their occupation, and working in general, but not necessarily to the employing organisation (Baruch and Wilkelmann-Gleed, 2002). The terms occupation, profession and career have been used interchangeably in the commitment literature (Meyer et al., 1993; Hackett et al., 2001); this is also evident by the various definitions proposed. Meyer et al. (1993, p. 539), however, advocate the use of the term occupational, since “…both professionals and nonprofessionals can experience commitment to the work they do”.

In the health care environment, Corley and Mauksch (1993) argue that nurses can have a number of commitments, some of which posses enhancing and others conflicting power, depending on the situations. These include, the patient, profession, career, work, job, organisation, work group, union, nonwork group internal or external to the organisation, and family and/or significant other (Corley and Mauksch, 1993, p. 118). However, the organisation-occupation conflict is less likely to be experienced among professional working for corresponding organisations (Lee et al., 2000). Meyer et al. (1993) examined the impact of the three dimensions of organisational and occupational commitment on various consequences in a sample of student and registered nurses. Data analysis indicated that occupational commitment correlated significantly with citizenship and other desirable behaviours and behavioural intentions. Baruch and Wilkelmann-Gleed’s (2002) study indicated that among commitment foci, occupational commitment was the highest among full-time employees in the NHS. Finally, the research of McCabe and Garavan (2008), examining commitment drivers among nurses showed that nurses took great pride in their profession, which they considered necessary for doing their work. Nurses’ commitment was mainly directed toward their profession and immediate work unit, and “…to a greater extent remained independent of the wider organization” (p. 536).

Literature has proposed some form of interaction between occupational and organisational commitment (e.g. Randall and Cote, 1991;
Cohen, 2000). Past research has also suggested a strong correlation between organisational and occupational commitment. There is also evidence regarding a causal path linking occupational to organisational commitment (Vandenberg and Scarpello, 1994; Hackett et al., 2001). In more detail, Vandenberg and Scarpello (1994, p. 543) argue that their study results advocate “…a causal priority from occupational to organizational commitment… [and] a significant positive influence of occupational commitment upon organizational commitment”. Based on the above, the following propositions are made:

**Proposition 12a:** Individuals’ occupational commitment will have a positive influence on individuals’ attitude toward knowledge sharing.

**Proposition 12b:** Individuals’ occupational commitment will have a positive influence on individuals’ intention to share knowledge.

**Proposition 12c:** Individuals’ occupational commitment will have a positive influence on individuals’ affective and normative organisational commitment.

A diagram illustration all of the above-mentioned propositions is presented in Figure 1, which is the proposed research model that could be empirically tested.

![Figure 1: The proposed research model](image-url)
Knowledge sharing behaviour has recently attracted the attention of researchers, after reports of failures of knowledge management initiatives that have been too much relied on technology, while neglecting the human factor (individuals and teams). Today, those aiming to realise the fruits of knowledge management started to become conscious of the magnitude of the human factor for successfully implementing initiatives. As Kim and Mauborgne (1997; 2003, p. 134) point out “creating and sharing knowledge are intangible activities that can neither be supervised nor forced out of people. They happen only when people cooperate voluntarily”. This is why, understanding the factors that influence the sharing behaviour is the first step for any intervention targeting for enhancing knowledge sharing at the organisational level.

With the aim to understand the drivers of sharing behaviour, this paper develops an extensive model to examine actual knowledge sharing, which is based on the social psychological theory of planned behaviour (TPB). The causal model proposed integrates the influence of various factors, namely past behaviour, perceived moral obligation, expected reciprocal relationships and commitment, and will be tested using primary data from physicians and nurses working in Greek public hospitals at the ward level, applying structural equation modelling. However, it is suggested that the model is further expanded to assess the influence of other factors, such as organisational climate and receiver influences.

To conclude, knowledge sharing in itself, especially tacit, is necessary for enhancing effectiveness in the workplace, as it can assist cooperation and problem solving, as well as the improvement of the quality of relationships among employees. It is not only influenced by positive organisational climate and other effective work practices, but in a circular chain of causality, it can significantly improve workplace attitudes and organisational behaviours, such as commitment, involvement and trust, that management has always been trying to promote. Therefore, sharing behaviour should be fostered, regardless of whether an organisation intends to formally implement knowledge management.

References


Renewal of skills in response to the crisis: the justification of research on adult skills

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Abstract:
This paper provides a critical overview of the aims, inspirations and expected outcomes of major policy and research initiatives on adult skills identification, evaluation and forecasting. It focuses mainly on the European Union with references to other continents. It shows that a new paradigm on human capital is emerging, putting emphasis on the continuous renewal of adult skills and having implications on research and education. It evaluates ongoing research projects on adult skills in the EU and the OECD and it explains the New Skills for New Jobs initiative of the European Commission. In this context Cedefop activity on the forecasting of skills and the Programme for International Identification of Adult Competencies (PIAAC) are expected to have a major impact in education and training over the coming years.

Keywords:
Adult skills, life long learning, generic skills, knowledge society, transition skills, competencies, human capital, labour market

1. Introduction

Mismatch in the supply and demand of skills in the European Union is well known. While this is already a serious issue, with vacancies remaining unfilled even during the crisis, several developments are likely to exacerbate this situation. Increasing competition due to globalisation, decreasing working population because of demographic developments, the demand for new skills in the move towards a low-carbon economy and technological progress all mean that in the future, Europe cannot allow the production of mismatches between what people learn at school or university, (or during their working life) and what is required from the labour market.
The EU has been allocating substantial resources for initiatives in research policy thus creating a new landscape for the research in skills in Europe. The European Commission Communication New Skills for New Jobs (NSfNJ) is the flagship consolidating these efforts and aiming at supporting the competitiveness of the EU by means of increased employability and social mobility.

Before assessing the research activities, it is useful to look at the economic arguments that underpin the need for research on skills. It is already well-documented in the academic literature that every additional year devoted to education can often increase annual revenues and may ease income inequalities. Recent research, however, is concentrating on the content of education, rather than its length and aims to find out which advances in education will ease income inequalities. A recent book (Goldin, Katz, 2008) explores the relationship between technological progress, economic inequality and the level of education. Goldin and Katz compare the pace of technological advancement with the educational adjustment to technological change. They argue that, although in the first half of the last century education raced ahead of technology, later on technology raced ahead of advances in education. It is suggested that education’s failure to respond to the demands of such rapid technological progress is, to some extent, responsible for the rise in economic inequality. Accordingly, the situation can be cured with the continuous updating of the technological skills of the labour force. In other words, it is suggested that the recent noteworthy rise in economic inequality - particularly in the United States - emanates largely from a prolonged educational slowdown vis-à-vis technological change. It seems therefore reasonable to conclude that the skills’ content of education – technological, professional or other - plays an important role in helping the educational system to be in line with technological developments and thus keeping economic inequality at bay. What emerges from this picture is the pressing need to find out which skills will be in demand for the workforce in the coming years.

While increasing inequalities are a main concern in the US, inequalities are comparatively less pronounced in the EU. Consequently, the European Employment Strategy (EES), which coordinates Member States Employment policies, focuses more on job security and worker mobility rather than inequality. An important concept embedded in the EES is ‘flexicurity’ – a strategy which involves moving from a ‘job security’ mentality to an ‘employment security’ mentality. However, to be effective, flexicurity needs workers to adapt to change in order to stay in the job market and advance in their working life. For this reason, flexicurity relies on a high worker training level and on the availability of learning opportunities over a worker’s lifetime. At the core of the EES is a commitment to expand and improve investment in workers’ skills. The
Employment Guidelines, which set the EES objectives, call for the attractiveness, openness and quality of education systems to be enhanced and for ‘lifelong learning strategies’ to be implemented.

2. The transition to new jobs through the acquisition of new skills

It is evident that, despite a declining employment rate and an increased loss of jobs, a substantial number of job openings remain vacant. Matching the vacancies with unemployed can be facilitated by an increased effort of Public and Private Employment Services in identifying opportunities for those looking for a job. Online tools such as the European Employment Service (EURES) portal make an important contribution to publicising information on vacancies across Europe. The Commission is working towards further enhancing the usability and effectiveness of this portal, while also promoting geographical mobility of those looking for work.

The central argument of this paper is that policies facilitating the workers' transition to new jobs, rather than protecting the old jobs, are going to be more effective in raising both employment and productivity. In an ageing society skills and technological advancements count more than ever and the promotion of lifelong learning in one’s lifestyle becomes an indispensable policy target. If the skills of those entering the labour market are below the skills of the average worker already employed, there is a risk of unfavourable developments in the relationship between employment and productivity. If these two essential indicators of the economy are to move forward together, there have to be sufficient incentives to innovate, to adopt new technologies or to shift labour and capital to sectors with strong productivity growth. Policies and labour market institutions should offer these incentives. For instance, the modernisation of labour laws, the provision of adequate active labour market policies, the implementation of modern social security systems but mainly the acquisition of new skills that are, or expected to be, in demand in a knowledge based society is essential to easing the effects of the crisis and to creating conditions that will facilitate full employment.

3. Acquisition of Skills is the only response in times of crisis

As evidence of economic difficulties is accumulating, any improvement in the EU employment performance seems very unlikely in the immediate future. This, however, is a lifetime opportunity to focus on human capital accumulation and development and to create the prerequisites for a quick
recovery. The argument also works the other way: By focusing only on short-term solutions to the crisis and by letting people made redundant and lose their skills and competences, we would create obstacles for overcoming the crisis, and would seriously lessen our potential for sustained growth. Hence investment in the right skills is indispensable. These have to match the demand coming from the labour market. In the EU, despite the crisis, some vacancies still remain open, because there seem to be no suitable candidates with the right skills.

4. Better anticipation is essential

We need to develop and apply better forecasting and anticipation instrument, and facilitate the uptake of the results by our education and training institutions, and private companies. The challenge is to specify what skills one will need to be able to continue working in their domain effectively or to change job. This is not a question that should be answered once these 'new' jobs exist. People who in 5 or 10 years time will look for a 'new' job are currently in school or at university or they may already be in work, but in 5 or 10 years time their job will look very different. Thus they may be forced to work in a different job. What are the factors that transform today's jobs?

<table>
<thead>
<tr>
<th>Key determinants for the future labour market and the needs for new skills</th>
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</thead>
<tbody>
<tr>
<td>- Globalisation: The evolution of international trade and globalisation lead to increased demand for high-skilled workers and reduced demand for unskilled labour in Europe and other developed countries. At the same time, upgrading of skills is also taking place in developing and emerging economies. These countries are becoming more competitive in knowledge-intensive sectors.</td>
</tr>
<tr>
<td>- Demographic development: The gradual ageing of our society indicates that people will have to work longer throughout their lives and will also have to adapt to the changing requirements that a job demands. An ageing population also means that healthcare services will see a rise in demand, with new and changing skills needed.</td>
</tr>
<tr>
<td>- Moving to a low-carbon economy: Sustainable growth will bring about new ways of producing energy, new modes of transport, and energy efficiency measures will be necessary, all based on new approaches and technologies for which new skills will be needed.</td>
</tr>
<tr>
<td>- Technological change: New technologies, such as information and communication technology (ICT), increase the demand for workers with higher computer literacy.</td>
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</tbody>
</table>
The New jobs…
To what extent and precisely how labour market demand and skills requirements will be affected by the economic downturn is not yet possible to say. What is possible to predict, from the current demographic profile of the EU, is that up until 2020, around 80 million people will have retired providing 80 million opportunities for new entrants into the labour market which in 10 years time will require different skills. At the same time up to 20 million new jobs could be created, depending on how well we can emerge from and develop after the crisis. Job creation is expected to be particularly strong in business services, but also the health sector or education, whereas in agriculture and forestry, but also in manufacturing and construction, job losses are likely to occur.

Higher education levels…
For many of these new opportunities and across occupational categories, education requirements are increasing - including those at the lowest rank of the occupation ladder. As a result, by 2020, we can expect an increase of almost 18.7 million jobs at the highest education level, and almost 13.3 million jobs at medium level. This would be offset by a sharp decline of almost 12.5 million jobs for those with no or low formal degrees. As a consequence, higher education will be required by the labour market. These are precious cedefop projections despite the fact that they are based on data gather before the crisis.

…and new skills
The above-cited projections have been undertaken at EU level, but forecasting and anticipation activities are also being carried out at national level. Some EU Member States, as well as countries outside of the EU such as the United States or Canada, already have well-developed forecasting and anticipation of new skills systems. Therefore there is scope for learning from each other's systems and experiences, with a view to promoting the creation of anticipation tools across the EU, and further develop instruments at EU level.

Equally the question of the uptake of forecasting and anticipation results by education and training systems and providers merits further attention. Social partners, in particular enterprises share the responsibility both to communicate future skills needs, and how to equip people with the right skills. Education and training systems and providers form an integral part of the challenge of skills anticipation. School curricula, the design of university courses or work-based training all need to take into account the need for new skills for new and changing jobs.
As a result the EU, and the Commission in particular, embarked in a number of activities that aim at improving short-term labour market trends on the EU level, developing tools to promote job guidance and mobility and developing better information on skills needs and mismatches on European level. In that respect, The European Centre for the Development of Vocational Training – Cedefop – has begun developing medium- to long-term skills forecasting on EU level, broken down by country, with the first results on the demand of skills published in 2008. Forecasts of skills needs, as measured by occupation and level of educational attainment, will be updated every two years. In addition, skill supply projections were just published in June 2009 to indicate possible imbalances in the labour market. Both projections are expected to be compared with employers’ surveys on skills. The European Foundation for the Improvement of Living and Working Conditions – EUROFOUND – through its European Monitoring Centre on Change, also conducts research and in-depth studies on change processes in specific economic sectors. Finally, the Commission is developing a range of ad-hoc studies looking at skills needs, in particular under the Sixth Framework Programme for Research and the EU’s Employment and Social Solidarity Programme. In addition to these, the Institute for Prospective Technological Studies (IPTS) analyses the impact of technological change on employment and skills structure. Finally, the improvement of understanding of global skills challenges through cooperation with international organisations (OECD and ILO) ensures that the NSfNJ priorities are reflected in EU policy processes (Lisbon and post-Lisbon strategies) and supported by Community financial instruments (notably ESF). The immediate concern after this introduction of the studies at EU level, is the value of skills in the economy and the benefits of forecasting skills.

5. What is meant by skills why they are so important?

Skills are the ability to use knowledge and know-how to complete a task or solve a problem, whether in a professional or learning context and in personal and social life. A highly skilled and adaptable workforce both helps boost the competitiveness of the economy as a whole, and benefits employers and employees. Young people and adults need to have the generic competences that will enable them to adapt to change and engage in further learning. Over their lifetime, learners and workers should also develop job-specific skills which should be kept up-to-date. Developing skills ensures greater employability in the long term, and can lead to better job opportunities and wage increases. Workers’ skills equally play a key role in their job satisfaction – an important component of quality of work –
and are vital for active citizenship. For employers, investing in skills is a way of enhancing their employees’ motivation and productivity, and of boosting capacities for innovating and adapting.

Why anticipate?
The fundamental rationale for anticipating future developments is that labour markets are imperfect. In addition, there are long delays between decisions to invest in skills and their final availability. Without such information there is likely to be more or greater mismatches in labour supply and demand.

Hence, by funding data collection and forecasting, the public sector is providing a facility that both the public and private sectors can use to get informed about investing in skills development. The value of such forecasts concerns mainly the medium term and not the prediction with accuracy what the future will be.

6. The Cedefop forecast

The Cedefop forecast is based on a multi-sector macroeconomic model, called E3ME (Energy-environment-economy model of Europe). This model provides projections of employment levels by sector, using Eurostat (national accounts) estimates. These employment projections are translated into implications for job creation by occupation and in terms of formal education attainment requirements. The occupational and qualifications shares within sectors are based on the patterns observed in the Labour Force Survey data. The forecast also includes an estimation of the ‘replacement demand’, i.e. job openings due to retirement, job mobility and migration. In combination, the Cedefop forecast delivers a comprehensive, consistent and detailed picture of future skills needs and job openings across Europe up to 2020. The following graph (Figure 1) presents one of the most important findings by forecasting the composition of the labour force in the EU in terms of high, medium or low skills. High skills correspond -very roughly - to the University level education, medium to the secondary school and low skills to those educated up to primary level. The figure that follows gives a very precise picture of the diminishing demand for those with low qualifications and the increasing demand for those with a higher level of skills. These projections can be confronted with the forecasts on the supply of skills and will be validated by comparing them to employers’ surveys on skills. It seems therefore reasonable to conclude that the benefits of having high skills or a higher level of education will continue to increase. However, it has to be noted that this forecast does not explain why the demand for higher skills is increasing.
Past and likely future qualification structure of jobs, shares in %, EU-25

![Bar chart showing the percentage of high, medium, and low skilled jobs in EU-25 from 2001 to 2020.](chart1.png)


The following diagram presents the recently published forecasts on the supply of skills that confirms the picture of the demand for skills in terms of composition of high, medium and low skills.

**Supply trends by qualification, labour force aged 25, EU-25 without Malta, plus Norway**

![Line chart showing the supply of high, medium, and low skilled workers from 2000 to 2020.](chart2.png)

*Source: Cedefop, 2009.*
The supply side projections offer in addition an interesting picture of the composition of skills in the medium term in terms of cohort groups. What it is striking from the following diagram is that no age group stays unaffected from the changes. Even for the over 60s the trend to getting higher level qualifications is more than evident. To this end it seems that life long learning policies will play an increasingly more important role.

**Changing qualifications of the labour force in different age groups, EU-25 without Malta, plus Norway**

![Diagram showing changing qualifications in different age groups](image)

Source: Cedefop, 2009.

7. **Anticipating skills needs at national level**

There is a long tradition of forecasting skills needs in Europe, but national experience differ in terms of the periodicity, the level of detail and the methodology used. The main methodological approaches employed to assess changing skills needs are: surveys of employers and employees;
Quantitative projections of employment based on econometric models (by occupation, sector and required level of education); foresight qualitative analysis including, for example, the development of alternative future scenarios for employment and skills needs;

Some countries have decentralised systems for anticipating skills needs, developed mostly at trade, sector or local level (for example Denmark, Spain, Greece, Hungary, Lithuania, Latvia, Portugal, Slovakia and Slovenia). Others, in contrast, coordinate a comprehensive system at national level, combining forecasts for the country and regional and sectoral studies (for example Austria, Germany, France, the Netherlands, Sweden and UK).

Why the demand for higher skill is changing?
Technological change – in particular Information and Communication Technologies (ICT) – is one reason for the shift towards higher level of skills. The use of ICT is very often associated with cognitive and analytical tasks, for example formal writing, together with interactive tasks requiring ‘soft skills’ like persuading, selling or managing. Demand for problem-solving and communication skills has risen. These are capacities that are mainly found in the high-skilled workforce. Across Europe, the proportion of workers undertaking non-routine tasks is already very high. About 60% of European workers estimate that they have to undertake complex tasks at work; a greater percentage consider that they have to solve unforeseen problems (80%) or learn new things at work (70%). (Eurofound, 2005)

The value of higher education seems well established by offering the skills that help workers to deal with complex tasks. What are, however, those skills that make the difference in each profession? Which skills or competencies are important across the spectrum of professions and make the difference for an individual?

Which skills and competences are important?
There is consensus that competencies (understood as the combination of knowledge, skills and attitudes) are essential for succeeding in a wide range of major outcomes for individuals, firms and society. Key competences refer to the knowledge, skills and attitudes that all young people should develop during their initial education and training and that adults should be able to learn and maintain through lifelong learning. The European reference framework for key competences defines eight core competences for lifelong learning (EU, Official Journal L 2006):

• Communication in the mother tongue
• Communication in foreign languages
Mathematical competence and basic competences in science and technology
Digital competence
Learning to learn
Social and civic competences
Sense of initiative and entrepreneurship
Cultural awareness and expression

These key competencies cover a wide range of skills, knowledge and attitudes and are the basis of thinking particularly in what concerns life long learning activities. Recently, however, the interest has started to focus on the importance of skills usually mentioned as transversal or general. The term generic skills also tends to be used often and for that reasons they deserve a more detail examination.

What do we mean by generic skills?

There is no consensus in the literature on the exact nature of generic skills. However, one of the most cited definitions considers them as skills which can be used across a large number of different occupations(Kearns, 2001). They include crucial skills such as literacy, numeracy and problem solving capacities but extend beyond these to contain a range of other cognitive, personal and interpersonal skills which are relevant to employability. Various frameworks could classify generic skills; One such framework includes several clusters of relevant skills:

Cognitive Skills (Reading, Writing, Maths, Problem-Solving, Computing)
Interaction/Social Skills (Influence: teaching/instructing/training/coaching, making speeches/presentations, persuading, motivating, etc.)
Self-Direction (planning & organising own activities & time, thinking ahead, horizontal interaction, team-working, listening, cooperating/collaborating, negotiating, sharing information, client interaction)
Physical Skills (stamina, strength, dexterity)
Learning Skills (requirement to learn new things, keep up to date, help others learn)

The uncertainties and the considerable gap of scientific knowledge about generic skills, their importance in comparison with trade skills and their growing significance in today's economic conjecture puzzles the academic community. The most comprehensive attempt to bridge this gap and understand generic skills’ role in the economy and the society is the survey in progress by the OECD in cooperation with the EU in the PIAAC programme.
Why employers or interested in generic skills?

Education and training institutions normally classify skills and train people according to professional occupations. Qualified employees acquire competences related mainly with their trade and are usually classified as high, medium or low skilled according to their level of education. Recently, however, there is a growing mismatch between the outcomes produced by educational establishments and the requirements of the employers. It seems that today's employers –and markets- seek more than qualifications; they look for individuals able to use their skills as an organic whole. They want them to be capable of reacting -or pro-acting - to events under conditions of uncertainty and limited information. In other words, they ask from them an ability to see things from different perspectives and to demonstrate that they are masters of their professions and of the skills they are using. Someone might argue that employers are looking for an attribute reminiscent of the classical period e.g. a sense of the wholeness of things (H. Kitto, 1957).

Obviously, this revitalized interest in general skills originates in the increasing uncertainty in actual market developments. As MIT professor Vest argues “the entire nature of the innovation ecosystem and business enterprise is changing dramatically in ways we do not yet fully understand” (Vest, M, 2006). In this environment, employers desperate to increase their competitiveness look for persons with a holistic approach to business and an ability to solve complex problems or invent new solutions (Economist, 2006). Some argue that employers are only interested in multi-talented individuals with exceptional general skills. In fact, since talent is difficult to define, it is evident that they are looking for non-sector specific skills or well-rounded skills. The term generic skills is widely used.

However, there is no consensus, neither on the importance nor on the ranking of these skills. The historical debate of general skills versus specific skills continues until today. Some argue that special skills are important for getting your first job whereas general skills help you in moving either inside or outside your company or occupation. Furthermore, the importance in terms of the ranking of generic skills is not valued consistently by employers, graduates, and academics. The following figure provides a clear sign of the considerable gap between academic institutions and employers in the ranking of these skills.
Relative importance (1= most important) employers, graduates and academics attach to a selection of generic competences

<table>
<thead>
<tr>
<th>Employers</th>
<th>Graduates</th>
<th>Academics</th>
</tr>
</thead>
<tbody>
<tr>
<td>n = 944</td>
<td>n = 5183</td>
<td>n = 998</td>
</tr>
<tr>
<td>1. Capacity to learn</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Capacity for applying knowledge in</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>3. Capacity for analysis and synthesis</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4. Capacity to adapt to new situations</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>5. Interpersonal skills</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>10. Elementary computing skills</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>12. basic general knowledge</td>
<td>12</td>
<td>1</td>
</tr>
</tbody>
</table>


It is hope that surveys like PIAAC will offer some answers to these long standing questions and controversies.

8. Programme for the International Assessment of Adult Competencies (PIAAC)

PIAAC will assess the level and distribution of knowledge, skills and attitudes across countries. It will examine different areas of competency including problem-solving in a technology-rich environment, aptitude to evaluate information and construct new knowledge, reading literacy and numeracy. Data from PIAAC will enable to investigate the links between important cognitive skills and their use at work and a range of demographic, economic and social variables. As a result, our understanding of labour-market returns to education and the role played by cognitive skills in enhancing labour market prospects should be improved.

PIAAC is likely to have an important impact when, in 2013, it will start producing reports and data. The PIAAC will provide a comprehensive assessment of differences in competencies between in individuals and across countries, in other socio-economic outcomes that underpin personal and societal success and in the performance of education and training systems in generating the required competencies. More than 30 countries are expected to participate in PIAAC and the total cost of the programme may exceed € 30 Million.

The main aims and implications of PIAAC are the following:

- To identify and measure differences between individuals and nations in crucial competencies and other economic and social
outcomes that are believed to underlie both personal and societal success.

- To assess the impact of competencies on economic and social outcomes, including individual outcomes such as integration into the labour market, employment status and earnings.
- To assess the performance of education and training systems in generating the required competencies at such levels required by social and economic demands.

PIAAC surveys representative samples of adult populations, including the non-employed, in a household context. The PIAAC also provides an international option for over-sampling a cohort of young adults and of following this over-sampled cohort in subsequent cycles.

PIAAC defines literacy as the interest, attitude and ability of individuals to appropriately use socio-cultural tools, including digital technology and communication tools, to access, manage, integrate and evaluate information, construct new knowledge, and communicate with others in order to participate effectively in society. PIAAC focuses on the component for the direct assessment of competencies on literacy, which previous national and international assessments have shown to be an essential foundation for individual success and can be considered a sufficiently stable trait to remain policy relevant over time as the PIAAC progresses.

What is the analytic potential of the PIAAC strategy for public policy?

When the PIAAC strategy was established, emphasis was placed on being able to inform policy makers to the following overarching themes:

- adult competencies and their individual as well as aggregate economic and social outcomes;
- the design and quality of education systems and levels and distributions of adult competencies;
- enhancing the prospects of adults at risk;
- improving school-to-work transitions and reducing youth unemployment;

What is the PIAAC timetable?
The table below presents the planning of PIAAC activities (as of November 2008)
At the core of PIAAC is an assessment of adult populations for their literacy skills understood as the interest, attitude and ability of individuals to appropriately use socio-cultural tools, including digital technology and communication tools and to access, manage, integrate and evaluate information, construct new knowledge and communicate with others. In addition, PIAAC collects information from respondents concerning their use of crucial working skills in their jobs – a first for an international study.

Previous international assessments, such as the International Adult Literacy Survey (IALS) have sought to maximize the coverage of cognitive competency areas, at the price of assessing each competency area with limited resolution, particularly at the low and high end of the performance distributions. This has been done by restricting the complexity with which each competency area is defined and assessed and by limiting the extent of contextual data explaining differences in the competencies and their impact on individual and aggregate levels. Furthermore, empirical results from these assessments suggest that the competency areas that were measured were generally so highly interrelated, that taken separately they offered limited additional value for policy analysis (for example, when used to assess the impact of the competencies measured on economic and social outcomes).

PIAAC takes a different route and shifts the balance from the assessment of competencies towards the collection of information on other social and economic outcomes as well as contextual data that can be used to examine the development, functioning and impact of competencies.
However, these previous assessments from a limited number of countries have produced some impressive results by providing answers to very critical questions in the labour market. For instance, let's think about the typical situation of unemployed people with different levels of skills attempting to find a job. Who will have the better chances of getting a job? Is it someone with low skills or another one with medium to high skills? The ALL survey clearly proves that on average in a 52 week period someone with medium to high skills has 60 to 70 per cent chance of getting a job, where someone with low skills has less than 50 per cent chance of getting a job. Despite the fact that ALL concerns only a limited number of countries, it confirms the essential message for the value of skills in the labour market. However, it is evident that skills cannot say the whole story of why someone gets a job or not. The issue is more complex and other attributes or factors are involved.

ALL has attempted to explain more complex relationships in the labour market, something that PIAAC is expected to be more innovative in. One example from ALL-illustrated in the following graph- is the connection between skills and income. What is the probability that someone with high skills and intensive use of computer belongs to the high earners in the labour market? ALL has compared four categories with logistic regression and the result—excluding Italy— is that in Switzerland, Bermuda, Canada, Norway and the US the combination of high skills and intensive computer use makes the difference for high salaries. In PIAAC researchers will have the opportunity to combine many skills or attributes and the

![Graph showing probability of exiting unemployment by skills levels](source: As reported in Learning a Living, the Adult Literacy and Life Skills Survey, 2005 page 115)
The academic community is eagerly waiting for the results. No doubt that PIAAC with its highly sophisticated structure, questionnaire and data analysis will provide more elaborate arguments about the importance of various forms and level of skills in 30 or more countries. Moreover, since PIAAC is expected to overlap at the level of 60 per cent with - OECD coordinated older surveys - ALL and IALS it is hoped that it will produce time series and results that will have a major impact on the labour market both inside and outside the EU. Since data and studies on generic skills were not dealt extensively until today by Eurostat statistical activities the results of PIAAC are expected with interest in both sides of the Atlantic as well as in Asia. Japan and Corea are participating in this survey very actively.

**How do the US and Canada deal with skills?**

Both the US and Canada are participating in PIAAC. However, as with the Eurostat statistics, the US Bureau of Labor Statistics produces biennial detailed projections of employment by sector and by occupation and broken down by state. Further activities complement the project, including the O*NET system for monitoring changing skills needs within occupations. O*NET is an online database developed by the US Department of Labor and offers detailed information on occupations, such as educational requirements, typical tasks, work conditions, and earnings.
as definition and descriptions of work activities, knowledge, skills and abilities required, wages and employment trends.

In Canada, ‘Sector Councils’ were put in place in almost 30 economic sectors. These organisations comprising business, labour, education and other key stakeholders examine current and projected human resource challenges (including how training is developed and delivered), identify solution, and coordinate and implement strategies to help firms to meet changing demands. Through their work, national occupational standards and certification programmes are devised, new entrants in the labour market are identified and prepared and career and occupational information is enhanced.

Specific skills under examination

Apart from generic skills an analysis of the skills and labour market needs of key sectors is needed. The European Commission has developed a common approach for identifying emerging competences across sectors, an approach applied to 18 economic sectors. For each sector, the most important economic and employment trends, drivers of change and emerging or changing skills and competences are mapped. On this basis, several alternative scenarios are created for how they may plausibly evolve and their implications for competences and occupation profiles in terms of jobs expanding, altering or declining are defined. The ultimate goal of these studies is to outline strategic choices to meet the sector’s skills needs, such as specific implications for education and training and recommendations addressing social partners and public authorities at all levels. Comprehensive results for 16 sectors covering 75% of jobs in the EU private sector will be available in mid-2009, providing a full picture of labour demand and its implications for restructuring of enterprises.

An important question is what structures could be used in policy making for implementing the results of these research activities. How can we be assured that important findings will be transmitted efficiently and adopted by Education and Labour Market Institutions?

The last sections of this paper will deal with the complex overall relationships in the EU among the main stakeholders in this area as well as with some of the most pressing problems. Most of the issues mentioned are under development and each of them requires an extensive analysis that is outside the scope of this article. They were included in this paper because they are becoming more important in the area of skills and competencies.
Cooperation in Education and training

Although education and labour market issues are the domain of Member States, both the Member States and the Commission have worked together on these issues with the Education & Training 2010 work programme and the European Employment Strategy, as Part of the Lisbon Strategy. This cooperation takes the form of an ‘open method of coordination’ to stimulate reforms and build higher skills through better education and training systems. This includes monitoring progress towards a set of shared objectives and against common indicators and benchmarks taking into account Member States’ very different starting points, with mutual learning as an important means of exchanging good practice and implementing tools and instruments agreed at European level.

In the education area the Commission has proposed that future European cooperation in education and training (including schools, higher education, vocational education and training and adult learning) should address the following four strategic challenges:

• Making lifelong learning and learner mobility a reality
• Improving the quality and efficiency of provision and outcomes of education and training
• Promoting equality and active citizenship
• Enhancing innovation and creativity, including entrepreneurship, at all levels of education and training.

There is hope that the ‘updated strategic framework for cooperation in education and training’ will ensure that the assessment of future skill requirements and the matching of labour market needs are fully taken into account in all planning processes for education and training activities.

Cooperation in the Labour Markets of Europe

In the labour market area, a series of Employment guidelines help in the coordination of activities and in the implementation of the Lisbon strategy. The open method of coordination, along with a series of guidelines, is also used; among the main priorities of the Lisbon strategy are to improve the adaptability of workers and enterprises and to increase investment in human capital through better education and skills.

It is interesting to examine some of the specific problems of the European labour markets, where results from the skills' surveys and studies could help in overcoming long term rigidities.

Preventing skills shortages by eliminating gender imbalances

Less than one third of occupations in the EU are ‘mixed’ occupations, while the remainder are dominated by one gender, according to the Labour Force Survey data. What is more, it is too often the case that female-
dominated jobs are at the lower end of the qualifications spectrum while several male-dominated professions are to be found in highly qualified areas of employment. Avoiding gender imbalances would help to ensure the allocation of labour where it is most needed and therefore avoid skills vacancies. As such, efforts should be pursued both ways, encouraging men into what are traditionally more female-dominated areas such as care work, and further facilitating women’s access to technical occupations. This should facilitate a better gender balance between high and low-skilled jobs and more equal opportunities in the development of skills.

Some developments in EU labour markets

According to a report of the European Foundation for Living and Working Conditions, the new jobs created in Europe between 2000 and 2006 tended to improve in quality. Nevertheless, distinct patterns of employment expansion can be found among European countries:

- Polarisation – in this situation, job creation is intense at the extremes of the job spectrum: most new jobs are either low- or high-paid jobs – Cyprus, France, Hungary, the Netherlands and Slovakia.
- Upgrading – job creation is more concentrated at the higher end of the job spectrum – Denmark, Finland, Ireland, Luxemborg and Portugal.
- Growth in the middle – Estonia, Greece, Lithuania and Latvia.
- Polarisation combined with upgrading – Austria, Belgium, Germany, Slovenia and the United Kingdom (UK).
- Upgrading combined with growth in the middle – Czech Republic, Spain, Italy and Sweden.

Trends towards polarisation bring concerns of inequality. Moreover, the persistence – and even development – of high numbers of low-paid jobs poses a challenge to the provision of a decent living standard to all workers and to the wider objective of social cohesion enshrined in the EU Treaty.

How could education come closer to the labour market needs?

The ‘Tuning Educational Structures in Europe’ project, which began in 2000, was developed by universities for universities and supported by the European Commission. The project allows universities to better adapt their curricula and define degree programmes in terms of learning outcomes, which leads to qualifications that are more transparent and ultimately better attuned to the needs of the labour market. Surveys undertaken by this project examined the perceptions of graduates, academics and employers regarding skills requirements, curricula and learning outcomes, and address
issues such as teaching methods, student workload and quality enhancement.
The name ‘Tuning’ reflects the idea that universities do not – and should not – look for uniformity in their degree programmes rather they should simply look for points of reference and a common understanding.

The EU Forum for University-Business Dialogue
In 2008, the European Commission launched a forum for a structured dialogue for cooperation between university and business, to look at ways for reinforcing the links between higher education and companies in areas such as governance, curriculum development, entrepreneurship, continuing education, knowledge transfer and mobility. This platform on European level provides a basis for dialogue on common issues and challenges, supports mutual learning and the identification of innovative solutions. The Commission Communication ‘A new partnership for the modernisation of universities: the EU Forum for University-Business Dialogue’, takes stock of what has been learned from the first year of the Forum and other relevant activities at European level about the challenges and barriers to university-business cooperation, the issues to be addressed and good practices and approaches which could be more widely used. The Communication makes proposals for the next steps in the Forum’s work and outlines concrete actions to strengthen university-business cooperation.

Mobility in the labour force
Towards a wide ‘European Higher Education Area’
The ‘Bologna Process’ aims at creating a ‘European Higher Education Area’ that will offer broad access to quality higher education and facilitate the mobility of students, graduates and higher education staff. Encompassing 46 countries, it seeks to advance reforms leading to comparable degrees organised in a three-cycle structure (bachelor, master and doctorate), further improve quality assurance in accordance with agreed standards and to promote fair recognition of foreign degrees and other higher education qualifications. The Bologna Process is intergovernmental, but all relevant stakeholders are involved in the discussions and decision-making, in particular higher education institutions and students. The European Commission helps Member States and neighbouring countries in the implementation of the Process with programmes, such as the Erasmus, the Tempus and the Erasmus Mundus.

The European Qualifications Framework for Lifelong Learning
The European Qualifications Framework (EQF) is a European reference framework aiming at making qualifications more readable and understandable across different countries and systems in Europe,
facilitating workers’ and learners’ mobility and lifelong learning. The EQF relates different countries’ national qualification systems to a common European framework with eight reference levels, encompassing all levels of qualifications acquired in initial and in continuing education (either general, vocational or academic). The eight levels are described in terms of learning outcomes, defined as a statement of what a learner knows, understands and is able to do on completion of a learning process.

This approach also promotes the validation of experiences obtained in informal and non-formal learning settings or through work. Countries of the EU are to relate their national qualifications systems or frameworks to the EQF by 2010 and make reference to the appropriate EQF level in all new qualification certificates and diplomas by 2012. The implementation of the European Qualifications Framework should increase the transparency of qualifications and facilitate access to further learning.

Cooperation in Vocational Education and Training
Cooperation in Vocational Education and Training (VET) takes place within the ‘Copenhagen Process’, named after the Copenhagen Declaration endorsed in November 2002 by the Education Ministers of 31 countries. At its last review in November 2008 in Bordeaux, the Ministers in charge of VET agreed to include a new priority in the cooperation process related to the improvement of the links between VET and the labour market. This includes in particular the development of tools to improve sectoral identification and the anticipation of skill and competence needs, the promotion of guidance, counselling, adult training and validation and recognition of informal learning.

The Leonardo da Vinci strand of the Lifelong Learning Programme 2007-2013 provides substantial financial support for the implementation of the VET policies and the Copenhagen process and notably for projects aiming to make VET more responsive to labour market needs. Another important priority of the Copenhagen process is the development of European tools to enhance the transparency, recognition and quality of qualifications in VET. Such tools can be found in the European Credit System for VET (ECVET) and the European Quality Assurance Reference Framework for vocational education and training (EQARF).

Support structures
The role of Public Employment Services
Public Employment Services help in matching supply and demand in the labour market by providing support services to both employers and job-seekers. They help employers to fill vacancies, provide job-seekers with job guidance and placement service and can assist them in meeting skills and training needs. Public Employment Services offer access to more
comprehensive and individualised services (including adequate retraining measures) in situations where, for example, there are not enough vacancies for every job seeker to find work immediately, a job seeker has skills that do not fit with current vacancies, or other problems make finding a job difficult. Therefore, they play an indispensable role in detecting and addressing skills mismatches and preventing the risks of structural and long-term unemployment.

The European Social Fund

The European Social Fund (ESF), one of the EU’s Structural Funds is set up to reduce differences in prosperity and living standards across EU Member States and regions. The ESF aims at improving the lives of European citizens by giving them better skills and job prospects. To achieve this goal, €76 billion will be distributed to the EU Member States and regions over the period 2007–13. ESF funding supports projects that improve access to training - in particular for the low-skilled and older workers - prevent and anticipate unemployment and support career and individual guidance. The funding also backs outplacement and mobility schemes that encourage workers to move across regions or across the European Union, where their skills are needed. The ESF trains and supports the employability of approximately 9 million people every year. In addition the ESF can help to identify future occupational and skills requirements, support the design and introduction of reforms in education and training systems that make initial and vocational training more relevant to employers’ needs and update educators’ and trainers’ skills.

The ESF financial procedure has been simplified for the benefit of Member - States and citizens. Under the European Economic Recovery Plan, the Commission has proposed further simplifications of the ESF to help Member States to utilise the fund in a flexible way to support those citizens mostly affected.

The European Globalisation Adjustment Fund (EGF) support, workers who lost their job as a result of changing global trade patterns. When a large enterprise shuts down or a factory is relocated to a country outside the EU or a whole sector declines in a region, the EGF can help the redundant workers to find new jobs as quickly as possible. A maximum amount of € 500 million per year is available to the EGF to finance such interventions. The European Structural Funds, in particular the European Social Fund, support the anticipation and management of change with activities such as life-long learning, in a strategic and long-term perspective. The EGF, on the other hand, provides one-off, time-limited individual support geared to help workers who have suffered redundancies as a result of globalisation.
New jobs and skill needs in a greening economy

As a result of investment to mitigate and tackle the effects of climate change, new markets and job opportunities are emerging, especially in sectors related to environmental services, clean technologies, renewable energies, recycling, urban and rural renovation or nature conservation. However, while new employment opportunities will arise, some jobs might become obsolete or be redeployed in the process of the restructuring of industries especially the ones directly affected by countermeasures to tackle climate change. For instance, moving from fossil fuel plants to renewable energy will create jobs and yet may equally mean that some workers will lose their jobs, both in the ‘traditional’ energy sector and in other linked industries. However, the skills required for the jobs that are lost may differ significantly from those needed for those that have been newly created. Moreover, many existing professions (for example in the construction and agriculture sector) will be transformed and redefined as their day-to-day skill sets and work methods are ‘greened’. The transition to a low-carbon economy could be hampered due to the slow pace of diffusion of new skills among the labour force and low awareness about new techniques, products and materials. Adequate training policies will be therefore needed to avoid skills gaps and shortages that would render green investments ineffective.

Concluding remarks

New surveys and studies on skills are a sign of Europe's effort to respond to the crisis by creating the conditions for recovery. However, the range of new and old surveys needs coordination so as to increase comparability among the surveys, harmonization of definitions between member states and differentiation between sectors. Surveys should also help in improving taxonomy of jobs in the labour market, taxonomy being an important issue for recruiters. The PIAAC programme as well as all the surveys and research in European organisations have great potential for consolidating our limited knowledge in this field, for bringing together the different features of this puzzle and for upgrading levels of education in the EU at the level aimed by the Lisbon strategy.

References


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http://mitworld.mit.edu/video/409/
Topic: Project Management

Critical systems thinking for project management (ABSTRACT ONLY)

*Martin Reynolds, Rob Taylor*

Priorities in determining indicator for economic efficiency of a building renovation project

*Svetoslava Enimaneva, Diana Antonova*

Contemporary aspect of a problem work with information

*Dimiter Ginchev, Nikolai Petrov, Nikolay Pavlov Atanasov*

Designing project management systems to deal with uncertainty

*Konstantinos Anagnostopoulos, Georgios Koulina, Stratos Koutroudis, Lazaros Papavasiliou*
Critical Systems Thinking for Project Management

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**Abstract (only):**

Project managers are increasingly aware of two realities in our contemporary world. One, making sense of complex interrelationships and the continual change brought about by such relationships and interdependencies. Two, the need to engage with multiple, often conflicting, perspectives on these realities. Projects enable such realities to be divided into ‘manageable’ arenas, but how do they perform in dealing with such realities? The conventional strategy underpinning the project management cycle consist of a linear process of (i) planning, (ii) implementation, and (iii) control.

An underlying problem is the mismatch between the reality and the strategy; a mismatch informed by an increasing body of literature associated with systems thinking and complexity science receiving popularity.

We take as our point of departure a reality amongst project managers that their work is conceived around planning, implementing and controlling. The critique presented is to do with the manner in which these activities might occur so as to better accommodate complex reality and to prompt more responsible project management. We examine each of the constituent three parts of the project management cycle in turn using systems ideas to explore how they may address complex reality. First, for systems ideas of ‘planning’ we use ideas of boundary critique from a tradition of critical systems thinking (CST) to explore the dilemmas of our inevitable bounded limitations on (a) the scope of framing of complex connectivity and interrelationships (i.e., we simply cannot be holistically ‘universe’) and (b) our engagement with multiple and different viewpoints (i.e., we simply cannot be interpretively and pluralistically ‘multiverse’). The critical and strategic turn is to move away from planning construed as mapping out real world fixed ‘systems’ towards planning using systems as a heuristic device for improving upon real world ‘situations’. Second, the problem of ‘intervention’ is considered one of developing systems for practice in order to deal with multiple perspectives. Effective intervention from a systems perspective must somehow
address effective stakeholder participation, including stakeholders not directly involved with project management but nevertheless affected – whether intentionally or not. Third, the problem of ‘control’ is considered as developing appropriate systems for understanding the changing complexities of reality, relinquishing the aspiration for absolute control whilst retaining the need for some sense of command over the project situation. The systems intention here is to promote models of ‘self-organisation’ as an alternative to models of ‘command and control’. These last two features of a strategic turn are exemplified using the viable systems model (VSM). The paper makes specific recommendations for project management education.

**Keywords:**
Project management, CST, complexity theory, boundary critique, VSM
Priorities in determining indicator for economic efficiency of a building renovation project

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Abstract:
Investment in building thermoinsulation is a subject to appraisal for efficiency from the position of discounted cash flows taken specifically by energy saving. The appraisal of investment as optimal is attended by achieving the shortest term for investment implementation, the lowest investment outlays, the maximum total net value of energy savings, the shortest investment payback period. The complex application of the dynamic methods for appraising economic efficiency of an investment – net present value, internal rate of return, profitability index and discounted payback period, involves drawing of particular values which comparison definitely will show if this kind of investment is practically “attractive”. However, the question for significance weight of each of these indicators above in decision making for implementation a particular real investment still remains unsolved. This requires working out a system of criteria, priorities, that can determine which of the indicators for economic efficiency of specific investment project will have the highest significance.

Key words:
Economic efficiency, renovation construction process, investment choice

1. Introduction
Mr. Kalin Rogachev, vice-minister at Ministry of Regional Development and Public Works, at 7th April, 2009 opens the round-table meeting “The pros and cons on partial thermoinsulating” with the words:
“Over 4 milliard leva (BGN) will be necessary for renovating the entire building fund in the country.” (Корчакова, М. (2009) Енергийната...
At the same meeting arch. Geliazko Ivanov, member of the Managing Committee of the Chamber of architects in Bulgaria, says:

“In Bulgaria only the large-panel flats count 670 000. At the present speed of implementing projects for buildings thermoinsulation, only for these large-panel flats we will need over than 600 years.” (Корчакова, М. (2009) Енергийната ефективност – тема с продължение. СТРОИТЕЛ, Април 10, 2009, p. 14)

The integration of Bulgaria to the European Union forces the fulfillment of the directives for energy efficiency increase to be done at a faster pace than reported. That imposes the processes on buildings investigation and provision of the resources needed for their transformation to the requirements for energy consumption levels to be placed at a more dynamical base. The responsibility for these processes is clearly divided:

- Upon the governmental, district and municipal buildings it is taken by the government and the state budget;

- Upon the buildings - private property of single economic subjects (companies and individuals) – it is on their own, their financial resources and their conviction on the indispensable character of the investment in energy efficiency increase of their own buildings. That causes renovation of detached objects (flats) in buildings instead of entire renovation. The result of these actions is inefficient for the building as a whole by reason of falling to get optimal energy savings. Therefore, the effect on the energy consumption in the building is very small.

Limited financial resources of the single economic subjects and the lack of clear orientation and knowledge of the energy savings in result of thermoinsulation, the value of necessary investment outlays for thermoinsulation and terms for their payback, demand to be collaborated and popularized a model that will ensure attainment of energy savings optimization with optimal value of investment in thermoinsulation.

2. Analytical model of the initial investment outlays for thermoinsulation and the cash flows of energy savings in result of thermoinsulation

The model is defined to have two basic elements:

- Investment outlays value. The first element depends on the material sort, its thickness, the price of the material according to its sort and thickness, as well as value of other outlays made for insulation implementation.
Upon external implementation the first element will be:

\[ I_{out} = \left[ Q_{ij} \cdot P_{ij} \left( 1 + p_m \right) + L \left( 1 + p_l \right) + E_{out} \left( 1 + p_E \right) \right] \left( 1 + p_{pr} \right) \]  

(1),

\( I_{out} \), BGN – sum of the investment outlays upon external implementation of the thermoinsulation,

\( Q_{ij} \), m² – the necessary quantity (the so-called practical standard) of thermo-insulating material with relevant thickness for 1m² area,

\( P_{ij} \), BGN – price of the thermoinsulating material with relevant thickness for 1m² area,

\( p_m \), % - rate for additional outlays for materials, usually \( p_m = 10\% \) (delivery-warehouse outlays),

\( L \), BGN – value of the manual labor quota for implementing 1m² thermoinsulation (quota = hours of manual labour wanted for covering 1 m² area with thermoinsulating material x tariff for hour manual labour),

\( p_l \), % - rate for additional outlays for manual labour, usually \( p_l = 80\% \) (social insurance, etc.),

\( E_{out} \), BGN – value of the mechanization (in the case it is the value of making scaffolding fitting),

\( p_E \), % - rate for additional outlays for mechanization (transport, scaffolding, etc.), usually \( p_E = 20\% \).

\( p_{pr} \), % - profit rate.

Upon internal implementation the first section will be:

\[ I_{in} = \left[ Q_{ij} \cdot P_{ij} \left( 1 + p_m \right) + L \left( 1 + p_l \right) \right] \left( 1 + p_{pr} \right) \]  

(2),

\( I_{in} \), BGN - sum of the investment outlays upon internal implementation of the thermoinsulation.
Value of the energy savings. The second element depends on the specific climatic region, the hours of constancy of the particular atmospheric temperatures during the heating period, the quantity of saved energy at detached temperature differences and at different specific ratios of thermal transition of the insulating materials, the price per 1kWh according to the energy resource (electricity, natural gas, etc.). The value of the energy savings taken in result of thermoinsulation are actually the net cash flows that will take part in calculating the indicators of economic efficiency of the investment, viz. NPV, IRR and PI. The comparison of the different values of the indicators taking into consideration their advantages and disadvantages (Mateev, 1998; Проданов, 1999; Александрова, 2001; Брусарски 2003) is to help in determining a priority indicator for investment decision making for thermoinsulation with specific insulating material.

\[
F_{m \times n} = \begin{bmatrix}
    t_{01} & \ldots & t_{0i} & \ldots & t_{0n1} \\
    \vdots & \ddots & \vdots & \ddots & \vdots \\
    t_{01} & \ldots & t_{0j} & \ldots & t_{0nj} \\
    \vdots & \ddots & \vdots & \ddots & \vdots \\
    t_{01} & \ldots & t_{0m} & \ldots & t_{0nm}
\end{bmatrix}
\]

\[
G_{m \times n} = \begin{bmatrix}
    \tau_{01} & \ldots & \tau_{0j} & \ldots & \tau_{0nm} \\
    \vdots & \ddots & \vdots & \ddots & \vdots \\
    \tau_{01} & \ldots & \tau_{0j} & \ldots & \tau_{0nm} \\
    \vdots & \ddots & \vdots & \ddots & \vdots \\
    \tau_{01} & \ldots & \tau_{0j} & \ldots & \tau_{0nm}
\end{bmatrix}
\]

\[
D = t_i \cdot G_{m \times n} - F_{m \times n} \cdot G_{m \times n}
\]

\[
CF_e = \frac{n}{1} \left[ \frac{(t_i - t_{0i}) \cdot \tau_{0i}}{R} - \frac{(t_i - t_{0j}) \cdot \tau_{0j}}{R_{renj}} \right] S_{ij} \cdot 10^{-3}
\]

\[
NPV = \sum_{i=1}^{n} \frac{CF_{e_i}}{(1 + r)^t} - I_0 \quad (7), \quad 0 = \sum_{i=1}^{n} \frac{CF_{e_i}}{(1 + IRR)^t} - I_0 \quad (8), \quad PI = \sum_{i=1}^{n} \frac{NCF_{e_i}}{I_0}
\]

(Проданов, 1999),

\[
t_{011} \quad ^{\circ} C - \text{values of the atmospheric air temperatures during the heating period,}
\]
\( \tau_{ij} \), h – hours of constancy of the values of atmospheric air temperatures during the heating period at different months and specific climatic regions,

\( F_{mn} \) – determinant of distribution of the values of atmospheric air temperatures during the heating period,

\( G_{mn} \) – determinant of the hours of constancy of the values of atmospheric air temperatures during the heating period,

\( t_i \), °C – temperature held up in the building,

\( CF_e \), BGN – attained (expected) value of energy savings during the heating period,

\( R \), m².K/W – the resistance of thermal transfer of the outer wall before thermoinsulation,

\( R_{renij} = \frac{\delta_{ins}}{\lambda_{ins}} \), m².K/W – the resistance of thermal transfer of the wall after thermoinsulation with specific insulating material with relevant thickness,

\( \delta_{ins} \), m – the thickness at which the insulating material is used for thermoinsulation,

\( \lambda_{ins} \), W/m.K – the specific ratio of thermal transfer of the relevant insulating material,

\( S_{ij} \), BGN/kWh – price of the energy used for heating, that will take part in calculations of the energy savings value,

\( I_0 \), BGN – value of the investment outlays according to the way of thermoinsulation implementing (outer/inner),

\( NPV \), BGN – net present value of the investment,

\( r \), % - annual interest rate of the credit for thermoinsulation,

\( n \), years – credit term in years,

\( IRR \), % - internal rate of return of the investment,

\( PI \) - profitability index of the investment.

3. Results

The value of the investment outlays upon internal implementation of the insulation material varies from 19.74 BGN/m² to 46.97 BGN/m² according to the sort of the insulating material (the most often used sorts of insulating materials from the single economic subjects are chosen) and its price (Справочник за цените в строителството, 2009) at thicknesses 0.01m and 0.05m. The last column of Table 1 shows the investment outlays value per 1m² that single economic subject should do if participating in procedure for loan through Residential Energy Efficiency Credit (REECL) Facility (Available from: http://www.reecl.org/bg/) with
the partnership of Raiffeisen (Bulgaria) Bank, ProCredit Bank (Bulgaria), United Bulgarian Bank and DSK Bank.

**Table 1.** Value of the initial investment outlays upon internal thermoinsulation according to material sorts and their prices at relevant thicknesses

<table>
<thead>
<tr>
<th>Material sort</th>
<th>Thickness (m)</th>
<th>Investment Outlays Value (BGN/ m²)</th>
<th>80% Io</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPS</td>
<td>0,01</td>
<td>19,74</td>
<td>15,79</td>
</tr>
<tr>
<td>EPS (Styropor)</td>
<td>0,05</td>
<td>22,83</td>
<td>18,26</td>
</tr>
<tr>
<td>XPS</td>
<td>0,01</td>
<td>21,42</td>
<td>17,14</td>
</tr>
<tr>
<td>XPS (Fibran)</td>
<td>0,05</td>
<td>31,22</td>
<td>24,98</td>
</tr>
<tr>
<td>Stone wool</td>
<td>0,01</td>
<td>24,57</td>
<td>19,66</td>
</tr>
<tr>
<td>Stone wool</td>
<td>0,05</td>
<td>46,97</td>
<td>37,58</td>
</tr>
</tbody>
</table>

Table 2 and Table 3 below present the matrixes of distribution of the atmospheric air temperatures $t_{0ij}$ (matrix $F_{m\times n}$) and the hours of their constancy $t_{0ij}$ (matrix $G_{m\times n}$) for the three specific climatic regions in Bulgaria (Климатичен справочник на НР България, 3, 1983) – Sandanski, Chirpan and Knedga. The atmospheric air temperature is given in interval of 2°C. The heating period lasts from October till April. The differences in the hours of constancy of the low temperatures at different months and regions are determinative for the quantity of expected energy saving.

**Table 2.** Distribution of the hours of constancy of the low atmospheric air temperatures at different months (during the heating period)

<table>
<thead>
<tr>
<th></th>
<th>Sandanski</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>F_{m\times n}</td>
<td>G_{m\times n}</td>
</tr>
<tr>
<td>$t_{\text{atm.}}$</td>
<td>$X$</td>
<td>$XI$</td>
<td>$XII$</td>
</tr>
<tr>
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<td>0,0</td>
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<tr>
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</tr>
<tr>
<td>-11</td>
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<td>0,0</td>
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</tr>
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<td>-9</td>
<td>0,0</td>
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<tr>
<td>-7</td>
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<td>-5</td>
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<td>31,3</td>
<td>85,4</td>
</tr>
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<td>3</td>
<td>2,2</td>
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<td>XI</td>
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<td>73.0</td>
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<td>132.4</td>
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<tr>
<td>17</td>
<td>93.3</td>
<td>11.6</td>
<td>3.7</td>
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</table>

### Chirpan

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<th>t° atm.</th>
<th>X</th>
<th>XI</th>
<th>XII</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
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<td>-17</td>
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### Knedga

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Data from Table 3 allow to calculate the hour-degrees and to determine their distribution at different months and climatic regions of the country during the heating period. It is accepted that the minimal permissible temperature inside the building is $t=20^\circ C$.

**Table 3.** Distribution of the hour-degrees for the three specific climatic regions in the country at different months during the heating period (HP)

<table>
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<th>Region</th>
<th>Total hour-degrees for HP</th>
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<th>XII</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
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<td>13824,2</td>
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The calculations of energy savings values correspond to resistance of thermal transfer of the panel wall before thermoinsulation $R=1.43$ m$^2$.K/W, thicknesses of the insulating material 0.05m and 0.01m, and ratios of thermal transfer for EPS $\lambda = 0.037$ W/mK, for XPS $\lambda = 0.026$ W/mK and for Stone wool $\lambda = 0.035$ W/mK.
Table 4. Values and distribution of the energy savings at different months and climatic regions according to the insulating material sort with 0.05m thickness, the energy resource and its price

<table>
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<th>II</th>
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<th>ACFse (BGN)*</th>
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*ACFse (BGN) – annual net cash flow of energy saving taken during the entire heating period 01.10.ɏ – 30.04.ɏ+1
Table 5. Values and distribution of the energy savings at different months and climatic regions according to the insulating material sort with 0.01m thickness, the energy resource and its price

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<td>electricity</td>
<td>0.154</td>
<td>0.15</td>
<td>0.20</td>
<td>0.31</td>
<td>0.28</td>
<td>0.27</td>
<td>0.25</td>
<td>0.08</td>
<td>1.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>natural gas</td>
<td>0.095</td>
<td>0.09</td>
<td>0.12</td>
<td>0.19</td>
<td>0.17</td>
<td>0.17</td>
<td>0.16</td>
<td>0.05</td>
<td>0.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone wool, 0.01 m</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>electricity</td>
<td>0.154</td>
<td>0.12</td>
<td>0.16</td>
<td>0.24</td>
<td>0.22</td>
<td>0.21</td>
<td>0.20</td>
<td>0.06</td>
<td>1.20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>natural gas</td>
<td>0.095</td>
<td>0.07</td>
<td>0.10</td>
<td>0.15</td>
<td>0.14</td>
<td>0.13</td>
<td>0.12</td>
<td>0.04</td>
<td>0.74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The sum of the energy savings attained at different months during the heating period is the annual net cash flow that will be used for calculating the indicators for economic efficiency of the investment in thermoinsulation.
Table 6 shows the opportunities that the banks – partners in REECL Facility give to the single economic subjects for ensuring the thermoinsulation financing.

**Table 6. Terms of Energy Efficiency Credits of the banks – partners in REECL program**

<table>
<thead>
<tr>
<th></th>
<th>UBB</th>
<th>Raiffeisenbank</th>
<th>DSK</th>
<th>ProCredit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit term</td>
<td>Up to 5 years</td>
<td>Up to 7 years*</td>
<td>Up to 10 years*</td>
<td>Up to 5 years</td>
</tr>
<tr>
<td>Annual interest rate for credit in BGN</td>
<td>12.75%</td>
<td>13.95% - 15.95%</td>
<td>13.00%</td>
<td>12.50%</td>
</tr>
<tr>
<td>Annual interest rate for credit in EUR</td>
<td>9.95% - 11.95%</td>
<td>10.75%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Charge for credit scrutiny</td>
<td>---</td>
<td>40 BGN/ € 20</td>
<td>25 BGN/ € 12.75</td>
<td>30 BGN</td>
</tr>
<tr>
<td>One-time charge for credit management (percent on the credit size)</td>
<td>---</td>
<td>2.45%</td>
<td>1.50%</td>
<td>1.50%</td>
</tr>
<tr>
<td>Charge for credit financial security appraisal</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>100 BGN</td>
</tr>
<tr>
<td>Other terms</td>
<td>---</td>
<td>Guarantee wanted; Salary transfer to account at the bank</td>
<td>Salary transfer to account at the bank</td>
<td>Guarantee wanted</td>
</tr>
<tr>
<td>Charges for account service</td>
<td>¥</td>
<td>¥</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The choice of financing demands to compare the opportunities not only in reference to the annual interest rate, but also in reference to the additional outlays rising for 1m² as a result of charges for credit scrutiny, management and financial security appraisal. The calculations are made at investment values 15.79 BGN/m² and 37.58 BGN/m². For “Energy Efficiency” credits of Raiffeisenbank, DSK Bank and ProCredit Bank, the outlays rising for the entire credit term is respectively 0.79 BGN/m², 0.49 BGN/m² and 1.54 BGN/m². The investment outlays rising for 1m² only because of the higher annual interest rate (AIR) of UBB in comparison with the AIR of ProCredit with 0.25 points for credit term of 5 years (equal for both banks) is 0.20 BGN/m² at I₀ (m²) = 15.79 BGN/m² and 0.47 BGN/m² at I₀(m²) = 37.58 BGN/m². That makes the UBB credit more attractive.
The comparison of financing variants in BGN between UBB, Raiffeisenbank and DSK is useless. A comparison ought to be done between the credit in BGN of UBB at AIR=12.75% and the credits in EUR at AIR=9.95% of Raiffeisenbank and at AIR=10.75% of DSK Bank taking into consideration the outlays rising as a result of charges for credit scrutiny, management and financial security appraisal. At $I_0(m^2) = 15.79\text{BGN/m}^2$ and $I_0(m^2) = 37.58\text{BGN/m}^2$ the UBB credit raises the investment outlays respectively with 1.99 BGN/m² for the entire term of 5 years and 5.39 BGN/m² for the entire term of 5 years compared to the DSK credit in EUR. At $I_0(m^2) = 15.79\text{BGN/m}^2$ and $I_0(m^2) = 37.58\text{BGN/m}^2$ the UBB credit raises the investment outlays respectively with 2.62 BGN/m² for the entire term of 5 years and 7.32 BGN/m² for the entire term of 5 years compared to the Raiffeisen credit in EUR.

The comparative analysis presumes the choice of credit in EUR not taking into consideration the eventual losses of exchange operations. The calculation of the indicators for economic efficiency of the thermoinsulation investment for credit term of 7 years and AIR=9.95% for credit in EUR, is expected to ascertain if the credit term is enough to payback the investment by the annual net cash flows taken specifically by energy savings.

Table 7 and Table 8 present the values of economic efficiency indicators calculated at insulating material thickness 0.05m, at the values of energy savings for the relevant climatic region of the country using electricity for heating, at the relevant credit term of the financing institution and taking into consideration the both variants of reading the net cash flows of energy savings:

I variant – the cash flows are taken for the fiscal year, i.e.

$$CF_x = \sum CF_{Oct_x} + CF_{Dec_x}$$ for year $X$,

$$CF_{X+1} = \sum CF_{Jan_{X+1}} + CF_{Apr_{X+1}} + \sum CF_{Oct_{X+1}} + CF_{Dec_{X+1}}$$ for year $X+1$;

II variant – the cash flows are taken for the entire heating period, i.e. for a year it is taken the time from 01.10. $X$ year to 31.08. $X+1$ year.

The data at Table 7 and Table 8 show clearly that for term of 7 years and AIR=9.95% of Raiffeisenbank the discounted cash flows of energy savings are not enough to payback the investment that initiated them. That presses the single economic subject to limit the consumption of its income in order to payback the credit in time and to avoid eventual penalty interest. The term of 10 years which DSK Bank gives at AIR=10.75% allows during the sinking period the investment in thermoinsulation to be paid entirely by initiated by its own net cash flows of energy saving without pressing the single economic subject to engage its earnings. The results do not confirm the acceptability of Raiffeisen credit because the
single economic subject is obliged, at least partially, to engage its earnings from eventual other investments in paying back the credit in time.

The problem on priority of a particular indicator for economic efficiency in making investment decision for thermoinsulation still remains unsolved.

It should be mentioned that mutually exclusive investment projects are subject to appraisal. It is known that the “internal rate of return” disadvantages show themselves through analysis of projects with identical purposes. An argument is the absolute equality of the IRR values (in both variants - I and II) for the region of Knedga using DSK credit although the different way of defining the net cash flows of energy savings. There are substantial differences between NPV values for the same region and the same insulating materials in both variants which proportion is 3.27:6.45:1.12. An analogous example are the same values of IRR for the region of Chirpan (insulating with EPS) and the region of Knedga (insulating with XPS), but the NPV values related to them differ 1.4 times. In case of choice between project for thermoinsulation of administrative building in the region of Chirpan and the same project for the region of Knedga, the internal rate of return method does not answer the question which of these two projects has a bigger contribution to the public well-being.

**Table 7.** Values and distribution of the indicators for economic efficiency appraisal of the investment using variant I for reading the net cash flows of energy saving (i.e. for a fiscal year)

<table>
<thead>
<tr>
<th>Region</th>
<th>Indicator</th>
<th>EPS, 0.05m</th>
<th>XPS, 0.05m</th>
<th>Mineral wadding, 0.05m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandanski</td>
<td>NPV (EUR)</td>
<td>-0.67</td>
<td>-2.52</td>
<td>-10.26</td>
</tr>
<tr>
<td>DSK Bank</td>
<td>IRR (%)</td>
<td>9.16</td>
<td>6.16</td>
<td>-3.50</td>
</tr>
<tr>
<td>10 years</td>
<td>PI</td>
<td>0.929</td>
<td>0.802</td>
<td>0.466</td>
</tr>
<tr>
<td>Sandanski</td>
<td>NPV (EUR)</td>
<td>-2.40 лв.</td>
<td>-4.57 лв.</td>
<td>-12.05 лв.</td>
</tr>
<tr>
<td>Raiffeisenbank</td>
<td>IRR (%)</td>
<td>2.24%</td>
<td>-1.20%</td>
<td>-12.37%</td>
</tr>
<tr>
<td>7 years</td>
<td>PI</td>
<td>0.743</td>
<td>0.642</td>
<td>0.373</td>
</tr>
<tr>
<td>Bank</td>
<td>Tenure</td>
<td>NPV (EUR)</td>
<td>IRR (%)</td>
<td>PI</td>
</tr>
<tr>
<td>------------</td>
<td>--------</td>
<td>-----------</td>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>Chiropan</td>
<td>10 years</td>
<td>-0.92</td>
<td>8.46%</td>
<td>0.901</td>
</tr>
<tr>
<td>Raiffeisen</td>
<td>7 years</td>
<td>-2.60</td>
<td>1.51</td>
<td>0.721</td>
</tr>
<tr>
<td>Knedga</td>
<td>10 years</td>
<td>0.41</td>
<td>11.72</td>
<td>1.044</td>
</tr>
<tr>
<td>Raiffeisen</td>
<td>7 years</td>
<td>-1.52</td>
<td>5.18</td>
<td>0.837</td>
</tr>
</tbody>
</table>
Table 8. Values and distribution of the indicators for economic efficiency appraisal of the investment using variant II for reading the net cash flows of energy saving (i.e. for the entire heating period)

<table>
<thead>
<tr>
<th>Region</th>
<th>Indicator</th>
<th>EPS, 0.05m</th>
<th>XPS, 0.05m</th>
<th>PI</th>
<th>Mineral wadding, 0.05m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandanski DSK Bank</td>
<td>NPV(EUR)</td>
<td>0,22</td>
<td>-1,48</td>
<td>-9,35</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IRR (%)</td>
<td>11,30</td>
<td>7,93</td>
<td>-2,61</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PI</td>
<td>1,023</td>
<td>0,884</td>
<td>0,513</td>
<td></td>
</tr>
<tr>
<td>Sandanski</td>
<td>NPV(EUR)</td>
<td>-1,51</td>
<td>-3,52</td>
<td>-11,13</td>
<td></td>
</tr>
<tr>
<td>Raiffeisenbank</td>
<td>IRR (%)</td>
<td>4,86</td>
<td>0,99</td>
<td>-11,23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PI</td>
<td>0,838</td>
<td>0,724</td>
<td>0,421</td>
<td></td>
</tr>
<tr>
<td>Chirman DSK Bank</td>
<td>NPV(EUR)</td>
<td>-0,09</td>
<td>-1,82</td>
<td>-9,69</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IRR (%)</td>
<td>10,46</td>
<td>7,26</td>
<td>-4,03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PI</td>
<td>0,990</td>
<td>0,858</td>
<td>0,496</td>
<td></td>
</tr>
<tr>
<td>Chirman Raiffeisenbank</td>
<td>NPV(EUR)</td>
<td>-1,76</td>
<td>-3,79</td>
<td>-11,38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IRR (%)</td>
<td>3,97</td>
<td>0,22</td>
<td>-11,85</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PI</td>
<td>0,812</td>
<td>0,703</td>
<td>0,408</td>
<td></td>
</tr>
<tr>
<td>Kardia DSK Bank</td>
<td>NPV(EUR)</td>
<td>1,34</td>
<td>-0,20</td>
<td>-8,26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IRR (%)</td>
<td>11,72</td>
<td>8,46</td>
<td>-1,73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PI</td>
<td>1,144</td>
<td>0,984</td>
<td>0,570</td>
<td></td>
</tr>
<tr>
<td>Kardia Raiffeisenbank</td>
<td>NPV(EUR)</td>
<td>-0,59</td>
<td>-2,47</td>
<td>-10,24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IRR (%)</td>
<td>8,02</td>
<td>3,80</td>
<td>-9,09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PI</td>
<td>0,937</td>
<td>0,806</td>
<td>0,467</td>
<td></td>
</tr>
</tbody>
</table>
Net present value should include all the cash flows of an investment for its efficient life. From this point of view the calculated NPV values are comparatively incorrect, because the efficient life of the thermoinsulation investment depends on the expiration date of the thermoinsulating material (usually over than 10 years), the way of laying the insulation, its eventual maintenance in the course of time and other factors. In that examination NPV is bound to the term of credit for investment implementation in order to help single economic subjects in their choice of optimal financing of a project for energy efficiency increase (through thermoinsulation of outer walls).

The profitability index excels as an explicit indicator for economic efficiency appraisal of investment in thermoinsulation in view of the fact that every increase in its values is invariably connected to increase in NPV values for the relevant project. The PI values calculated with the net cash flows (initiated during the term of credit for insulation implementing) which are more than 1 guarantee the entire payback of the investment in that term. The purpose of investment in thermoinsulation is exactly the same – to reduce the thermal energy loss through outer walls insulation in order to reduce the energy consumption for heating and improving the comfort inside the building, and the investment outlays to be entirely paid back by the net cash flows (energy savings) initiated by that investment. Furthermore, PI shows the value that every unit of investment earns taking into consideration the time value of money. The higher value of PI unconditionally reflects the higher value of NPV for the same project. It is clear (Table 8) that among all the loan products for financing projects on energy efficiency increase through thermoinsulation of the outer walls, the only economic efficient credit is the one suggested in euro by DSK for the term of 10 years at APR=10.75% and should be used for implementing insulation with EPS at 0.05m thickness for the regions of Knedga and Sandanski.

4. Conclusion

1. The analytical models of the initial investment outlays for thermoinsulation and the net cash flows initiated by energy savings allow appraising the economic efficiency of the investment in thermoinsulation taking into consideration the characteristic features of the specific climatic regions in Bulgaria, the insulation material sort, its thickness and price, the price of energy resource used for heating, as well as the terms of different loans.

2. The net cash flows taken by energy savings as a result of thermoinsulation also allow appraising the economic efficiency of every credit product designed for financing energy efficiency increase.
The examination results are to be used for collaboration of credit product that should have greater utility to the single economic subjects in comparison with the currently suggested. Efforts are to be exert for designing a credit model which will allow the cash flows attained by energy savings to be used for discount from the interest rate of the credit for energy efficiency.

3. The variation of the values of economic efficiency indicators accordingly to the specific climatic regions, the insulating material sort, thickness and price, taking into consideration the price of energy resource used for heating and the loan terms, allows to point out the priority of “Profitability Index” indicator in making investment decision for thermoinsulation.

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Contemporary aspect of a problem “work with information”

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Abstract:
Information is intelligence or data about an event or object. Originally the term “information” (from the Latin informare – learn, to give shape to, form to, body to) denoted the process of providing the substance or knowledge for something. The report consists of a brief exploration of the development of the fundamental concept of ‘information’, with respect to the incorporation of information systems and technologies, and risks arising from their use.

Keywords:
Information; systems; technologies

1. Introduction

In 1961 the Russian academician Alexander Harkevich (1904-1965) gives the following definition of information (in English Information - knowledge, data, facts): “Information is information about many phenomena in nature and society, which can be facilities for storage, transportation and transformation.” It appears to be sufficiently complete and accurate because it is not amended and the establishment and used widely in the literature and practices.

According to the American mathematician and founder of cybernetics Norbert Viner Professor (1894-1964) definition of information is: "Information is an indication of the content received from the outside world in the process of our adaptation to it ... The process of obtaining and using information representing the actual process of adjusting our life to a chance of business environment.”

Claude Shenon called information "that reduces the uncertainty of an object to another, which is essentially the disinformation object to second. Shenon's definition is double opposite reflection i.e. information is define by himself or more accurately as the opposite of its antidote. This shows the difficulty of defining the term "information", which comes from the cognitive nature of his philosophical category (such as point, area, etc.). According to some scientists the information is defined as Invariant isomorphism and as available as other heterogeneity.
2. Presentation

Acceptation the information to consider at least three levels of abstraction:
1. Statistics-probability level is which it is considered by the mathematical theory of information founded by Shonon.
2. Semantic level is which accounts the fact that certain information may make sense for an object.
3. Pragmatic level is which is interested not only makes sense for an object, but there is a certain utility for him.

Further information will be in regard to leadership and determining and working probability of a mathematical model of knowledge, facts or data to any dimension of things. Definitions for information, which are defined by scientists, used to reflect the beginning, the processes and results of mentally-cognitive activity of the subject and society. Format for presenting information is called communication, i.e. information is transmitted in the form of messages and it is the main content of the messages.

Changing any physical quantity reflecting the message in the process of transfer is called a signal. While the information has been abstract in nature (such as mathematical formulas), the signals are material and energy developing its form depending on the knowledge that reflects the information it can be technical, physical, biological, economic and others. There is another type of classification of technological working information. It is as follows: Parametric information - is a set of numeric evaluations of the meanings of any parameters and results of measurements obtained from the research, analysis and control; Topological information - represents geometric images, charts, drawings, site maps and images of objects in different projections; Abstract information - is a mathematical formula expressing any dependencies generalized images and concepts; Reliability information - identify operational behavior of objects and systems in nature until the end of their existence or transformation. Transfer, processing and storage of information related to the actions of various mechanical and semi-automatic devices, the creative activity of the human, economic, technical and technological random and systematic conversions in society. In the above link science may be regarded as a complex developing multi-dimensional information system created by man and serving the people (public).

The Development of practice and science, the non-systematic constant flow of information, huge amounts accruing knowledge in scientific, artistic and other communities by type are placed before the public with many problems for their rationalization. In this should be carried out research and manufacturing of different ways, processes, approaches, techniques, methods and practices for administration of new uncovering truth and lessons in being.
The modern citizen is obliged to focus in the complexity of the world, able to find, extract, analyze, organize and store information and choose appropriate forms of its presentation. This requires specific knowledge of the habits of a certain line of work, system or methodology: a set of models and systems for effective management and control of thoughts, cognitive, spiritual, mental activity. This includes the skills of analysis, synthesis, comparison, generalization, abstraction, modeling and structuring of information.

Computer and information communication technologies are leading the change beginning in the modern information society. So is not no matter what values of the modernization of information communication technologies are implemented and subject leader in science and education, society and the world, which ones and which play a key - leadership and why. Today information and knowledge become top priority of the European Union for development of the economy of the community as a “knowledge economy”. In these processes is important in what, how and how fast the new learned and apply the experience gained and lessons learned from theory and practice.

It should be borne in mind that not all the information and knowledge are used as a commodity. The modern stage of society, they are kind of strategic weapon. It is so and especially in the so-called “information war” or non-announced clear that from the beginning of the 21st century complicates and increases the risk management in society and security world.

As the dimensions of the theoretical development and practical application of information technologies in public education increased interest in the acquisition and application of knowledge to their aid. This is particularly used in the preparation, for example, to any educational material for the knowledge base. Particularly significant is the study and use of various software products from computer and information-communication technologies in the decision, its optimization and choosing the most appropriate option for action.

It is therefore necessary to develop targeted skills for the rational application of cognitive methods and other ways of using information that is directly related to the mentally-cognitive research and creative activity. Decision of such a task normally uses a knowledge base which is a major part in an intellectual system, which in itself represents a model in a specific subject knowledge area.

Databases and knowledge are used as a basis for the activation of the previously formed ideas, habits and mental cognitive methods work. Under methods and ways of using information means a set of different mental and practical activities, including: analysis, synthesis, summary prescient, comparison, clustering, support posts remind plan, classification, structure,
systematization, scheme making, design, modeling, formalization, using models and other information. (As appear in the new theory and practice). Under the model information means any image analogue (mentally or conditions: picture, description, diagram, drawing, graphics and design) of an object, process or phenomenon, which is used as their “surrogate” in the decision of some Information task.

In the information model reflects different cognitive aspects of the modeled object in the form of signs, symbols, words, and descriptions, theoretical (abstract) constructed and other theories. Capable of presenting information model depends on the purpose of modeling. As everyone model the information model contains all the information about the site, but only that part which is necessary for a decision of the customer.

Work on the design and construction of knowledge base is analogous to work on creating an information model. Development of the knowledge base of policy decision entails interrelated tasks as formalization and presentation of knowledge. Constructing the knowledge base itself includes the following stages:

First stage, it is specifying the subject area. At this stage, choose a specific area of knowledge.

Second stage, it is retrieval of knowledge. At this stage, analyze and collect material on the selected topic. Knowledge sources are textbooks, reference books, materials, research in the problem domain, knowledge accumulated by the investigator and artist of the early and others. Of how the subject is able to work with independent sources depend on the volume and quality of knowledge. They are drawn from texts, literature and reality, and it depends on the quality of the material presented in creating knowledge base. Ability to work with the literature and is active in developing the collection of text material, taking into account the following: perception and the separation of key concepts and categories of the topic, coherent system performance elements from the basic scientific concepts and highlight their important relationship, and relationship co-obeying; formalized and structuring of the volume of collected materials and others. To activate the previously formed mental activities - analysis, synthesis, summary prescient, structure and design.

Third stage, it is structuring knowledge. There is defined terminology list of basic concepts and their attributes. The concepts are classified by content and establishing logical connections between them. For the presentation of material in the knowledge base the system analysis. In the process of structuring the material is made from scratch hierarchical model of the subject, as then determined the functional relationships between elements. In creating the structure of the model using the collected materials, applying and developing such ways and methods of using information such as analysis, classification, group comparison, support
posts, structure, systematization, formalization and modeling.

Fourth stage, it includes presentation of material in a formal form, which reflects the fundamental concepts and relationships between the concepts of the chosen topic. Implemented through scheme is making as columns, tables, text, structural and logical scheme as a hypertext performance.

The work on these stages requires the separation of all the necessary concepts and definitions, showing interconnections between the components of the considering subject area and establishing links with other subject district. In the collection, structuring, formalization and systematization of the material for designing knowledge base to construct their own knowledge and personality. Thus, the reproduction of knowledge and help achieve their goal of a process of knowledge in a particular subject area allowed:

1. To be activated various techniques-methods of mental activity, such as analysis, synthesis, summary, disregard, structuring.
2. To be developed methods and working with information related to the perception, gathering, processing and presenting information.
3. To be applied optimally and efficiently methods and different ways of using information in the examination of new material - object (entity) of observation.
4. To be updated existing knowledge and codified systematic knowledge and others.

The Methods and means of using information acquired by the nature of the various theoretical and practical activity, i.e. in the course of the study and application of a detection or extraction of knowledge in diverse processes of formation of all or unity of knowledge and development skills. Thus the student (subject) is not just by intuition perform cognitive activity, but receives an overall idea of it, making the acquired techniques and methods work with information in practice.

Method of training starts with teaching information based on some training material to be in the form of a structure. Structuring of the material is conducted in accordance with the stages of development based on knowledge of the application of systematic analysis. At first the teacher may propose to develop a theme of Main subjects of specialty. Further analyze the content and composition of the chosen topic. All material is presented systematically, as seen from the elements and units which will be held and what he is obliged to present in the components themselves.

Then it is structured. At this stage is done on the topic of division blocks, sub group elements (concepts, phenomena, equations, etc.). The content of a block of content is separate paragraphs, chapters or sections. Subject reflects a new element of structure that is gradually catch system. The result obtained ratios of vertical hierarchical blocks sub blocks,
elements of the selected material. Individual elements of the system are connected not only with vertical connections, and establish horizontal and possible internal relationships. Establishing a system of relations with the external environment "is defined relatively objective links. The work will be presented in a formal form as a structural and logical scheme.

The terms of such simple methods describe the development of ways and methods for handling information and forming system identification information and a picture of something or human society or the world. It is essential for development and enrichment of information and cognitive theories and practices related to the recent achievements of science and technology.

The Modern society is a community of reading and listening in view of the exceptional access and supply of various kinds of information and knowledge and accelerating demand for professional skills and new opportunities in the field of socio-economic life. The Reading and listening are related to the way perceive, feel and think with the meanings of things, knowledge and experience, inherited, acquired or obtained as ready information and knowledge, models, models and values.

Thanks to a speech and second signal nature, human beings use exclusive advantage of the information signals and information to adapt and develop to the other representatives from the animal world on the planet. They inherited, and have exchanged information and cognitive experience directly in the middle of the existence not only through its universal and unique research-creative nature, but by an increasingly integrated and multi-device system for adoption / transmission, storage and processing of information. It is used in various types and volumes of material media in the growing volume of various types and dimensions measuring units.

The enormous increase in volume and diversity of information makes it difficult oriented solutions, and complete selection of goals and values which seek to achieve and pursue. Competence of any modern professional level without constant monitoring of changes and innovations in the field and market segments of the economy, it is impossible to be current and competitive, if not influence the strategies and management of education. It is particularly important at Union targeted building society, with powerful competitive market economies such as the European Union. Building skills for learning and skills to quickly view, play live, identification of the object detection and monitoring of change self-recognizing subject underpin the European development of information society, markets and society knowledge.

But this is impossible without a fundamental rethinking of the proximity between physi and techne and the essence of the front or near remoteness to any connection or conflict in micro-and macro world. Signs,
symbols, which represents and creates something, may make sense and way of existence. Are therefore important productive research on information and communication and computer technologies and international cooperation, especially between countries that are integrated each other. The importance of methods and capable of handling information is directly evident, especially in the growing multi-deepening description, definition and search for rational solutions multi systematic and complex organizational forms of education.

The emergence of information warfare in the last decade of the twentieth century, a new type of conflict and a form of confrontation and competition raises the question of revaluation of the systems to work with information that directly affect the state administration and management of resources, forms of influence and use funds for violence.

Not with standing the rise of modern scientific and technological knowledge is still information and information systems can not be fully used as a cognitive capacity, especially for increasing the efficiency of managing properties themselves technical objects (devices and complex systems of systems) or the qualities and capabilities subjects. In this sense, they carry a risk - the origin as an objective but also subjective, which requires study, knowledge, creation of various techniques and models for observation. These include the means to protect, manage and adjust the parameters of the operation of technical systems. Similarly take part and apply different methodologies developed to enhance the effectiveness and safety of individual and joint work of the people. Risk that may be, for example, a technical system, not only remain in the program, which is itself a technical system. And especially in terms of armed conflict or in the realm of threats - war (Clausewitz). Regarding the nature of the entity as a generator of risks, it will continue to surprise research, creative potential and skills.

The Subject creates accidentally or purposefully conditions similar creative to oppose their own shortcomings, gaps and weaknesses and emerging risks and threats and hazards to humans and societies. The risk is related to opportunities for damage and losses.

The existence of risk is not unusual, since everything is defined or unknown conditions determination. Therefore, the result of monitoring, active and passive participation in an event is in virtue of the uncertainty (uncertainty). The risk is related to variability of the results and with an ability of the actual result to be different from expectations. The discrepancy between object and subject of knowledge-based nature has a sense of existence and the multi dimensionness predetermined the complexity and choice in the seeking a solution. The Impact of technical, human and organizational factors for conversions in society depends on information and cognitive level of management, innovation and
motivational example of character and activities of the case entity manager or leader.

3. Conclusion

At the beginning of the 21st century the scientific and technical knowledge progress in the discovery of nature and discovery of truth through statistics, probability level of information and knowledge. On this basis, appear and new subjects of research and education, and already known to have a more precise and clear understanding of the origin of their subject knowledge.

Modern information technology methods and reduce risks at work and environment. They must help the public to prevent accidents, but they can complicate and accelerate the appearance of danger. This is a real fact, if you go beyond the control of human and technical systems, especially if they be used as a weapon in the political race of nations and alliances of countries.

References

Designing Project Management Systems to Deal with Uncertainty

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Abstract:
Uncertainties may lead to several project schedule disorders. Disrupted schedules bring time and budget overruns, peaks and valleys on resources profiles, and increased system nervousness due to the unavoidable frequent project rescheduling. The uncertainty comes from numerous factors such as inaccurate initial durations’ estimation, delays caused from weather conditions or material arrivals, inadequate quantity of resources etc. Especially, parallel activities are a universal source of risk found in every project. Critical Chain/Buffer Management (CC/BM) appeared last years as a promising application of the Theory of Constraints (TOC) to project management in the related literature. TOC is a general approach for understanding and improving all systems, from organizations to system of systems design. According to this theory, every system has at least one constraint that prevents it from working ideally. Following a short overview of the basic concepts of TOC and CC/BM, this paper aims, first, to evaluate the TOC and CC/BM approach with regard to uncertainty and project risk management; and, second, to determine guidelines for designing effective project management systems using this method. A real case study illustrates the differences between CC/BM and the traditional project scheduling methods.
Keywords:
Buffer Management, Critical Chain, Uncertainty, Project Management System, Theory of Constraints

1. Introduction

One of the most frequent phenomena in project management is the project lateness and failure to meet the objectives. Traditional methods, such as CPM and PERT, are proved inefficient and the reasons are the techniques used for resources levelling, estimating the duration for each task and the contingency time used in planning.

These are the drawbacks that E. M. Goldratt tried to solve by defining the project as a system that has to be improved. In his book “The Goal”, introduced the Theory of Constraints (TOC), a systemic theory for continuous improvement of a system. In order to achieve this scope, proposed tree logic structures and diagrams illustrating the current and the future situation as well.

Critical Chain is the application of TOC in project management. Using TOC in project management exploits the benefits offered by the systemic thinking. Moreover according to Dettmer (1997): “Systemic thinking is preferable to analytical thinking in managing change and solving problems”.

2. Introducing the TOC

First of all some basic meanings and principles introduced by TOC must be described. According to Dettmer (1997) the following list is defined:

1. An optimal system solution deteriorates after time as the system’s environment changes. A process of ongoing improvement is required to update and maintain the effectiveness of a solution.
2. Systems are analogous to chains. Each system has a “weakest link” (constraint) that ultimately limits the success of the entire system.
3. Strengthening any link in the chain apart from the weakest one, does not improve the strength of the whole chain.
4. Most of the Undesired Effects (UDEs) within a system are caused by few core problems.
5. Core problems are, almost never, apparent. They manifest themselves through a number of UDEs linked by a network of effect-cause-effect.
6. Elimination of individual UDEs gives a false sense of security while ignoring the underlying core problem. Solutions that do this are likely to be short-lived. Solution of a core problem simultaneously eliminates all of the resulting UDEs.
7. Core problems are usually perpetuated by a hidden or underlying conflict. Solution of core problems requires challenging the assumptions underlying the conflict and invalidating at least one.

8. System constraints can be either physical or policy-based. Physical constraints are relatively easy to identify and simple to eliminate. Policy-based constraints are usually more difficult to identify and eliminate, but they normally result in a larger degree of system improvement than the elimination of a physical constraint.

9. Inertia is the worst enemy of a process of ongoing improvement. Solutions tend to assume a mass of their own, which resists further change.

Using TOC requires compliance with these certain rules. However, in order to find the Undesired Effects, the so-called Thinking Process is used according to which the Undesired Effects are turned into Desired Effects and are embodied to the system. The phases that the system treats can be summarized in the following entities:

![The Thinking Process](image)

The CRT (Current Reality Tree) and the FRT (Future Reality Tree) represent the current status of the system and the expected reality that we want to impose. The other structures are the tools, in order to find the UDEs (Evaporating Tree), and turn them into DEs (Prerequisite Tree) by causing changes to the system (Transition Tree).

3. TOC and Project Management

For project management the UDEs are related to the allocation and leveling of resources and the contingency time. The first describes the so-called “Student Syndrome”, which means low effort in the beginning of a task, increasing as the deadline comes closer. The result in most cases is a late activity delivery. The resource requests for more time, using as excuse the quality improvement.
The second behavior, known as “Parkinson’s law”, describes the tendency of resources to expand their work to the given time, even if they can finish it sooner. Another tested technique is the multiple assignments of one resource on two or more tasks at the same time. Multitasking is used in order to maximize the productivity. However, resources share their time between several activities resulting to a waste of time.

In CPM the schedule is date-driven and each task has a specific start time. This can result to the Parkinson’s Law, because the resource has no motivation to finish work earlier. Furthermore, the PERT method considers a percentage of each task, as contingency time. This percentage, embodied in the task’s duration, is about 80-95%, making very difficult to monitor the amount of time assumed.

4. Changes in the System

After finding the UDEs in the current reality it is tried to achieve the scope (future reality), which is executing projects in less time and budget without any quality reduction. The modifications proposed by Goldratt, and the Five Focusing Steps (fig. 2) are presented in this section.

![Diagram]

**Figure 2:** The Five Focusing Steps Procedure
Firstly, the constraint that prevents the system from working ideally must be identified. When the introduction of Critical Chain or TOC in a system is tried, the constraints could be an element of the system. In a project management system, where Critical Chain has already been introduced the constraint is the largest sequence of tasks, similar to critical path with the difference being in the manner and the time instant that leveling procedure is applied.

Exploiting the constraint is a procedure which ensures that the system resolves the constraint. According to that, we have to interfere in the previously found UDEs. As mentioned, most problems arise from the way that the durations are estimated, in terms of the contingency time and generally risk management. As a result, the use of the “Statistical Law” is needed to clear the durations from any contingency and extra time that could be added from estimators.

As shown in Figure 3, after the 50% of the initial estimation, as the additional available time increases, the possibility of in-time completion for each individual task decreases. Instead of that, the cumulative probability is always increasing. In other words, if we aggregate more than one such “possibilities” in one sequence of events, we can manage uncertainty in a more secure way and in less time as well.
Subordination of all other parts makes the system more stable by absorbing the negative fluctuations from the critical chain. In this case, feeding buffers are used (time buffers used as safety time) at the end of each non-critical chain which joins the critical as shown in Figure 5.

The fourth step is to elevate the decision made during the previous steps in the system. A summary of these decisions follows:

1. Reduction of the durations to the half, in order to avoid the “Student Syndrome”.
2. Elimination of multitasking. The resources should be allocated in one task to complete it in less time.
3. Development of the relay racer behavior among the resources to prevent system from “Parkinson’s Law”. As soon as one resource finishes an assigned task, passes the outcome to the next without any delay.

Also, there are some company measures that must be changed to motivate the resources work as required. For example, in case that there is a penalty for late activity completion, it must be abolished. Instead of that,
rewards have to be considered for the resources executing in time their assigned activities.

Another measure that assists a Critical Chain system is the Early Start Scheduling (ESS). The benefits of that method could result effectively in some risks relative to:

- The cost of tasks and the general buffer. Late start raise costs by spending money and time needed by every task.
- The “Student Syndrome”. When a project starts, the resources are able to begin with initiative and easy activities and normally accelerate their effort.
- The changes could appear in a completed task.

5. Dealing Critical Chain with Uncertainty

In the previous sections the way that project management systems manage the risks is presented. Apart from the problems caused by the same conflict confronted using TOC, there are some unexpected risks. These contingencies could be separated in two sections. As Figure 3 shows, the diagram has two zones, the pink and the yellow. The pink represents the Common-Cause Variation and the yellow illustrates the Special-Cause Variation. The first is inherent in the system and responsibility of the management. This kind of variation seems to be the most frequent in project management (94% of the whole uncertainty) and Critical Chain method deals with it by exploiting the Statistical Law and the Buffer Management. The second could be caused from a group of workers, a part of the production or a specific machine. Such cases represent the 6% of the whole uncertainty. In order to prevent the project from those risks, a project manager could use the techniques proposed in the PMBOK or apply TOC in that variations and then, find the most appropriate solutions.

5.1 Buffer Management

Critical Chain uses buffers in order to minimize time variations of a chain (feeding and project buffers), cost flow variations (cost buffers), and to emerge resources for an incoming critical task (resource buffers). All these mechanisms are used in order to prevent from a negative fluctuation.

Feeding buffers are placed wherever a non-critical chain joins a critical. Besides, project buffers are placed at the end of the critical chain. In a Gantt chart, they appear as individual tasks having no assigned work. When one task is not finished in time, the consumption of the buffer starts. The innovation that Critical Chain introduces is that the safety time a/ is separated from the task; b/ combines the variations of a chain (not of an individual task); c) could be measured in order to know anytime how much
has been consumed in order to make or prepare the right actions. The Fever Chart, illustrated in Figure 6, shows how these actions are implemented.

The graph is separated in three zones: the green zone, in which there is no problem if the duration of the chain enters, the yellow zone, which is also the zone which consumption creates no real concern. However, in that zone, risk management measures have to be planned to apply. Finally, during the red zone, these measures are applied in order to return again in the yellow zone. Another serious issue that the managers have to deal with, is the size of the buffer. In other words the safety time considered for each chain. There are three methods for buffer sizing proposed in the literature. The first method, called the 50% buffer sizing rule, proposed by Goldratt (1997).

The buffers are sized to be the half of the chain that they protect. The 50% is determined from the Statistical Law of individual tasks. Individual tasks (buffers are individual tasks on a schedule) must be sized in the 50% possibility in terms of the initial size.

The second and the third methods use the following equation that combines the estimates and the mean duration of the tasks constituting the chain.

\[ \sqrt{(S_1 - A_1)^2 + (S_2 - A_2)^2 + \ldots + (S_n - A_n)^2} \]

where \( S \) is the safe estimate (by the estimator) and \( A \) is the mean duration. This method is called Square Root of the Sum of Squares (SSQ). The difference between the second and the third method is that on the latter a bias can be added in the root if required. The SSQ method is more preferable because of using the estimators’ times. This increases the accuracy because of the variance that appears between the different activities.
The algorithmic steps for Critical Chain implementation are the following:

1. Lay out the network of the tasks with their resource requirements and reduced durations in the half duration.
2. Transfer all the tasks in their late start. Check if there are conflicts. If there are go to step 3, else go to step 5.
3. Remove all the resource conflicts by transferring the tasks earlier or later, until all the conflicts are solved.
4. Identify the critical chain of the project.
5. Add the project buffer in the end of the critical chain.
6. Add feeding buffers in chains that join the critical chain.

6. Implementation of Critical Chain method

The algorithmic steps for Critical Chain implementation are the following:
1. Lay out the network of the tasks with their resource requirements and reduced durations in the half duration.
2. Transfer all the tasks in their late start. Check if there are conflicts. If there are go to step 3, else go to step 5.
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4. Identify the critical chain of the project.
5. Add the project buffer in the end of the critical chain.
6. Add feeding buffers in chains that join the critical chain.

6.1 The Project

Critical Chain method applied to a real project of a well-known Greek telecommunications and software development company. The scope of the project is to insert new features in already used mobile software and to update a previous software version of a telecommunication’s hub (GSM switch).

The project is separated into three phases, i.e. the prestudy, the feasibility and the execution. All the software packages are constituted from these three phases. At the end, there is a final task, the DFU Project (Design Follow Up).
In this section we compare the differences between the classic Critical Path Method and the Critical Chain, shown in Figures 7 and 8. Figures 9 and 10 show the Gantt Charts produced by these methods.

6.2 Comparative Results

Firstly, there is a different termination date. CPM finishes the project on 9/7/2009 instead of CC method that completes on 26/3/2009. This is about 26.6% better time result, with the safety time included. Secondly, in Critical Chain’s Gantt chart the predecessor tasks have been transferred from the synopsis tasks (packages), to the individual tasks in order to create the chains.

![Figure 7 The project data calculated by CPM](image1)

![Figure 8 The project data calculated by CCPM](image2)

Also there is only a small difference observed between the two largest sequences (the critical path and the critical chain), because there are not many resource conflicts to level. Though, we are able to see the split critical task meaning that the resource is assigned to another task. In critical chain this is impossible because of the way that levels the resources. As Figure 11 shows, in CPM, over-allocations are caused and must be managed in different ways. In Figure 12 are illustrated the feeding buffers (green), the project buffer (yellow) and the critical tasks. Note that...
behind the feeding buffers are placed non-critical tasks that are not displayed. However, it is crucial to present the way that feeding takes place in the spots, where the chain that they prevent, joins a critical task.

Figure 9 The Gantt chart for CPM

Figure 10 The Gantt chart for CCPM

7. Conclusions

Recently, Critical Chain approach has received increasing attention in the project management literature and among project management practitioners. This method has been recognized as valuable to help the managers handle the activities that are subject to considerable uncertainty that may lead to schedule disruptions.

In this study the core idea of the Critical Chain, which is the application of the Theory of Constraints in project management, is presented in outline. This approach applied to a real project to illustrate the differences between Critical Chain and the traditional project scheduling methods. As a result the schedule that Critical Chain achieved proved to be shorter than the corresponding CPM schedule.

On the other hand, there are some disadvantages and gaps in Critical Chain literature regarding to its leveling procedure, the duration estimation
rules and the possibility of existence more than one critical chain. Thus, a more effective leveling algorithm and method to estimate the durations of activities is required. Finally, some criteria must be adopted in order to choose the appropriate critical chain for the project.

Figure 11 Over-allocation as results from CPM

Figure 12 Buffer Management of the Project

References


**Topic:**

**Engineering / Energy**

Hierarchic dependencies in beer brewing *(ABSTRACT ONLY)*

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Reliability research of contact brush meeting of electrical machines

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Developing a framework for the implementation of sustainable energy management from the end users standpoint

*Theodora C. Kouloura, Dimitrios C. Panagiotakopoulos*
Hierarchic dependencies in beer brewing

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**Abstract (only):**
The authors explain on the example of beer brewing how (partial or layers of) processes can be evaluated and fused to a complex model applying general hierarchy theory as a basis for systemic comparisons and analogies. Hierarchic direction of all process hierarchies is the time axis. Beer brewing is deployed along one symbolic time interval representing one technological cycle with all its interventions and activities, but ignoring the scaling of time: ending one step or (part of a) stage and beginning the next one is not only a limit in time, but also a conditional one. Control procedures are necessarily parallel to the technological process, which results in a complex aspect of decomposition. 9 simple aspects of decomposition state the level of abstractness of investigating. All processes are fused step by step into a polythematic hierarchy aiming at studying the polyhierarchic nodes and the data and knowledge exchange therein. It allows more in depth to follow, monitor and understand and to reveal essential but usually ignored nodes of control – among others, such ones leading to surrounding facilitating, recycling, and utilising, etc. activities. Among others, two classes of process hierarchies are observed: 1) One stressing on the technological essence – structured stepwise continuous, and 2) One on some management, financial and economic aspects – is layered and stepwise continuous. The latter has the typical ‘three levels of plant management’ extended onto a fourth one via Internet – combining new trends in systemic analysis process monitoring and control via knowledge-based control systems (KBCS) a step is made towards a higher quality of industrial progress. The interplay of several hierarchic dependences with well formulated own definitions allows using different conceptual instruments in one model. A sophisticated mathematical knowledge based control model reduces the intermediate interventions after launching to almost none: It calculates the proportions of ingredients right before technological manipulation, lets the plant produce continuously many ‘portions’ of beer without interrupting for sterilising, i.e. it lets the ‘living yeast keep themselves and their environment clean’, not polluted by other organisms’ mutations and keeps the environment and processing stability of a living system. Systems control in production plants or corporations requires embracing all, genuinely all actions, conditions, materials and instrumentation. However,
experience shows that these rules are violated by ignorance, leisure or mismanagement. Management investigations usually start with economic aims adjusting technology, creating instrumentation, methods and materials, and neglect the immediate supporting environment, handling or recycling the waste, sterilising and cleaning reagents or equipment, before and after using them, and many more, which are unavoidable for generating the desired end product. The 9 simple process hierarchies reveal this insufficiency and provide the tools to point to the nodes, where the data and knowledge needed are obtained, can be copied and redirected for processing under another aspect. The idea of keeping ‘a clean environment’ by knowledge based systems control, shown on the example of beer brewing as a living system, can be generalised as a basic assumption for systems control. Applying theory of general hierarchies for fusing into a perceptual-motor arch processing of information and knowledge resources, hierarchy and logical criteria modelling as basic methods towards environmental control was developed, refined and step by step published during a long period and in parallel to developing the methodology of knowledge based control systems.

**Keywords:**
Brewing, fermentation, process hierarchy, knowledge based control, living systems, polythematics
Visualising and evaluating hierarchy types and operations –

a systemic toolbox

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Abstract (only):
The paper introduces critical hierarchy analysis and synthesis, and is based on a rich slides show visualising the most important types and operations partially compared to the tables of definitions. The typology of hierarchies shows a great variety of classes due to one or several invariant characteristics (ICs). To estimate and evaluate a target type before starting the design may save a lot of time and effort for failures, resulting in indecisiveness and hesitations, multiple re-designing, hovering debates on details, which will then be overthrown by the next more general conception. The causes provoking uncertainty lie in the nature of systems design: in the complexity of objects and the degree of modelling abstractness we want to reach, neglecting some specific features and stressing on others; in the complexity of the system’s surroundings and where we draw the borders, to what extent we focus on the relations between the system and its surroundings, or when several systems take part, etc. It is a play in the scale between abstract and concrete understanding. Hierarchies serve as a skeleton for systems analysis, design and synthesis both top-down and bottom-up on the scale of abstractedness. Their ICs allow a systematised sequence of decisions, adjusted to the design process, objects, subjects, relations, limits, aims and perspectives in question. Operations with hierarchies allow to apply partial design results (multiply), to construct a knowledge base for classes of applications. This is especially necessary for higher dimensions of examples or beyond the common human imagination possibilities. Designing systems and hierarchies goes hand in hand with the analysis of constructions, with comparing and evaluating, in what extent they express the observed or manipulated complexity. Systems, and the hierarchies spanning them, are useful for all domains of human knowledge. The required mathematical types of imaginative abilities are quite rare in common population, but also in very high intellectually developed personalities. Intellectual capacities have many expressions and the mathematical one is only one of them. However, humans like most living beings are born to orient themselves in natural environments, to react ‘at a glance’ on perceptions. The nervous system of living beings has and operates the same structures and processes, which were laid in the basics of the general hierarchy theory. It is the way living beings and humans are thinking and reacting, and an ‘open door’ for comprehension of complexity.
Visualising the basics of general hierarchy theory is one of the possible ways to avoid unnecessary indecisiveness and hesitations, to incorporate a broader human potential for systems research and applications, to allow not only students in higher grades, but also pupils and children from some age on to get used to systemic and hierarchic thinking, before the strictly treelike patterns of social and power conglomerates spoil the natural freedom of imagination.

**Keywords:**
Analysis, comparing, design, evaluating, freedom of imagination, hierarchy, operations with hierarchies, typology of hierarchies, synthesis, system
Reliability research of contact brush meeting of electrical machines

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Abstract:  
The present report is about valuation of the indicators of reliability of the contact brush meeting of collector electrical machines with reading of their constructive special futures and work off of failure. This valuation is including the conditions of meeting’s work, the influence of the construction and a number of exploitation characteristics. After respective researches of the composite reliability model, the analytic equations about their probability for flawlessly work are obtained. The model allows to be mentioned the constructive special futures and the conditions of work of the contact brush meeting. It is a factor for managing of the reliability and quality of the collector electrical machines. It is a factor for managing of reliability and quality of the collector electrical machines.

Keywords: Reliability, contact brush meeting, electrical machines.

1. Introduction

The paper is devoted to valuation of reliability parameters of collector electrical machines. The reliability of contact brush meeting in operation period technical operation is examined. Its conditions of work, the influence of the construction and a number of exploitation characteristics are read. After respective researches it is composed reliability model of technical exploitation of contact brush meeting.
An analytical equation of probability for work without refusal of the meeting is worked out / equation 13/. In this equation the basic indexes of reliability are presented by parameters, depending of constructional characteristics and conditions of work. It is made for period, less then time period for border wear of the brushes of meeting.

Reliability model of investigated meeting allowed reading constructive characteristics and conditions of work. It is factor for management of quality of functioning of all similar electrical machines.

In the paper is suggested exemplary use of suggested model of research.

2. Status of the problem

For a specific type collector electrical machines (CEM) is existed a minimal admissible value of the height of the electrical brushes $h_{min}$, until which the contact brush meeting will work normally in the process of exploitation [11]. It follows that in the process of the examined work off $t$ the value of the height of the brushes should satisfy the condition $h_t \geq h_{min}$.

For the period of normal exploitation of CEM is typical a linear dependence of the wearing out of brushes $\Delta h_t$ from the current time $t$ [8]. In this case we reached the following equation [1]:

$$\Delta h_t = k_M \cdot F_t \cdot 2\pi r_c \cdot n_b \cdot t,$$

where: $k_M$ - coefficient which is depending from the material of the brushes;

$F_t$ - contact pressure in the brush meeting in certain period of time $t$;

$r_c$ - radius of the contact ring on which the brushes are rubbing;

$n_b$ - the electrical machine’s frequency of rolling.

The contact pressure in the meeting is changing according to law (principle) [2; 10]:

$$F_t = F_0 - c_{BH} \Delta h_t,$$

where: $F_0$ - inceptive contact pressure in the brush meeting, when $t = 0$;

$c_{BH}$ - constant, which is defined from the construction of the brush-holder and the material from which is made.
As a rule, the worked off brushes are replaced in moment when is occurred the minimal admissible wearing out $\Delta h_{\text{min}}$, because of which $F_i$ is varying in the limits from $F_{\text{max}} = F_0$ to $F_{\text{min}} = F_0 - c_{BH} \cdot \Delta h_{\text{min}}$. From the salvation of the equations (1) and (2) we get for $F_i$:

$F_i = \frac{F_0}{1 + 2\pi c_{BH} k_M r_c n_R t}$.

The researching of the process of variation of $F_i$ from equation (3), is defined the character of variation of the insensitivity of the stream of failures $\omega(t)$ of brush meeting of CEM.

3. Solving the problem

We are defining the intensity of the stream of failures $\omega(t)$ of the brush meeting with using the theoretical dependence between the probability of flawless work (PFW) in a moment in time $t$ and the probability for failures $Q(t)$ which is expressed with $P_{FL}(t) = 1 - Q(t)$. With the mathematic transforms, which are related to the deducing of the main law of reliability from literature [3], we get the equation:
We are examining the period of normal technical exploitation (TE) of the contact brush meeting of aviation transducers for which PFW is high, that means $P_{Ft}(t) \to 1$. In this case we get:

$$\omega(t) \approx \frac{dQ(t)}{dt}.$$  \hspace{1cm} (5)

We transform equation (5) by multiplying its right side with $d(\Delta h_i)/d(\Delta h_i)$, that means the intensity of the stream of failures $\omega(t)$ of brush meeting we define as a function of its wearing out $\Delta h_i$, according to equation:

$$\omega(t) = \frac{dQ}{d(\Delta h_i)} \frac{d(\Delta h_i)}{dt},$$  \hspace{1cm} (6)

where: $dQ/d(\Delta h_i)$ - thickness of distribution of the wearing out of the brushes, which is depending by the quality of the material, construction and technology of making;

$d(\Delta h_i)/dt$ - speed of wearing out of brushes, which is depending from the construction, physical special futures of the material, the conditions of the meeting’s work.

Since on the working capacity of the brush meeting is influence large quantity factors of electro-chemical and constructive character (without predominating of any of them), so in this case according to the central limited theorem from the theory of the probabilities [9], it follows the acceptation for normal law of the wearing out of the brushes. In this case for the thickness of distribution of wearing out of the brushes, we write following equation:

$$\frac{dQ}{d(\Delta h_i)} = \frac{1}{\sigma_{\Delta h_i} \sqrt{2\pi}} \cdot \exp\left\{-\frac{(\Delta h_i - \overline{\Delta h_i})^2}{2\sigma_{\Delta h_i}^2}\right\},$$ \hspace{1cm} (7)

where: $\overline{\Delta h_i}$ - mathematical expectation of the wearing out of the brushes;

$\sigma_{\Delta h_i}$ - average quadratic diversion of the wearing out of $N$ brushes.
For average quadratic diversion of the wearing out of the “i” brush \( (i = 1, \ldots, N) \) \( \sigma \), we get according to [5; 7] this equation:

\[
\sigma_i = \sqrt{\frac{1}{N-1} \sum_{i=1}^{N-1} (\Delta h_i - \overline{\Delta h})^2},
\]

where: \( \Delta h_i \) - wearing out of the “i” brush from the meeting; \( \overline{\Delta h} \) - average wearing out of \( N \) number of brushes.

If the average speed of the wearing out of the brushes marks with \( \overline{V}_{WOB} \), so for \( \Delta h_i \) of the “i” brush, which has average work off to the failure \( t_{WF} \) and \( \overline{\Delta h} \) of \( N \) number of brushes, which has average work off of failure \( \overline{t}_{WF} \) can be written as:

\[
\Delta h_i = \overline{V}_{WOB} \cdot t_{WF}; \quad \overline{\Delta h} = \overline{V}_{WOB} \cdot \overline{t}_{WF},
\]

where: \( t_{WF} = \frac{1}{N} \sum_{i=1}^{N} t_{WF_i} \).

By the formula (9) we get for average quadratic diversion of wearing out of brushes the next formula:

\[
\sigma_{\Delta h_i} = \overline{V}_{WOB} \cdot \sigma_i = \overline{V}_{WOB} \cdot \sqrt{\frac{1}{N-1} \sum_{i=1}^{N-1} (t_{WF_i} - \overline{t}_{WF})^2}.
\]

Respectively for the thickness of distribution of the wearing out of the brushes will be the equation:

\[
\frac{dQ}{d(\Delta h_i)} = \frac{1}{\overline{V}_{WOB} \cdot \sigma_i \cdot \sqrt{2\pi} \cdot \sigma_i^2} \exp\left\{ -\frac{(\Delta h_i - \overline{\Delta h})^2}{2\sigma_i^2} \right\}.
\]

With equations (1), (6) and (11) we’ll get the finally dependence for the intensity of the stream of failures if the electro-brushes:

\[
\omega(t) = \frac{2\pi r_c k_{MC} F_c n_{R}}{\overline{V}_{WOB}} \cdot \frac{1}{\sigma_i \sqrt{2\pi} \cdot \sigma_i^2} \cdot \exp\left\{ -\frac{(t - \overline{t}_{WF})^2}{2\sigma_i^2} \right\}.
\]
Then for PFW of the brush meeting of CEM in unspecified current period of time $t$, we get according to formula (2.1.15) from [3]:

\[
P_{FW}(t) = \exp \left\{ -\frac{2\pi r_c k_m F_i n_R t}{V_{WOB}} \cdot \frac{1}{\sigma_i \sqrt{2\pi}} \cdot \exp \left\{ -\frac{(t-t_{WF})^2}{2\sigma_i^2} \right\} \right\}.
\]

The algorithm for counting this PFW is concluding in this: For a current moment in time of work $t_{CURR}$ which corresponds to the condition $0 < t_{CURR} < t_{WF}$, by formula (3) we count the contact pressure in the brush meeting $F_i$ in the period of time $t_{CURR}$; by formula (10) we count the value of $\sigma_m$; the value of the intensity of the stream of failures $o(t_{CURR})$ is counted by the formula (12), and by formula (13) – the value of PFW $P_{FW}(t_{CURR})$. In this way, the main quantitative indicators on reliability of the brushes are represented by parameters, which depends on the constructive special futures and the conditions of work for the examined period, which is lower than the period for limited wearing out that occurs.

In this final formula (13) for PFW most parameters are given in the factory documentation and those, which are not $\sigma_i, t_{WF}$, can be defined easily with special tests.

4. Instance using of the current model for examination

Let’s do some examination of PFW of brush meeting of electrical machine for time of the technical exploitation $t_{CURR} = 1000 \, h$. The initial data for the research are from the table: number of the revolution $n_R = 12000 \, 1/h$; radius of the collector rings $r_c = 0.03 \, m$; $k_m = 1.32 \times 10^{-6} \, m^2/N$; $c_{B1} = 6.2 \times 10^{-4} \, N/m^3$; $F_0 = 0.8 \times 10^{-5} \, N/m^2$; average speed of the wearing out $V_{WOB} = 0.5 \times 10^{-5} \, m/h$; minimal height of the brushes $h_{min} = 0.016 \, m$.

The examinations are done with eleven $N = 11$ identical electro-brushes in a period of $2200 \, h$ technical exploitation, with this is available the following statistic for the work off of failure $t_i, h: 1800, 2100, 1900, 2200, 1850, 1950, 2150, 2050, 2000, 2060, 2060$. With this under failure we understand event that is connected with decreasing height of the
brushes below the minimal admissible height $h_{\text{min}} = 0.016 \text{ m}$. This event respectively enforce of brushes with new one.

5. Counting

The average work off of the failure is counted according to:

$$t_{WF} = \frac{1}{11} \sum_{i=1}^{11} t_i = 2000 \text{ h}.$$ 

Average quadratic diversion is counted by the formula (10):

$$\sigma_i = \sqrt{\frac{1}{11-1} \sum_{i=1}^{11} (t_i - 2000)^2} \approx 400 \text{ h}.$$ 

By the formula (12), we define:

$$\omega(1000) = 0.21 \cdot 10^{-5} \text{ failure/h}.$$ 

For PFW of the electro-brushes by the formula (13), we get:

$$P_{F_{PW}}(1000) = 0.975.$$ 

6. Conclusions

1. In the present article is shown a model for counting of the quantitative indicators of reliability of contact brush meeting of electrical machines.
2. The model allows to be mentioned the constructive special futures and the conditions of work of the brush meeting and in its own way to have influence on their reliability.
3. The suggested in the paper model of research is factor for management of quality of functioning of all similar electrical machines.

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BIEN: A tool for managing industrial energy systems

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Abstract:
In this paper the BIEN software is introduced, which is a tool for the sustainable energy management suitable for the managing and supervision of industrial units by the end users. Following the Ashby’s law for the requisite variety, which mainly suggests that only variety could absorb variety, and taking into account that the management of an Enterprise has limited variety to absorb, which are the changes of its Environment, BIEN software could be considered as the appropriate attenuator.

The scope of the BIEN is to indicate directions for the sustainable management of the complex socio-technical energy system of an Enterprise. Additionally, the software could give a sense of the future situation of the Enterprise in case of applying a Proposed Plan of modifications. Thus, it can be considered as a valuable managing tool for managers and decision-makers as well as an indicative framework for external auditors (governmental, private etc).

The “driver” and basic idea of the BIEN is that supposing a group of changes, formally, D, in the environment of the Enterprise, which are defined as threatens and choosing a set of modifications, R, in the Enterprise, which are called reactions, it can realize if the results, characterized as, T, meet the group of a targets frame, S, considered by the management. Upon changing the targets, considered by the management, from S to S primed, S’, the software proposes the way to choose the appropriate set of modifications R primed, R’, in the Enterprise in order the new results T primed , T’, meet the new targets.

Keywords:
Software BIEN, sustainable energy management, energy systems

1. Introduction

According to published research works the energy management is a complicated subject which could be approached pretty well with the Systems Theory and using cybernetic models (Kouloura et al., 2008).
Based on Systems theory and its related law about “requisite variety” the management of an enterprise has to be capable to organize and manage effectively the complicated socio-technical system of energy. For this purpose certain tools are required that will play the role of attenuators and will help the Managers to take decisions related to energy management. More specifically in the energy management subjects, the managers need tools to indicate them the most effective technical and managerial intervention they have to implement (Geller et al., 2006). From a literature review about known tools for energy management and the study of their characteristics and abilities (Wei et al., 2006), it was concluded that:

- The existing tools don’t cover the subject globally
- It is necessary the existing tools to be extended in order to adapt the systems thinking
- A new kind of tools for energy management focused on enterprises managers’ standpoint would be useful.

In the next section a tool constructed to help the decision makers considering the energy system of an enterprise as a socio-technical one and based on the principles of viable energy management is presented.

2. Systems Theory & The Necessary Tool

As Kouloura et al. (2008) argue, Beer’s model could be considered an effective tool to understand how organisations work and specifically how an Enterprise could manage its energy system. Additionally Beer uses Ashby’s “law of requisite variety” to underpin his theory (Ashby W., 1956).

On the other hand Beer considers the “insufficient variety” of viable systems, meaning that all viable systems are permanently threatened by “dangers” for which they do not allocate the suitable reactions because they do not have the required variety.

Heterostasis is the attribute of a system to change and to be improved. Thus the heterostasis can produce continuous improvement, innovation, quick change, transformation and it is connected with the idea of Beer for insufficient variety. Viable System Model (VSM) of BEER includes (from its basic design) heterostasis as one of its properties (Espejo, 1981, 2000).

Since organizations (more specifically enterprises) can be considered as sociotechnical systems, homeostasis can be used in modeling them.

Certain general characteristics of social organizations are brought out in this viewpoint, like:

1. the social systems are large, self-organizing and self-regulating systems. This means that changes of D (set of possible environmental disturbances), R (set of possible system responses to these
disturbances) and T (set of targets for the system) are absorbed, produced and decided respectively throughout the organization

2. the parts of social systems are distinguished by relative autonomy. The compensations constitute the results of autonomous behaviours in the system

3. the managers of a social system determine its limits and objectives and consequently the set of disturbances D for which they have to produce a set from applicable responses R in the set of objectives T that they determined. Thus, taking into account the regulation viewpoint, the scope of management is choosing and modifying the sets D, R and T to maintain the viability of the system

For the social systems, the set D of disturbances is determined by the threats and the occasions of environment and the set R of responses is defined by the managerial strategies to correspond to disturbances D. When a managerial response has the possibility to absorb many disturbances d, then it absorbs larger variety from the environment. As Espejo argues (Espejo, 1981) “one way to do this depends upon the observable fact that different organisational structures have different variety absorption capacities. Indeed, Beer’s model of the organisation structure of any viable system can suggest ways of increasing the structure’s absorption capacities, thus permitting the achievement of more stringent targets while reducing managerial information needs”.

Thus, the answer to the basic question “why the enterprises need a “tool” to move towards the viable energy management, which will be the objective of this tool and which will be results from its use” is concluded that: Enterprises need a relative “tool” to be used as an attenuator in the energy management from their management standpoint. Thus, a software was constructed capable to indicate how an Enterprise for whom:

1. the existing energy situation has already been modelled (based on cybernetic models)
2. energy and managerial indicators are determined
3. its indicators are compared with the indicators from Best Available Techniques (BAT) and those based on the principles of Viable energy management and
4. the ideal situation has been defined

will choose the best interventions in order to move from its existing energy management situation towards a better one. An additional challenge of the software is to determine (in case there are optional “roots” to move towards the ideal situation) the way to choose the best root according to criteria declined by the decision makers.
3 The Tool-Model “BIEN”

3.1 The objectives of the tool
The objectives of the tool which is constructed are:
A. To recognize the energy system of an enterprise as a socio-technical one and based on this concept to indicate all the stakeholders of the energy management problem.
B. To give the possibility to the managers
   ✓ To realize if the organizational structure of their enterprise absorbs enough variety from the environment
   ✓ To select simple changes in the organizational structure of their enterprise which if applied could lead to a new organizational structure which could absorb higher variety from the environment
   ✓ To make a forecast for whether applying this structure in the enterprise who will be the profits that is to say how many they will approach in their objective
C. To present interventions that can decrease the variety (as metre of complexity) of systems S1-S5 (Walker, 2006), ranged by subsystem and by weighted grades. According to the above mentioned it is obvious that the management of an enterprise does not allocate sufficient variety in order to face the threats of environment and more specifically the threats connected with the changes in the subjects of energy.
   Consequently the suitable tool like a model is required (Christopher W., 2007). The aim of a structured model will be to constitute a tool giving directions to the managers in the way to manage the complicated socio-technical energy system. Additionally the model will focus on to give the possibility to the managers (via simulation of their enterprise) to recognize the results of their choices.

3.2 The general mathematical basis
In order the existing situation of energy in an enterprise to be evaluated and be compared with the desired one (according to BAT) and/or the ideal one (according to the viability) three basic indicators are used. The users of the tool have the opportunity to select from a pool of indicators or to construct their own ones. As default, the tool-model “BIEN” defines the following indicators: The indicator $y_1$ express the total primary energy used per product unit (in kWh/ prod.unit)
3.3 Basic operation

The structured model will include in briefs
1. records about general data of organizational structure of the enterprise as well as projection of gaps of the structure in comparison with the basic elements of the structure defined by VSM (Rios, 2008).
2. proposed interventions to fill the above mentioned gaps and an estimation of the effect of these interventions.
3. options for additional improvements in organisation structure which increase the absorption of environments variety (e.g. ISO, EMS, Business Excellence etc) and an estimation of the effect in energy management

4. Choice of technical interventions and estimate of their effect if applied (Wickart et al., 2007)

5. determination of the situation in which will reach the enterprise after the

6. implementation of the proposed interventions and its comparison with the one forecasted from the BAT and the ideal one.

5 Conclusions

Concluding, the constructed software BIEN:

1. gives the opportunity to the managers to check the structure of their enterprise and to find out possible weak organizational points in comparison to a known cybernetic model like the Viable System Model of Beer

2. proposes additional organizational modifications based on other known methodologies and standards like Business Excellence, Quality Assurance etc.

3. presents possible technical modifications from a large pool of all kinds of technical interventions, arranged by every energy sub-system

4. calculates the appropriate sustainable energy management indicators and finally evaluates all the interventions, organizational, technical and mix of them, proposing the Best Plan based on criteria chosen by the decision makers.

5. in parallel, calculates the future situation of an Enterprise after the implementation of the proposed modifications and compares the results with the targets of Best Available Techniques and those of Sustainable Development. Thus every Enterprise could have an image if it is close or far away from its targets and from the principles of Sustainable Development related to energy management.

References


Developing a framework for the implementation of sustainable energy management from the end users standpoint

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Abstract:
This paper presents the development of an integrated framework for effective implementation of energy management in complex systems like the sociotechnical energy systems of industrial plants and buildings. Based on the results of an extended literature review, it was concluded that there is a necessity for important improvements in energy management from the standpoint of end users. The whole subject is complicated and there are not the appropriate tools for the decision makers to select and implement the proper changes. Thus, for the majority of energy end users, the challenge to develop a general and integrated framework was arise. The basic steps in this work are: (i) Analysis of case studies for different systems of end users (industrial plants and buildings) (ii) Detection of organizational and technical problems in energy management system of the end users and (iii) Development of a common framework to manage the energy systems. As a conclusion, a general methodology for sustainable energy management was verified and validated using real data from a sample of Greek enterprises. A model was constructed, which analyses the existing energy situation of an end user (industrial plant or building). That model, taking into consideration the targets of the management, indicates the best way for the end users to move towards sustainability. This model could be considered as a stand alone tool for decision makers.

Key Words:
Energy Management, end users, Integrated Framework
1. Introduction

According to the published report about the Innovative Projects, supported by the IEE Programme, there was a steady reduction in the energy intensity of industry for the ten years before 2004, while the share of total energy consumption was relatively unchanged as a result of industry growth and increased outputs (IEE, 2008).

Although the industrial energy intensity is projected to continue falling, the overall consumption, particularly of electricity, is set to maintain a steady growth.

The industry sector continues to present major challenges for policy makers and other actors, especially in view of the target of 20% energy savings by 2020 outlined in the recently-published Action Plan for Energy Efficiency.

Furthermore, the implementation of the Energy End-use efficiency and Energy Services Directive of EE, leads to intensification of measures to support industry in areas such as measurement, verification and benchmarking of energy efficiency, as well as the application of new and renewable energy technologies in the sector. The main aim will therefore be on stimulating creative and effective new projects which both build on previous success in the sector, while also bring about greater involvement of industry, particularly SMEs.

As the International Energy Agency (IEA) argues industrialised countries have significantly reduced their primary energy use per unit of GDP over the last three decades. Major OECD countries taken together used a third less primary energy to generate a unit of GDP in 2000 compared to 1973 (IEA 2004).

The decline in energy intensity has been driven largely by improved energy efficiency in key end-uses such as vehicles, appliances, space heating and industrial processes. A recent study by the IEA provides a detailed analysis of how much of the decline in energy intensity (changes in final energy consumption per unit of GDP) was due to energy efficiency improvements and how much was due to structural changes.

Energy efficiency improvements result from ongoing technological progress, response to rising energy prices, and competitive forces pressuring businesses to cut all types of costs including energy costs. In addition, governments have implemented a wide range of policies and programmes such as funding research and development (R&D), energy efficiency standards, educational efforts, obligations on market actors and financial incentives to accelerate the development and adoption of energy efficiency measures. These policies and programmes have contributed to the improvement in energy efficiency experienced in OECD countries during the past 30 years (Geller et al. 2006).
Proponents of energy efficiency policies and programmes argue that greater energy efficiency saves consumers and businesses money while reducing the adverse environmental impacts associated with energy production, conversion and use. In particular, greater energy efficiency is viewed as a strategy for reducing carbon dioxide emissions and helping countries meet their Kyoto Protocol targets (WCED, 1987). Energy efficiency advocates also argue that efficiency improvements can provide social benefits such as increased productivity and employment, reductions in the high energy cost burden faced by low income households, improved comfort and public health, enhanced national security, and conservation of finite resources such as oil and natural gas.

On the other hand, managing the energy saving associated with an organization’s operations has been a subject of increasing importance over recent years. However, very little emphasis has been given in both academia and industry to define what constitutes either an energy management system (EMS) or an effective EMS. There are still no well-defined and accepted criteria that may help to establish an effective EMS. EMS is defined as the policies, objectives, organization, management, controls and resources which are in place to manage energy in all parts of the business.

An effective EMS needs to be a more formalized version of existing management systems for the control all of energy, safety, environment protection and production. Moreover, effective energy management comes as a result from the combination of EMS structure and the organization’s energy saving culture.

British Standard Institute (BS 8800, 1996) defines a management system as “a composite, at any level of complexity, of personnel, resources, policies and procedures, the components of which interact in an organized way to ensure a given task is performed or to achieve or maintain a specified outcome”.

Traditionally both academic community and practitioners have tended to address energy saving by focusing on technical aspects and looking for the immediate causes of energy losses after they have taken place.

It must be highlighted the need for addressing energy saving proactively. In addition to this, the emergence of new regulations and international standards will drive organizations to improve their energy performance. As a result of this, organizations have to pass from a reactive approach to a proactive approach to energy saving.

Energy management could be an aspect of the overall management function that determines and implements the organization’s energy policy. This involves a series of activities, initiatives and programmes which focus on technical, social and organizational aspects and refers to all the individual activities within the organization. These activities are associated
with the concept of continuous improvement through ‘control loops’, which involves planning, organizing the work, implementing, evaluating, checking the outcome against the plan, and adjusting/taking corrective action.

The degree of energy saving in an organization is an emergent property resulting from the interrelated activities of people who design the organization, manage it, and operate it (Rafn I., 2002). There is still a need for a systemic approach to understand the systemic nature of energy saving. This systemic approach can be used to assess the effectiveness of existing EMS. It is hoped that this approach will lead to more effective management of energy.

2 The Initial Reflection

While the recognition of the global problem of energy management and especially from the end users standpoint has been noted in research papers, proceedings and official papers from International Organizations, a general way to handle it has not yet been presented. The focus of this work is to present the development of an integrated framework for effective implementation of energy management in complex systems like the socio-technical energy systems of industrial plants and buildings which will be a useful tool for energy end users (Prose et al. 1997).

As a first step of this work, an extended worldwide literature review about energy management has been executed in order to answer basic questions like “which are the tendencies that prevail in the scientific community related to energy management” and “which subjects still have not been examined sufficiently”. It was resulted that:

1. changes to the energy management have to be done
2. the hole subject is very complicated
3. there are no real tools for decision makers specifically in the framework of energy management in an Enterprise.

Additionally, it was concluded that the basic components for the development of a methodology focused in the energy management in viable socio-technical systems (like the end users of energy) were as follows:

- the determination of procedure/interrelations/organizational structure which are necessary for the implementation of sustainable energy management in an Enterprise
- the determination of methods to check the performance of the energy management system
- the determination of procedures to move an Enterprise from the existing situation towards a desired situation.

More specifically, the Reflection which rises was:
How the final consumers (Industrial plants and buildings) manage the energy?

Are there targets/border lines from the environment that influence them on issues of energy management?

If they continue managing the energy with the way that managed it until now, will they achieve these targets? If not, what should have been done so that they achieve them? Are there suitable tools for the decision-making in the energy management from the end users stand point?

Are there already known methodologies for change in the way of energy management? How close to the viable energy management are the end users and if they are not so close are there suitable tools that could “show the way” for the viable management?

Based on the basic Reflection the following teams of reflection were determined:

**Team of Reflection A**
Which is the existing situation in energy management in the enterprises? Which indicators are used in order to express the energy situation of an enterprise and which are their range of value? Which are the prevailing tendencies on energy management issues from consumers’ point of view?

**Team of Reflection B**
Which are the existing restrictions, worldwide and locally, with regard to the energy consumption/management in Enterprises?

**Team of Reflection C**
Which is the future ideal situation of an end user, regarding its energy management that could reach?

**Team of Reflection D**
Are there the suitable tools for end users (their decision makers) to move them from the existing situation of energy management to an ideal one?

**3 The Basic Steps**
In order to answer the Teams of Reflection noted above and finally develop an integrated framework useful for the end users of energy, the following methodology used. First of all a case study of an existing industrial unit was analyzed using the cybernetic model, Viable System Model (VSM) of Beer (1979). The industrial unit, which produces and
consumes thermal and electric energy, was old and with a high intensity of used energy. Consequently it was considered as typical of the industrial sector. It was concluded that the systemic methodology as well as a cybernetic model could be used to detect insufficiencies in the energy management in industrial plants taken into consideration all the factors that influence the energy management (technical, economical, environmental and social) (Pearce, 2000). Moreover, it was emerged that the considered enterprises, which are particularly complicated systems, could be supported by a systemic methodology. Using a cybernetic model like VSM, their organisational and technical parts that require improvement in energy management could be detected (Rios, 2008).

With the completion of above mentioned study the following additional reflection was arise:

Team of Reflection E

Is there
- a general method that could examine the energy management of a complicated system like e.g. an enterprise into its continuously altered environment or a building with its tenants etc
- a tool that could impress the existing energy situation of enterprise, connect it with its total situation and give the possibility of determination of its “weak” points in the energy management as well as the possibility if the most suitable changes become its new energy situation to be determined with clarity.

This Reflection was answered as argue Kouloura et al. (2008a), with the generalisation of the idea of application of systemic methodology in the energy management of industrial groups and the use of a cybernetic model like the VSM, as tool for the diagnosis of energy situation for enterprises that produce and/or consume energy as auxiliary “product” (Brocklesby et al. 2006).

At the same time a new reflection was raised:

Team of Reflection F

In which categories of energy consumers (end users) the systemic methodology as a general methodology of energy management could be used.

The Industrial, the Domestic and the Tertiary sectors as well as the sector of Transports are considered as consumers of energy. Based on the motivation of reflection F, the application of Systemic methodology in the energy management of a building used as residence was examined (Case Study 2) while afterwards the methodology was
generalised using multiple criteria with different weighing factors for the choice of Best Interventions Plan (Kouloura et al. 2008b).

The two case studies of energy management, in industrial plants and in building of residences, using systemic methodology to analyse them as socio-technical systems revealed a “uniformity” in their energy management (Jackson, 1951). Thus, a fundamental study of common confrontation of energy management in the Industrial and Domestic sector using systemic methodology was executed (Ashby, 1999) and the reflection of Team F was partially answered while it remains for investigation if the methodology could be applied also for the remainder sectors of consumers (tertiary and transports) Afterwards it was decided the existing energy situation of Greek industry to be investigated and data from a sample of Greek enterprises were collected. Thus, two Questionnaires were structured and they were dispatched in industries of all sectors. The Questionnaires aimed to collect information about the use of primary energy, primary production information, administrative and organisational information as well as information with regard to the relations of enterprises with their environment. The data that were assembled by in total 22 Enterprises, confirmed the gap between ideal and the real situation of energy management in Greek industry, answering in Team A of Reflection.

As a next step and based on the principles of Best Available Techniques (BAT) and Sustainable Development, indicators were developed for the different sub-sectors of Industrial sector with regard to energy management. Moreover, a comparison between existing energy situation of Greek industrial sector (based on the indicators calculated using the real data from the 22 enterprises) was done and the gap from the expectations based on BAT was confirmed. A methodology was constructed, based on the above mentioned steps and it was applied and validated using the real data from the sample of Greek enterprises. Thus, Teams B and C of Reflection were answered.

Given the existing situation of the Greek industrial sector related to energy management and the known limitations that determine the future situation, a research was accomplished if there are tools to help the consumers (industries, domestic buildings etc) to move from the existing energy situation initially towards to an improved one based on the BAT principles and finally to the sustainable energy management. It was realised that for consumers and more specifically for the industrial groups, the “tools” that exist are limited. Thus, on one hand the application of systemic methodology in collaboration with the Principles of Business Excellence in the energy management (based on the data that had been collected for Greek industrial sector) was investigated and on the other hand a frame of analysis and modelling of energy management in
industrial groups supported by the systemic methodology was determined (Bronnimann, 2008).

4. The final tool

The critical question which rises from the above mentioned framework is “do the enterprises and specially their decision makers have a helpful, proper, relative simple and integrated tool in their effort to move towards sustainability?” (Espejo, 2000). The target, to determine a tool, incorporating these characteristics, which could support a general framework for choosing the best criteria for sustainability, it was raised and looked very attractive.

In parallel, it appeared that this “tool”:
1. could be general,
2. is not influenced considerably from initial (existing) situation of Enterprises hence it could be used for any enterprise in the world and
3. is independent from the situation in which the Enterprises want to achieve (e.g. in the situation that is forecasted by the BAT or by the definition of viable management and/or in an intermediate situation)

From the above mentioned it emerges that with the suitable modelling taking into consideration the targets of the management and showing the best way for the end users to move towards sustainability, Team D of reflection could be answered (Bossel, 2000).

Thus the challenge is to create a suitable “tool” to indicate how an Enterprise for which:
1. the existing situation has been impressed (using analysis with cybernetic models)
2. energy and administrative indicators have been determined
3. has been compared with the BAT and the beginnings of viable energy management and
4. the ideal situation in which it will be supposed to move was determined it will realise the movement from the existing energy situation to another one better and in case it could follow alternative paths in order to realise it, how it will select the Best Plan based on criteria that the enterprise will place by itself.

The Figure 1 presents the flowchart of the above analysed framework.

5. Boundary Conditions

The developed framework could be characterised as general taking into consideration the following boundary conditions:
1. It covers the energy systems of Industrial plants and buildings. The Tertiary and transportations sectors were not examined extensively. Although, there is the sense that the same methodology (with small modifications) could be applied also to these sectors.

2. It considers only the energy management of end users. The management of energy resources as well as the management of energy transportation are not included in the study of the problem.

3. Although, using the systemic approach, all the stakeholders of the problem (energy management of energy consumers) are recognized and are considered in the solution of the problem, the proposed solution is biased by the local society and focused on the principles of sustainable development.

6. Conclusions

The above described framework, which was developed for the implementation of sustainable energy from the end users stand point and specifically for the industrial plants and buildings, consist a unique, prototype and stand alone tool for decision makers.

It examines the complicated energy system of the end users not only as a technical system but as a sociotechnical one. Based on this analysis it recognizes gaps in the organizational structure of the end users as well as in the technical parts of the system.

It uses the systemic approach involving all the restrictions of the energy management problem (electrical, economical, environmental and social) and indicates the appropriate interventions for the sustainable energy management.

It takes also into consideration the targets of different stakeholders and shows the best ways for the end users to move towards sustainability.

Finally, based on and from a pool of probable organizational and technical interventions, the future or desired situation of an Enterprise could be determined through this framework.

The methodology is general and it was verified and validated using a large sample of end users. As that, it can be characterized as a dynamic one in the sense that it can take into account all the changes and progress which occur in the environment of the end users and can be applied at every time or in different periods for the same end user showing the progress in the energy management and detecting the weak points of complicated energy systems.
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International Business Collaboration and Communication
Tools Using WEB 2.0 Techniques (The Intermas e-Consulting Platform Case Study)

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Abstract:
Internet has been evolved as one of the most important tools for companies and has been adopted in all sorts of ways from internal data collection tool to a competitive advantage itself by allowing the companies to provide new services. Despite the fact that communication and collaboration between companies, using software and internet, has been established many years ago there have been few radical changes on the way these tools are designed and used. The latest internet trend is WEB 2.0 and it can be shortly described as: “The construction/design philosophy for websites and applications, which allow users to do more than just retrieve information. They can build on the interactive facilities of "Web 1.0" to provide "Network as platform" computing, allowing users to run software-applications entirely through a browser. Users can own the data on a Web 2.0 site and exercise control over that data. These sites may have an "Architecture of participation" that encourages users to add value to the application as they use it.”

From the upper description we can understand that introducing WEB 2.0 techniques in B2B communication could increase productivity and reduce the time and resources demanded for projects which require collaboration and especially these that involve companies from more than one country.

For this reason our research’s primary objective is to investigate the possibilities of implementing WEB 2.0 technologies and techniques for business applications and information systems. The target field of our research is the communication – collaboration of enterprises/organizations that are running international projects.

Most of our data are empirical and are extracted from the design and operation of “e-consulting platform”, a web service designed by Argyriou Alexandros, Bitros Andreas, Charidimos Spinthakis and Troulis Yiannis and used by Intermas Consultants LTD.

The scenario for this case study is based on project management for international projects that are running under the supervision of Intermas Consultants LTD and cover areas such as, Users Interface, Communication tools, Transparency Automation etc.
More specific, we aim to demonstrate some of the most widespread techniques, such as “Wikis”, “Mobility”, “Users Orientation Design”, “Simplicity”, “Modularity”, “Widgets” etc, and how they can be used for business e-collaboration. Finally, we will try to demonstrate the WEB 2.0 approach on designing user oriented software for business collaboration and which are the fundamental rules that should be implemented in order to be successful.

Keywords:
WEB 2.0, Project Management, Collaboration tools, Communication tools

1. Introduction
1.1. B2B Software, Internet and Web 2.0

From a historic point, internet/intranet was a major add-on on business procedures and business communication, its success can be indicated from the very early adoption of intranet networks that companies created in order to allow communication and data transfer internally and externally (with some close connected and trusted supplier or distributors). Now days we can observe the impact of this small revolution on just a few numbers, such as the penetration rate of computers (greater than 80%) on businesses (irrelevant to their size) even at the less developed countries.

Moreover, the creation and establishment of a whole new sector (I.T.) and the internal budget that companies spent on Information Technology, prove that business community believes on the benefits of I.T. and supports its growth. That’s why from time to time there have been evolved several applications that aim on enterprises and the cover all (or almost all) aspects of company operations. Thus we have ERP systems for the internal monitoring of the company, CRM systems that manage relations with customers etc. There are also business applications that aim to reach directly customers, creating on-line selling points or even more, according to the latest trends, by using web 2.0 techniques such as creating corporate blogs, RSSs etc in order to promote brand awareness.

The latest internet trend is WEB 2.0 and it can be shortly described as: “The construction/design philosophy for websites and applications, which allow users to do more than just retrieve information. They can build on the interactive facilities of "Web 1.0" to provide "Network as platform" computing, allowing users to run software-applications entirely through a browser. Users can own the data on a Web 2.0 site and exercise control over that data. These sites may have an "Architecture of participation" that encourages users to add value to the application as they use it.”

The “gap”, according to our beliefs, is that the software that enterprises use is mainly designed for monitoring day to day operations and it doesn’t allows employees to contribute a greater input. That phenomenon can be easily identified on software applications that require
collaboration - communication and project management. So our empirical research is focused on the use of Web 2.0 techniques in order to increase, in matters of quality, the human input on process that are closely related to human team working such as technology transfer, consulting etc and the overall project management support.

2. The Approach of Intermas e-Consulting Platform

2.1. The Basic Stricture of the Solution

Intermas Consultants LTD is a consulting agency specialized on sectors of Research and Technology Development, the international projects which it consults and usually manages require teamwork and collaboration of people with totally different educational and cultural background, all the above reasons, point out Intermas as an ideal example for our empirical research. The design of the on-line platform (e-Consulting Platform) which we will base our research has been done by Mr. Argyriou Alexandros, Mr Bitros Andreas, Mr. Charidimos Spinthakis and Mr. Troulis Yiannis (Intermas senior Partner).

The basic aim was to create a project management / collaborative tool that would allow users/project’s participants to co-work under several projects with a consultant as a supervisor. Given that as a fact we stick to the three basic parameters of project management: “Who does What by When”, we also simulated the whole process of consulting as a closed circuit of actions (Diagram 1) and finally we choose to monitor the project on three levels: Project as a unit, Work Packages (W.P.) (first project’s sub module) and on Tasks (second project’s sub module).

In addition we designed a user oriented environment in order to improve users experience. Unlike most of the other project management platforms, Intermas’s platform appears to the user only the necessary buttons that he needs in order to perform his tasks and to communicate with other users. The basic design philosophy includes the main buttons to be conveniently located on the left of the screen, the “working area” to be at the center and the communication – additional menus to be located on the right side. (Picture 1). For example, a consultant is able to see the edit menus and other more complicated menus that are related to the project management, instead of a simple user. The same philosophy has been kept and on project’s information’s/files in an attempt to simplify the whole users navigation experience.
Diagram 1

Picture 1
2.2. The implementation - User management

Having as main target to improve collaboration and to allow users to interact, avoiding at the same time to create a chaotic situation, we choose the following users level structure (Diagram 2). At the top of the hierarchy of a project is a consultant, consultant operates as an administrator / project manager, he creates and adjust the basic parameters of the project (this procedure is analyzed later), he also set’s the users that are marked as W.P. Leaders and correlates the rest of the users with specific W.P.s In that way users are grouped in a proper way in order to exchange information and files without interrupting the workflow of other teams.

The procedure which consultant is using in order to organize the project is based on the W.P.s, after the separation of the project on W.P.s consultant inputs specific data (including users and W.P. leaders) and tasks about every W.P. separately, these data are combined and they create the whole project.

2.3. The implementation – Project Monitoring & Coaching

By having separate the project into deferent parts each team of a W.P. has some specific tasks to achieve in order to complete the whole W.P., that way users understand and visualize the common target they have to achieve, it is also usefull the additional menu that exist on the right side of the screen allowing to the user to watch news that are related on the W.P. that he belongs, that way users can keep easily track of the many events that occur on a project. Users have also a personal e-agenda which help them to watch their milestones and the important dates for a project.
2.4. The implementation – Communications

For the communication of the participants, we used a two ways philosophy; initially users have a shout box (one for every W.P.) that they can use in order to collect fast and easily information from their collaborators, if this method of communication isn’t sufficient enough users can arrange an e-meeting that contains real-time audio and video. Using these two methods W.P. teams organize themselves according to the timetable and start cooperating.

2.5. The implementation – Collaborations

In order users to have access to all necessary files we created an e-briefcase on which users can find files which contain information about the W.P. they participate, they can also upload or download files in order their collaborators to be able to read and edit them. The design of briefcase was quite challenging due to the fact that we should establish rules upon editing.

2.6. The implementation – Automations

Probably one of the most important breakthroughs of Intermas platform was the great amount of automation that made the platform look really smart. As the Consultant/Project manager, creates W.P.s many of the data are collected, combined and distributed on other modules of the platform. For example, the dates of the deadlines are marked on the e-agenda of the user; also every Task of a Work Package has its own unique folder etc and all these with just a few clicks. More over the extraction of data is quite easy and allows that way further expansions on platforms reporting tools.

2.7. The implementation – Mobility

Another impressive feature of the Web 2.0 architecture is the totally on-line operation (only through a web browser), allowing to the user/participant to use, without time spending procedures, almost every available computer and internet connection. We have also create a mobile extension of the platform and it can be used from smart phones, that feature combined with the SMS/e-mail auto reporting that platform is also equipped can keep the user informed for every step of the project. Finally a widget (desktop application) constructed in order to help participants to monitor their project and being formed for every crucial information, without having to access the platform.
3. Conclusion

From our up to now feedback regarding the use of e-consulting platform we have received positive reaction, and apart from that, we can also admit that it has help us on better organizing and managing our projects. Of course it’s very early to have some solid evidence but we are quite optimistic about its future performance. We would also like to clarify that a collaborative systems, like the one we shortly explained above, doesn’t guarantee the successfully completion of a project, instead it reveals the true competitive advantage of almost all enterprises, the human factor and its willingness to participate creatively on a project. Finally we should mention that the coordination of all these web 2.0 techniques was the real difficult part and not their individual implementation.

Acknowledgment

We would like to thank Professor Nikitas Asimakopoulos and John Thanopoulos for their valuable contribution, as well as Intermas Consultants Ltd for allowing us to export these information.
Using 3D Computer Graphics for Furniture Design and Marketing: The Greek Companies Case Study

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Abstract:  
The aim of this research is to determine, evaluate and promote the capabilities offered by the use of 3D CAD software in furniture design development in generating marketing competitive advantages. Furthermore, a main objective of the work done was to develop guidelines that would facilitate furniture enterprises in decision making concerning the use of 3D CAD software and the respective training of their employees. The first step was to record cases where 3D CAD software was used in furniture design, and subsequently a comprehensive research plan was developed and conducted. The research scope comprised both enterprises developing and trading 3D CAD software and furniture enterprises using such software. The necessary data was collected by carrying out a combination of personal interviews and questionnaire surveys and it was subsequently analysed using descriptive statistical methods. The total number of questions (11 of open type and 11 of closed type) was structured in two subgroups. The first subgroup concerned characteristics of the used 3D CAD software, such as type, purpose, capabilities, special features, cost and profit. The second subgroup included questions relevant with the special characteristics of enterprises using 3D CAD software in furniture design. A pro-sample from that enterprises was selected, some suitable correction were made and finally 72 questionnaires were gathered. 121 variables were analysed using SPSS ver. 16.0, and the statistical methods Frequencies, Descriptives, Crosstabs and Correlations controls were applied. The analysis results indicate that the two strongest motives
for using 3D CAD software in furniture design are the need for realistic design visualisation and the increased competition in the furniture enterprise market sector. The use of 3D CAD software extends to all stages of furniture design development and to phases that precede or follow it, such as marketing, production and sales. In large-scale and complex projects in particular 3D CAD software can serve as an important management tool. Furthermore, a bidirectional relation between furniture design studies and promotion and advertisement materials. This is due to the fidelity of digital images and their capability to approximate reality with accuracy. The interest in using 3D CAD software, concentrates on the sectors of design (92.3%), production (92.3%) and sales (76.9%). In that user base, users with age between 21-30 years believe that 3D CAD software contributes to better design, while those with age between 31-40 years dispute any positive contribution of 3D CAD software to furniture production. The economic benefits are mainly focused on the design time reduction by 49.6%, on the cost production reduction by 27% and on the increase of sales by 28.3%.

Keywords:

1. Introduction-Literature Review

Computers, are today a very important communication tool between the designer and the client and have been established as something necessary in contemporary design enterprises (Curry et al, 1993). CAD software enables designers to easily manipulate the design to meet the client requirements and can therefore be used as a marketing tool (McLain-Kark and Rawls, 1988).

Since the early 1970s, when the first CAD software was designed and until 1980, the 2D and 3D CG (3 Dimensional Computer Graphics) consisted a small and specialized section of available business software, due to the high cost of computer hardware and the lack of software with friendly and easy to use user interfaces (Foley et al. 1990).

The 3D CG, in order to reach today’s level of development went through a decade which was focused on intensive research regarding them (Bertol, 1994; McConnel and Waxman, 1999).

The main objective of using 3D graphics software in the furniture design sector was initially to impress the customer. (Maxmann and Zhang, 1995; Otjacques et all, 2008). However, it was soon realized that the potential of its use was much higher. Nowadays, the use of such software is considered as mandatory in the furniture industry and it extends to areas far beyond furniture design. (King, 1998; McConnell and Waxmann 1999; Leslie and Reiner 2006; Oh et al 2006; Ansel et al 2007). This means that the Greek furniture market shows a mobility regarding the use of software
packets for design. However, it is not known to what degree this mobility, with the introduction and the use of those new technologies and the new potentials they can offer, consists a new phase of the furniture sector’s development (Gianousiadis, 1981; Sinometis, 1982; Clemons and McLain-Kark, 1991). The furniture design and the capability of creation and introduction of new models in the market, have to do with the cycle of life of those models in the market (Nanouris, 1981; Bumgardner et al, 2001, Nes and Cramer, 2003; Papadopoulos, 2005). In this framework, the institution of “awards for furniture design” were repeatedly created and operated both in the international and the Greek area (Stamou, 1982; Benningston, 1986; Pile, 1990).

Recently the interest of the professional designers was focused in the use of 3D CAD software in 3D printers for rapid prototyping and manufacturing to produce buildings, furniture and models (Sass, 2005; Iwamoto, 2004; Igarashi et al, 1999; Lipson and Spitalni, 2002).

Despite the widespread use of 3D CAD software in the furniture sector however, the way that furniture enterprises valuate those programs has not been adequately clarified so far. The result of this vague picture is, in general, the slow acceptance and promotion of the use of this relatively new technological mean. So, what remains is to investigate and analyze the existing 3D graphics software in the furniture design sector, what its essential usefulness is, what criteria are taken into account in their evaluation by the furniture enterprises and what conclusions regarding their aim and their extensibility as well as the implantation of any required extensions are made. For these reasons, such research in the sector of furniture design is deemed necessary.

The aim of this research is to investigate the degree and the perspective in which the 3D CG software has penetrated and is utilized in the furniture design sector. In this framework, the documentation and the evaluation of the benefits and advantages of the use of software packages for design, also consists another aim of the research. Furthermore, an additional aim of this research is to examine the degree in which the use of 3D CG software has penetrated in other procedures of the furniture industry, apart from the design area. In addition, the combination of the development and the use of such software from specialised users – enterprises characteristics – is also examined, since it can assist in determining the degree to which that software is developed and used. The ultimate target is, through this research’s conclusions, to benefit: a. the furniture enterprises decision making process regarding the use of those programs and b. the proper training of the executives.
2. Methodology

The organization of the research and the methodological procedure that was followed is briefly presented in Fig 1.

The market research covered the use of 3D CAD software, in furniture production enterprises both from Greece as well as from abroad. The research started with searching the Internet for companies developing 3D CAD software and a full catalog of 3D software products was created. A first communication with those enterprises was made using telephone and/or e-mail. Subsequently, the a preliminary questionnaire was developed, which was then answered via e-mail by the international enterprises and in a personal interview with representatives of the local ones. The aim of that questionnaire was to gather information regarding the existing 3D CAD software, to identify their potential uses in the furniture sector, as well as to determine the degree of the available information on this subject. The questionnaire analysis enabled the development of an enhanced questionnaire covering the subject from more angles in a comprehensive manner. The development of the extended questionnaire was carried out according to the methodology of social science (McCarthy and Perreault, 1987; Kouremenos, 1987; Zacharopoulou, 1993; Kiriazopoulos and Kioulafas 1994; Churchill, 1996; Kotler 2001) and market research (Lee et al, 1987; Tsaklaganos, 2000). The total number of questions (11 open type and 11 close type), was structured in 2 subgroups. The first group was concerning important 3D CAD software characteristics, such as type, use, implementations, cost, benefit and special features, while the second one was targeting special characteristics of the enterprises that use such software in furniture design in particular, or in CAD-CAM systems in general.
Review of bibliography

«Case study» of 3D

Receipt of personal

3D software Market research of

Foreign

Local

Creation of the final questionnaire for 3D software research in the

Statistic processing-results

**Figure 1.** The methodological approach of the research's object (in purple color the market research).

From the total number of enterprises that were found to use 3D software for the design and the production of furniture, a sample of 15 enterprises was randomly chosen initially, and it was later expanded to 35 (Zacharopoulou, 1993; Tsaklaganos, 2000). The questionnaire was send to enterprises belonging to that sample. The research was made in the period 2003-04. The answers were then statistically analyzed using SPSS for Windows ver 16.0. The analysis involved introducing 121 variables and applying the Frequencies, Descriptives and Crosstabs methods (Norusis, 1997; Howitt and Cramer, 2003).
3. Results

From the questionnaires that were sent, a percentage of 87% was filled in and returned to us, which is a really high percentage compared to similar questionnaire-based researches.

3.1 The level of market’s knowledge regarding the existence of 3D CG

Initially, the percentage of enterprises information regarding the market of 3D CG was researched. As expected, the total of the CAD – CAGD software users is aware of the terms «photorealistic» and «3D», while the percentage that is aware of the terms «three dimensional representation», «photo representation» and «Render» is particularly high (Fig. 2). Other terms that have to do with 3D CG special terms, are shown to be known by only 33.3%. It is worth to mention here that this percentage consists of people only between 21 and 30 years old. This result can also be characterised as expected, since people of younger ages are more familiar to new technologies, in contrast to people of older ages that tend to dislike them to some degree.

![Figure 2. Knowledge of terms regarding the CG](image)

Despite the fact that takeovers, amalgamations and changes in the condition of the enterprises is an everyday reality that causes confusion in some respect, it was found that there are currently 39 3D software applications in the Greek market, which is a really significant number for the size of the Greek software market. The most popular in descending order of popularity are: AutoCAD (100%) > 3ds MAX (83.3%) > Archicad
(75.0%) > Maya - Solidworks - Pro-engineer - Lightwave (58.3%) > ESTIA (30.0%) > 1992 PRO - Rhinoceros - Form Z - Catia (41.7%) > Vector works - Cinema 4D (33.3%) > Softimage XSI - Messiah - Truespace - Imagine - Renderman (25.0%) > Strata 3D - Houdini - Amapi/Infini D / Carrara - Ray dream studio (16.7%) > Inventor series - Ideas master – Solidedge – Poser (15.4%) > Extreme 3D – Universe (8.3%) > Bruce – Helix - Motion builder – Sculptor – Aris – Tekton - Claris CAD – Planit (7.7%) > Allplan (0.0%).

3.2 The level of software use

The software applications used are presented in the Fig.3, where AutoCAD is the mostly used program in the market and 3D Studio MAX next, while Greek 1992 PRO (23.1%) and Pro-engineer (23.1%) follow with only a small percentage difference. The other Greek program falls also behind in its use from the Greek furniture enterprises. This means that despite the advantages of the 2 Greek programs, they haven’t yet gain an important part of the market. One of the reasons for this is also the low degree of awareness of them in the Greek market. (see also Sec. 3.1 above).

A relevant research (McConnel and Maxmann, 1999) in Florida, USA showed that the use of AUTOCAD rises to the percentage of 46%, of the 3D Studio to 34% and of the Form-Z to 7%.

![Figure 3. The level of software use](image)

Regarding the furniture products categories, in the design of which some design software is used, the kitchen furniture, the closets and the office furniture are mostly designed with such software. That was expected since those categories have to do with surface furniture, whose production has a big degree of industrialization. Furthermore, a characteristic result is that in
a small degree (less than 40%) the use of such software has been adopted in all categories of furniture products.

![Percentage of use of 3D CG programs in the furniture production](image)

**Figure 4.** Percentage of use of 3D CG programs in the furniture production

These software applications can be implemented in all stages of a design with higher percentages in the formation of the initial idea, in the study of the final form, in the 3D design and in the final presentation (Fig. 5). Based on the opportunities for creative development of imagination that those programs offer, the percentage of their use in the stage of the initial idea (84.6%) is impressive as well as expected. However, some authors argue that those software applications have nothing to offer in this stage of design (McConnell and Maxman, 1999; Ansel et al, 2007). Naturally, the last years, many attempts from the enterprises producing such applications have made considerable efforts for improvement in this respect during the last years.
Figure 5. Application percentages of 3D CG in all stages of furniture design

The use – implementation of such software packages goes back to 1 to 14 years, with an average of 9 years. The 53.8% of those who answered has been using software packages and 3D CG for a period bigger than 9 years, while nobody exceeds the 14 years of use. 100% of the, relatively, new users, of those who have been using the programs from 1-9 years, do not use them in the study of materials which shows that, in this stage of the design process there is significant room for improvement.

3.3 The benefits of the use of 3D CAD-CAM Software

The interest of everyone who answered that use the design programs (CAD), is focused on the sectors of design, production and sales, where the percentages are 92.3% for the 2 first sectors and 76.9% for the third. From the users of such programs, those that were between 21-30 years old believe that the use of such software contributes towards better design, while those who are between 31-40 doubt about their contribution in the production. The highest percentage of the last ones believe that that the advantages from the use of such graphic computers have to do with the creation of designs easy to understand, which are easily modified and impress the costumers. All those that believe that the programs contribute in the better design, see that the benefit comes from the ease with which one can make modifications to those designs.

Benefits from the easily conceivable designs, is believed from the 100% of those who believe in the contribution of the software in sales. Table 1
shows the benefits of the use in every occasion, where remarkable percentages gather the Easily understandable Designs and the Ease of design modifications (92.3%), the Impressive for clients (84.6%), the reduction of the mistakes and the speed and clarity of the depiction (from 76.9%). In addition, Table 1 also presents the results of Pearson correlation coefficient for all the benefits of 3D CG using benefits, in order to realise their cross-correlation per pairs. Thus, it appears that the higher values of Pearson correlation coefficient are presented in the variables: economy of design – speed of design (0.822), accuracy of the result – creation of new shapes (0.732), – reduction of mistakes (0.693), improvement of the design of the production communication with convenience in modifying the designs (0.640) and digital information about the product (0.677) for significant level p<0.01. That is to say that the means of the above pairs of benefits do not differ statistically considerably at a 2 tailed level.

In more details, the above results show that:

a) the bigger the saving in designs the bigger the speed of the completion of the design

b) the bigger accuracy of the result creates more effective new etc.

The aforementioned benefits regarding the use of 3D computer graphics in furniture design become a financial benefit as well. More to the point, the increase on sales prevails in the total of those who answered (100%), with second, close to the previous the reduction of the time needed for the production of the (92.3%) and third the reduction of the production cost (76.9%). Those percentages involve the total of those asked that believe that there is financial benefit from the use of software. The average reduction of the production time for the design of a design proposal is considered to be 49.6% and the average reduction of the production cost 27.0%. Finally the average increase in sales is about 28.3%. The further analysis of the answers in relation to those 3 subjects gives interesting information:

- The quantification of the reduction of the design time, in the opinion of those asked is very characteristic: one third (1/3) of the answers give reduction of the time in a percentage of 20-35%, another one third (1/3) of the answers show a percentage of 36-50% and in the other 1/3, 51-80%.
- As to the factor of production cost reduction, it becomes evident that in 70% of the answers this is around 10-30%, while in the other 30% it is around 31-50%.
- In 20% of the answers, increase in sales of a level of 3-10%, results from the use of 3D graphics. In 50% of the answers the sales increase in the region of 11-30% and in the other 30% an increase of 31-60%.
- The $X^2$ independence test showed that there is a positive correlation
between the finding of financial benefits and the use of the above programs and the years of use and the amount of staff used. More on the point the more the enterprises have used 3CG programs and the more staff they have the bigger financial benefit they have ($\chi^2$ Pearson = 3.933, Kendall’s tau-b = 0.318, p=0.01 και $\chi^2$ Pearson = 5.714, Kendall’s tau-b = 0.082 and p=0.01 respectively).

- Finally, the financial benefits in production seems to have a positive connection in a big degree with the number of staff used and a negative with the annual turnover of the companies ($\chi^2$ Pearson = 13.333, Kendall’s tau-b = 0.126, p=0.001 και $\chi^2$ Pearson = 13.982, Kendall’s tau-b= -0.051, p=0.005 respectively).

3.4. The research’s profile

From the enterprises that participated in the research of the final questionnaire, the 69.2% is active in the construction and the trading of furniture, the 15.4% in the industrial design and the rest 15.4% belongs to modeling-rendering-animating enterprises (Table 2). The total number of enterprises, which are related with industrial design and modeling-rendering-animating, believe that the financial benefit occurs because of the advantages offered in the design. Furthermore, the 100% of the industrial design enterprises believes that the financial benefit results from the advantages offered in production despite the fact that they do not deal with this. In addition, from the construction and commercial enterprises a benefit in the production can be seen by only a percentage of 77.8%. Finally, the construction and commercial enterprises combine the use of sales programs with professional or industrial as opposed to the other enterprise types mentioned above.
Table 1: Frequencies and Pearson correlation coefficients of benefits of 3D CG software usage in furniture design

<table>
<thead>
<tr>
<th>3D CG using benefits</th>
<th>Frequencies</th>
<th>Pearson correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fr.</td>
<td>t-test</td>
</tr>
<tr>
<td>Easily understanable Designs</td>
<td>92.3%</td>
<td>24, 91, 3</td>
</tr>
<tr>
<td>Speed of design</td>
<td>76.9%</td>
<td>17, 46, 6</td>
</tr>
<tr>
<td>Plausibility of design</td>
<td>61.5%</td>
<td>18, 07, 3</td>
</tr>
<tr>
<td>Impressive for clients</td>
<td>84.6%</td>
<td>18, 00, 7</td>
</tr>
<tr>
<td>New form development</td>
<td>53.8%</td>
<td>19, 02, 4</td>
</tr>
<tr>
<td>Reduction of mistakes</td>
<td>76.9%</td>
<td>18, 00, 7</td>
</tr>
<tr>
<td>Speed and Clarity of depiction</td>
<td>76.9%</td>
<td>22, 60, 3</td>
</tr>
<tr>
<td>Accuracy of result</td>
<td>69.2%</td>
<td>17, 54, 4</td>
</tr>
<tr>
<td>Design econom</td>
<td>46.0%</td>
<td>18, 00, 4</td>
</tr>
<tr>
<td></td>
<td>y</td>
<td>2%</td>
</tr>
<tr>
<td>---</td>
<td>----</td>
<td>-----</td>
</tr>
<tr>
<td>10. Ease of design modifications</td>
<td>92.3%</td>
<td>0.43</td>
</tr>
<tr>
<td>11. Digital product information</td>
<td>69.2%</td>
<td>-0.43</td>
</tr>
<tr>
<td>12. Improvement of communication between design and product</td>
<td>7.7%</td>
<td>0.12</td>
</tr>
<tr>
<td>13. Space savings at retail location</td>
<td>30.8%</td>
<td>0.08</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).
The highest percentage of those enterprises is, as far as it concerns being a legal institution, the S.A. type (46.2%). After that the, L.T.D., the P.L.C and the G.P. types have a similar but significantly lower than S.A.. percentage. The personal companies consist a small percentage of the total number of companies (Table 2).

The 75% of the enterprises that took part in the research have up to 30 employees. In particular, the 37.5% has up to 10 employees, the 37.5% of the enterprises has between 11 and 30 employees, while only 25% has more than 30 employees. Considering their education level the 81.8% of them are college graduates, and more specifically 54.5% are technical college graduates, 18.2% university graduates and 9.1% holds a Masters degree. Of those asked there is a percentage of 18.2% that corresponds to graduates of high schools and equivalent (Table 2). Finally, the structure of the enterprises that took part in the research, from the perspective of the level of the annual turn over is given in Table 2.

As for the occupation of the persons that filled the questionnaires on behalf of their enterprises, they are mostly (90%) either design directors (50%) or just designers that work in the design office (40%).

As for the age of persons that answered the questionnaire, they are classified in 2 groups. The 66.7% are 21-30 years old and the rest 33.3% 31-40 years old. This attests that 3D CG, as new technologies tools, are used from relatively young people. Those of younger age have better knowledge of the market of such software programs as there are 14 programs that are known from people within only 21-30 years old.

Table 2. The profile of the research’s enterprises

<table>
<thead>
<tr>
<th>A/A</th>
<th>Characteristics of the companies in study</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A.</strong></td>
<td><strong>Area of interest</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Production and trade of furniture</td>
<td>69.2</td>
</tr>
<tr>
<td></td>
<td>Industrial design</td>
<td>15.2</td>
</tr>
<tr>
<td></td>
<td>Modeling – Rendering – Animating</td>
<td>15.2</td>
</tr>
<tr>
<td><strong>B.</strong></td>
<td><strong>Company’s legal status</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S.A.</td>
<td>46.2</td>
</tr>
<tr>
<td></td>
<td>L.T.D.</td>
<td>15.4</td>
</tr>
<tr>
<td></td>
<td>P.L.C.</td>
<td>15.4</td>
</tr>
<tr>
<td></td>
<td>G.P.</td>
<td>15.4</td>
</tr>
<tr>
<td></td>
<td>Personal company</td>
<td>7.7</td>
</tr>
<tr>
<td><strong>C.</strong></td>
<td><strong>Educational Level of staff</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post-graduate</td>
<td>9.1</td>
</tr>
<tr>
<td></td>
<td>Graduate University</td>
<td>18.2</td>
</tr>
<tr>
<td></td>
<td>Graduate Technical College</td>
<td>54.5</td>
</tr>
<tr>
<td></td>
<td>Highschool and equivalent</td>
<td>18.2</td>
</tr>
</tbody>
</table>
D. **Annual turn over**

<table>
<thead>
<tr>
<th>Range of Annual Turn Over</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;1,000,000 €</td>
<td>44.4%</td>
</tr>
<tr>
<td>300,000 – 1,000,000 €</td>
<td>33.3%</td>
</tr>
<tr>
<td>100,000 – 300,000 €</td>
<td>11.1%</td>
</tr>
<tr>
<td>&lt; 100,000 €</td>
<td>11.1%</td>
</tr>
</tbody>
</table>

4. **Conclusion**

The two most powerful motives for the use of 3D computer graphics for furniture design seem to be the need for realistic visualization of the designs and the competition between the enterprises in the market. The initial decision for the use of 3D CG is taken in order to promote the enterprise. This is because the visual power of the graphical representation is highly regarded in today’s world of multimedia. At the same time, the competition begins to appear as a motivation, as those who gain a good experience with the use of 3D CG, can have further advantages. In general, in most cases, the tools of 3D CG are not essentially involved in the production of the design proposals and these tools are usually seen as something extra that it’s use in not mandatory. The use of digital design technology, as part of a complete information system, is for the time being, a privilege for only a few of the big enterprises.

The first important data that is acquired from the first contact is the familiarization with this software technology, the discovery of the capabilities that this offers and its expansion. Therefore, every time that a need comes forward, it is examined if it could be better completed by the design programs. It is slowly being discovered that the basic demands of the design procedure, like accuracy and speed, are characteristics that someone who uses this computer technology can have. The use of software leads to gradual discovery of the convenience that they offer, in their adoption and their acceptance as a tool for work.

However, the thing that usually captivates the use of such software is the discovery of its power as a production tool. One can easily realise that the implementation can be expanded not only in all phases of the design stage, but also in stages before and after that, such as marketing, production and sales., In the furniture sector, where the design is a fundamental characteristic element of the production, these software applications are a very important bridge between the artistic creation and the industrial design, while at the same time they consist an important management tool when it comes to large and complicated projects.

The goal is the continuous improvement of the graphics quality combined with low cost, as well as the development and exploitation of the capabilities and the advantages of the 3D design software beyond the design study. The relation of the study's designs with the materials for
promotion and advertising comes from two ways and this comes from the accuracy of the digital pictures, but also from the ability those have to approach the reality. Naturally, the digital 3D world can not substitute the sense that the reality gives, but an affluence of digital generated pictures. Furthermore, this can not substitute the creative experience that the designer has when she creates an idea. However, it gives tremendous capabilities of alternatives, modification and changes of the idea and offers a substance of really new capabilities to design.

The excess supply of design programs makes the choice of the most appropriate one for furniture design difficult. The phenomenon observed is the adoption of the most popular CAD software packages, something that in not irrational. The question is weather this is something useful, or differently, if it is the best solution. The specialized programs for furniture only, serve at the same time both the production and the sales, but they do not support research and the development of new products. However, it is important to take into account whether a software is going to be part of a comprehensive enterprise information system or not.

The cost for the implementation of 3D computer graphics in the furniture design depends on many factors. First of all, the extend of the implementation of the design study is crucial and after that also in other sectors. In any case it is clear that somebody can have very good results from the use of 3D CG, sparing only a small amount of money.

An important role has the education, through which educated handlers with demands are obtained. This is needed in a market that moves really fast and demands a continuous observation of the developments. Anyway, most of the users and especially the younger ones, seem to be enough up to date about the software that exist in the market, while they are completely familiar with the new technological definitions such as photorealism, 3D etc.

Generally, for most of the enterprises that took part in the research, it is found that they have a complete awareness of the benefit they can have from the use of 3D computer graphics programs. Almost all of them have a design unit, in which they use digital technology. This unit is mainly staffed from young people and in more of half of the enterprises from T.E.I graduates.

It is found that the benefits from the use of 3D graphics extend, apart from the design, to two other sectors, those of production and sales. The maximum benefit is achieved when the examination of the production procedures is being made through a complete informational system. Then, the additional benefits in the additional sectors are being added increasing the total benefit for the enterprise.

The majority of those using 3D graphics computer programs, believes that there is a benefit in the design and uses them in almost every kind of
furniture, in some of them less, in some of them more, emphasizing on the furniture categories that have a big degree of industrialization of their products.

The use of such programs is being preferred especially for the stages of the design study that have to do with the rational design and the final results, but many are those who use them as tools and for the study (esthetic, constructional) of the material and their behavior. Benefits appear in the reduction of the space of work, in the advantageous methods of storing and filing, in the easily conceivable designs, in the credibility of the 3D picture, in the creation of new shapes, in the speed of completion of the design process, in the attribution of different views from a 3D digital model, in the attribution of different options from a 3D digital model, in the clarity and accuracy of the designs, in the easiness in interfering and modifying them and in the eradication of mistakes in the creational and esthetic part of the study.

The thing that without doubt brings immediate financial benefit in the sector of design study is the time savings needed for its production, which is in average reduced in half.

An also high percentage of the users believe that there is a benefit in the sector of production. This comes from the reduce of the mistakes in the production, in the small number of trial models, in the simulation of the dynamic integrity checks, in the connection of the production with the sales, in the credibility of the product in relation with the designs and in the improvement of the communication between the design and the production.

The highest financial benefit results from the reduction in the production cost, almost 33%, because of the minimization of the errors in production.

Naturally, less are those who find out that the benefit from the use of 3D CG programs in the design comes in the sector of sales. This benefit is the same with the credibility of the designs, the complete comprehension of the designs, in the impact on the customers, the sense of individualization in the service to the customer, but also in the way the product is handled, in the capability for interfering for improvements in the stage of the design study. The sales, as known, are importantly helped by the advertising and the communication marketing. In both of those sectors, photorealistic illustrations are used very often, which have contributed in the increase in sales. It is a general belief that from the use of software comes an increase in sales and, because of that, a financial benefit.

5. Proposals

Beyond the things mentioned before, it additionally comes up that the researched software packages in the sector of furniture and the wood could
have very efficient implementations. The advertising use of 3D interactive
digital models is being suggested, instead of the static photorealism. It is
certain that those will have a greater effect on the prospective buyer, as
every one who is interested, will at least be able to rotate a furniture or be
rotated around this. Much more, if he is given the ability to browse a part
of the furniture (eg. to open a drawer or the door of a furniture) and have
experience and pictures equivalent to those of a visit in a furniture
exhibition. Also, the use of «ghost models», as they are called, could help
in the discovery of the hidden mechanisms, the method of assembly,
materials of inner contraction. The result would be the satisfaction of a part
of the consumers, without the necessity to have a complete model in every
showroom (which takes space).

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The role of built-in argumentation systems in computer-supported collaboration: An analysis using actor-network theory

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Abstract:  
In this paper we analyse the role of built-in argumentation systems in software platforms used for computer-supported collaboration in organisational settings undergoing strategic change. Using an actor-network-based frame of analysis, and by employing system dynamics modelling and simulation, we examine the role that different argumentation system features, such as providing wide accessibility and structuring the discourse space, and different representational modes of organisational power structures have on the effectiveness and the efficiency of change. We conclude that built argumentation systems that provide an enhanced and independent from existing positional power structures and dominant forms of argumentation discourse space contribute positively to the quality of the change effort.

Keywords:  
Argumentation, actor-network theory, organisational change, system dynamics, computer-supported collaboration
1. Introduction

This paper concerns the use of (technological) artefacts in the process of organisational change. Organisational change takes place at different functions and at different scales, and is the result of the fluidity of the external environment that induces a need for operational and strategic flexibility (Chakravarthy and White, 2002; Volberda, 2003). The latter is the driver of strategic change at corporate and functional level, whereas the former that of operational change, frequently expressed as operational improvement initiatives. In this article we concentrate on strategic change that can be defined as an attempt to align the organisation as a whole, or some of its functions (e.g. operations) with the external environment taking appropriate actions both internally and externally (Rajagopalan and Spreitzer, 1996). More specifically, we focus on a prosessualist perspective of strategic change that incorporates the dialectic and teleological models of the Van de Ven and Poole (1995) typology.

The approach that we adopt is the “strong process approach” which ontologically views organisations as consisting of “processes” rather than “things” (Tsoukas and Chia, 2002) and applies the process research approach for understanding organisational change (Tsoukas, 2005; Van de Ven and Poole, 2005). It adheres to the claim that process research methods are more appropriate for researching processes, especially when the focus of interest is in interaction between agents and technological artefacts at the micro level of agency. The ontological assumption is that organisations are not collections of individual “pieces” (human and nonhuman), but situation-specific webs of social relations in which technology enters and modifies, and, in turn, is modified (Taylor, 1993; Tsoukas and Chia, 2002). More specifically, we view strategic change as a continuous process of actor-network formation (Latour, 2005) whose generating translation activity involves extensive argumentation. Within the dialectic model of change (Van de Ven and Poole, 1995), we assume the existence of different, frequently conflicting, positions and the need for strategic conversation in decision making and consequent action. We aim to explore the role that different implementations of argumentation and different forms of institutionalisation in organisations have on change processes. We consider implementation and institutionalisation of argumentation because these two attributes influence not only the way problematic situations can be structured and/or through which the burden of information facilitating the management of wickedness can be tackled (Conklin, 2006), but because they can also contribute to the management of social complexity which is the result of different mental models and power imbalances (Ford and Ford, 1995; Corner et al., 1994), and which influences the effectiveness of change.
Our main concern is the exploration of the long term dynamics of change with respect to the support provided by collaboration-enhancing information and communication systems which define and structure the argumentation and negotiation discourse and provide information in context-specific formats. This investigation takes place under the assumption that change is an actor-network formation and maintenance process, in which translation is “the process of making connections, of forging a passage between two domains, or simply as establishing communication” (Brown, 2002). Within this translation process, we argue that argumentation is an important component whose long-term effect on the strategy and change processes has not been yet considered explicitly.

Methodologically, we use system dynamics modelling and simulation for this theory building enterprise. In general, simulation modelling as an organization and management theory development instrument, situated between pure deductive and inductive methods, can overcome the limitations of traditional approaches as far as their ability to analyse multiple interdependent processes operating simultaneously is concerned ((Davis et al., 2007; Harrison et al., 2007). In addition system dynamics modelling and simulation helps in theorizing about cycling relations between concepts and developing cyclic logic propositions.

The rest of the paper is organised as follows: We first briefly review the organisational change literature with a focus on the process approach. We then introduce our perspective of change as actor-network construction through a process of successive translations. Following, we discuss argumentation as a component of the process of translation. Then, we discuss the relation between collaboration-enhancing information and communication technology, argumentation, and organisational context, before we use the constructs developed for the construction of the system dynamics model. Simulations with the system dynamics model are used to develop our propositions, before we conclude our paper.

2. Organisational change: issues and approaches

The dialectic model of strategic (organisational) change is, in effect, a process-based model which maintains that strategic change in organisations is the result of competing theses which are adopted by or assigned to various types of agency: human, material and disciplinary. Theses create anti-theses which compete before arriving in synthetic positions that can be considered as temporary stabilizations of organisational processes. Organisational processes can be considered as a series of activities within which, as well as in their boundaries, agents having different positions/views are engaged in dialogues concerning (future) actions. In such a view, stability and change are explained in the same terms: stability is due to processes that maintain the organisation so
that it can be reified “as the same thing by some observer(s) while change occurs when the processes operate in manner that is reified by observer(s) as changing the organisation” (Van de Ven and Poole, 2005). In both instances, stability and change are judgments (social constructs), not real things, since the organisation is, in effect, a process that is continuously constituted and reconstituted (Rescher, 1996). Feldam (2000) has empirically shown how organisational routines, the supposed most stable part of an organisation, are not repeated stable patterns of behaviour but “emergent accomplishments”, flows of connected ideas and outcomes that perpetually interact and change in action.

The emergent accomplishments are the results of the development of consensus, or “accommodated” (Checkland, 1981) positions, which is one of the core activities of the strategic change process that does not take place in a political vacuum. Politics in the change process is important because “creating affective change and adaptation within the organisation depends upon effective use of politics” (Eisenhardt and Zbaracki, 1992). Inevitably, this “political” perspective leads to one of the central issues of change processes, that of the uneven distribution of power among organizational agents.

In the adopted, essentially structuration-oriented, perspective of change, the organisation structure defines power at agent level, while at the same time agency, by (re)defining the organisation structure, (re)distributes and (re)assigns power. Nevertheless, in acts of negotiation, argumentation and persuasion, which constitute the main elements of “political” activity in the process of change, power is not expressed only in a positional form. Rhetorical, or argumentation, power can also define agendas and manipulate decisions and actions towards specific directions. Positional power implies that arguments put forward by powerful organisational agents do not require extensive and rigorous justifications in order to be accepted. On the other hand, rhetoric power stems from the knowledge of the use of the organisation’s argumentation system (the types of arguments that are easily accepted) and/or the accessibility to information in comprehensive form so that it can be used to support arguments. The link between positional power and argumentation/rhetorical power is bidirectional (Bourdieu, 1984), i.e. positional power can impose specific forms of argumentation that are for the benefit of those having it, whereas rhetorical and argumentation power can result in new social structures, and consequently different positional power structures.

In the new forms of organisation of low hierarchies and low degrees of job specialisation, information is distributed within organisations in a unified form. Filtering for the specific needs, and the personal and work contexts of employees and managers is minimal (Sennett, 2006), thus indirectly, equating positional power with argumentation power. Here,
however, there is a role for technology. While some of the available networking and collaboration supporting software packages, such as Lotus Notes, contribute to this homogenisation in information distribution and to the conservation of power structures (Lilley et al., 2004), as we will see in a following section, other more sophisticated tools can act as the enablers of the enlargement of the strategic change discourse, as well as the enablers of positional power re-distribution.

The use of context-switching (or data presentation format switching) collaboration systems, brought to support strategic conversation either in a continuous ad hoc manner or in planned meetings and workshops, can facilitate the exposition of individuals’ mental models and motives and the development of synthetic views that generate new organisational knowledge. As we will discuss in a following section, this may result in a re-distribution of the rhetorical/argumentation power within the organisation. Consequently, an ICT-supported strategic conversation of high quality may suppress the imbalances of power, while not necessarily eliminating, or reducing the influence of the reasons that generate them. However, this has to do with the way the computer-supported collaboration system and its built-in argumentation mechanism are institutionalised and used. Section 4, in addition to presenting an overview of the relation between organization studies and argumentation, discusses this issue. Before that we present our actor-network-based perspective of organisation change.

3. Change as actor-network construction through a process of successive translations

Actor-Network Theory (ANT) is a discourse-analytical, process-based approach to technology-centred, or influenced by, social phenomena, but not only (Latour, 2005). Under an ANT lens, strategy and strategic change can be described and explained on the basis of the multidimensional dynamics of a network of actors and variables (Warzynski, 2006; Denis et al., 2007). The distinct feature of ANT is that it is a theory which includes under the same umbrella both human and non-human agents. In fact, ANT is an approach that has been developed to accommodate the role of technology (non-humans) in the process of knowledge construction and social change. ANT attempts to show how the relative strength of scientific truth is contingent upon the capacity of the producers of that knowledge (actors) to coordinate and align heterogeneous elements (other actors) in durable networks. Initially, ANT was developed for and used in the sociology of science and in studies of technology policy (Callon, 1986; Law and Callon, 1992), where it was found that successful policy implementation requires the support of extensive networks and mediators for accomplishing the required changes. Hence, ANT maintains, in order to
initiate change, leaders and managers must understand the context and the networks within which change takes place and must build on the interests of others to eliminate the inertia through a common, agreed social reality. Therefore, ANT adheres to an agency-based translational model of power and change, in which the competency and power of inducing change, in the long run, stems from the network (actant) rather than from the leader (or any other actant/agent) who is just an aspect of the network and is embedded in it.

Networks include both human and non-human elements, such as machines, software, texts, etc. The network is configured through the enrolment of (human and nonhuman) allies into a network by means of negotiation (Grint and Woolgar, 1997). Actants construct new relationships with other actants through a process of translation. Translation is the ability of actants to keep other actants involved in change processes of any kind by translating their interests, needs, values and efforts into their own language. Translation occurs through communication and interaction between acts and is a four-stage (‘moments of translation’) process of problematisation (an actant – e.g. an initiator of change – defines a problem in such a way that can be recognised as problem of the others and proposes a discourse for its solution), interessesment (gradual dissolution of existing networks and their replacements by a new network created by the enrollers – role assignment and commitment for action guarantees by others), enrolment (coordination of actions by negotiation, persuasion, seduction, etc. to achieve the network a solid identity), and mobilisation (communication and creation of centres for translation to entice new members-actants in the network, i.e. the alliance is “mobilised” to represent an even larger network of absent identities). It should be noted that the notion of translation is different from that of diffusion in that in translation the initial idea, meaning, proposal, artefact, etc, around which the network is formed, changes as it travels in time and space through successive translations (Brown, 2002).

For example, through the lens of ANT, changing the manufacturing strategy of an industrial machinery producer towards increased flexibility would require a four-stage activity. First, the initiators of strategy, for instance the production managers, would have to persuade other managers, as well as workers and non-human agents, such as sales reports, production plans, etc, that the solution to the manufacturing strategy problem lies with them rather than with corporate management or external consultants. Secondly, any new networks forming that are in opposition with the aims of the network under consideration must be dissolved and actors should be attracted to the network. For example, if the marketing function is trying to form a network with corporate management and some members of the production function to promote the idea that the problem is in marketing
initiatives rather than in production capabilities, this network must be blocked and its actors and potential actors should be attracted to join the manufacturing strategy actor-network. Third, the network should be solidified as a single identity by, for example, issuing a formal plan or by producing a SWOT analysis, or a technical assessment, resulted from the network “members” collaboration. Finally, the network would act as a representative of the whole company in negotiations and potential transactions with vendors of flexible machinery which is required for achieving the strategic objective of flexibility.

Actor-network theory stresses the contingent nature of networks and network building. There is a constant need to establish and reproduce the network (Grint and Woolgar, 1997). Since networks that are based solely on human relations tend to be weak, material embodiment seems necessary. For example, the installation of flexible machinery may act as the binding element of the actor-network. The same role may be played by software-based collaboration platforms which inscribe (Latour, 2005) the negotiation and argumentation logic used in the network construction process. But, although argumentation and negotiation are core activities of the different phases of translation, so far they have not considered and researched explicitly. This is despite the fact that the methodological relation between strategizing micro-activities (the strategy as practice approach) and ANT has already been identified (“how strategy manifests itself in practice, how it becomes mobilised and stabilised through processes of heterogeneous association” (Steen et al., 2006)).

Based on the above, in an actor-network theory perspective, argumentation systems as formal built-in functions of computer-supported collaboration systems, or as informal organisational entities, constitute actants in a strategic change network formation. They constitute actants that are necessary as allies for attracting other actants in the network initiated by the initiators of change. As we will see in section 5, there are different attributes of argumentation systems per se, the way they are institutionalised within the organisation context, as well as the way they are embedded in the strategic change process, which influence the degree of effectiveness of the change process manifested in the efficiency with which translations are accomplished, i.e. how associations/linkages among actants are constructed.

4. Argumentation in translation and strategic change management

It is a decade since the gap in academic research between management and argumentation has been identified (Sillince, 1999). However, since then, very little research has been undertaken towards establishing argumentation as an important part of organisation and management
studies. Argumentation has always been on the fringe of management and organization studies, probably because of the bias of the field towards macro or meso-level perspectives. The recent shift of interest towards micro-level perspectives (Whittington, 2006), is gradually introducing argumentation in the study of organizational processes, including those of strategic change, and may eventually establish it in the core of its body of knowledge.

The purpose of an argument is to show that a nontrivial assertion may claim validity, whereas nontrivial assertions are propositions whose validity is not obvious without further details and cannot proved or verified by evidence (von Werder, 1999). Argumentation is a context-based sense-making process (Weick, 1995) which varies according to (socially) constructed rules and (social) groups. According to Bloor (1978), characteristic forms of argument will emerge in a social setting, standing out by their frequency (e.g. when in a specific organisation seeking argument justification is always with reference to a specific report, or with reference to what the industry leaders do, etc). Inevitably, this gives each social structure its dominant argumentation repertoire of explicit legitimation which solidifies and increasingly constrains social and organisational behaviour, and is used for characterising and evaluating actions, events and other organisational phenomena “which are often organised around specific metaphors and figures of speech” (Potter and Wetherell, 1987). As a result, institutionalised justifications exist as objective, widely available rules, which, directly or indirectly, tell organisation members how to argue. Clearly, the institutionalization process of the argumentation form is not a positional- and rhetorical-power-neutral process. Organisation members with high organisation power need not justify the arguments extensively, while those with rhetorical power may bias the organisation discourse, both in the short and long term, towards specific forms that have more affinity with the institutionalised argumentation forms weakening other forms, which however include more substantive arguments.

Excessive use of positional and rhetoric power results in lowering the quality of the organisation’s decisions and actions, and lowers the efficiency and effectiveness of the process of translation in actor-network formation. The quality of decisions and subsequent actions, in our case, the quality of translations, is a function of the argumentation rationality, i.e. the thoroughness of the decision preparation as revealed by the arguments put forward to support the decision (von Werder, 1999), or the translation process. There are two groups of determinants of the soundness and convincing power of argumentations: the depth and the breath of an argumentation are the structural determinants, and the quality and quantity of arguments serve as determinants of the substance of argumentation. The
quality of arguments is determined by differentiating them as being true, false, well-tried, possible, etc. The quantity can be determined by indexes such as ratio of pro to contra arguments, as well as by the mode of the solution of conflicts between pro and contra arguments (von Werder, 1999). Positional and rhetorical power may obscure these measures towards the production of false assessments.

In the following two sections we aim to investigate whether information and communication technologies in the form of groupware (computer-supported collaboration) and collaborative problem-solving systems enhance or deter the quality of argumentation, translation and eventually strategic change.

5. Computer-supported collaboration systems with built-in argumentation functions in organisational settings

Since the late seventies, for many, the bringing together of information and communication technologies in the form of computer-mediated communication systems (or groupware), has been viewed as a step towards more democratic organization structures, towards elimination of formality, better accessibility to corporate issues and wider participation in decision making (Hiltz and Turoff, 1978). Since then, a number of system designs and implementations have been proposed with different degrees of sophistication and a variety of features, but their accessibility and institutionalisation in real organisation settings is still at an embryonic phase. The late generations of such systems are directed towards collaborative problem structuring and resolution and knowledge management building on the fact that social capital (connectivity, commitment and trust) leads to intellectual capital (Nahapiet and Ghoshal, 1998).

The advantages of the use of computer-supported collaboration systems instead of face to face encounters include the immediate availability of different forms of data (video, text, computer simulations, etc.) and the ability to generate a continuous record of any exchange, which in the long run, we can say that it constitutes a substantial organisational memory. However, the form of discussion/communication and the way of storing meetings and encounters have a decisive effect on the way groupware systems are institutionalised in organisations. Managers and employees participate more productively in meetings and decision-making sessions when they have a clear idea of the issue, and what it means to them as organisation members and as thinking citizens. Clearly, systems that provide context- and user-specific views of the issue in hand (e.g. how a problem looks for a marketing executive is different from that of an accountant) are likely to be more acceptable than others that provide only a limited number of homogeneous views. The same holds
for the capabilities of the systems as far as expressing views in different formats is concerned. Formalisation of communication is another issue. Some issues are dealt better in an informal and wordy way, whereas others may require more formal structures to reach decisions or consensus more productively through formal logic argumentation and rule-based conflict resolution (Karacapilidis and Tzagarakis, 2009).

The mechanisms and the results of summarizing dialogues also matter. Specific organisations are more comfortable with an organisational memory which is not too detailed (who said what when and how) (Lilley et al., 2004), whereas other require detail. This may change with time, or according to the issue. Hence, the groupware system should be flexible enough to allow for different ways of summarizing. Finally, a key issue on the institutionalisation of computer-supported collaboration systems is that of the accountability of their use. That is, how accountable are meetings, or sessions, where anonymity in expressing views and voting may overturn opinions and practices imposed by those having positional power. Hence, technology can either amplify existing power structures or demolish them inducing more democratic access to arguments and distributed argumentation power.

In summary, there are particular features of collaboration systems that matter in the institutionalisation and in their consequent use in the argumentation/translation process. These features when enabled may enhance the quality of decisions/translations in the long run as they augment argumentation rationality. In the next section, using a system dynamics simulation model, we theorise on this generic proposition.

6. Theorizing on the role of built-in argumentation systems in computer-supported collaboration

In this section we build up on the discussion so far to develop a system dynamics simulation model to investigate the role of built-in argumentation systems in computer supported collaboration in the change process. We focus on the characteristics discussed above to theorize on the relation between the argumentation features of the collaboration-enhancing information system and the quality of organisational change as a result of the durability of the actor-network formed.

In employing system dynamics, or any other simulation approach, in the organisation and management studies theory development process, the main idea is to introduce experimentation laboratory conditions in social systems research. In a rather formal way, Campbell (1990) defines theory as a “collection of assertions, both verbal and symbolic, that identifies what variables are important and for what reasons, specifies how they are interrelated and why, and identifies conditions under which they should be related”. From a different perspective, DiMaggio (1995) argues that theory
is “an account of a social process, with emphasis on empirical tests of the narrative as well as a careful attention to the scope conditions of the account”. However, independent of its assumed focus and the emphasis given, most scholars of theory development agree that theory consists of constructs, propositions that link constructs together, logical arguments that explain the propositions using existing widely accepted theories, and assumptions that define the (restricted) area within which the theory is valid (Davis, et al., 2007). The process of theory development is the process by which all four elements are bound together, having in mind possible, or even actually carrying out in parallel, the evaluation of theory by means of either testing the ability to explain variance of a variable or a criterion, or by assessing the richness of the theory and its fit with empirical data, or by testing its fit with empirical data (Eisenhardt, 1989).

Figure 1 below shows the system dynamics model developed on the basis of the discussion presented in sections 2, 3, 4 and 5, where the constructs, propositions, logical arguments and assumptions of the theory we are developing were outlined. The model was developed for reifying the abstract proposition made at the end of section 5. The dynamics of the stock quality_of_argumentation depend on the accessibility that managers and employees have on the argumentation discourse, as well as on the structure of the argumentation discourse. These depend on the features if the collaboration information system (ICT), which supports accessibility and structured dialoguing, but also on the way this technology is institutionalised in the organisation. The latter is assessed on the basis of the degree of representation of existing positional and rhetorical power structures and repertoires, repetitively. That is, how the information technology artefact neutralises them and provides a more democratic discourse space.
The quality of argumentation influences positively the strength of argumentation (strength_of_arguments) and consequently the quality_of_translations, and the durability of the actor network (durability_of_AN). The quality of argumentation influences negatively the positional power and the rhetorical power of those involved in the different phases of translation. Argumentation of low quality, principally based on dominant rhetorical repertoires and positional power structures, further strengthens the positions and the views of those actors that possess them and know better how to use them. Opposite effects on existing structures and repertoires have the results of high quality argumentation, i.e. quality translations and inevitably durable networks.

The degree of institutionalisation of the ICT system influences the level of inscription of translations and the durability of the actor-network. On the other hand, the durability of the actor-network which was the result of high quality argumentation, and which results in an effective and efficient change process, increases the institutionalisation and use of the collaboration technological artefact, which in turn augments the accessibility and the structure of the discourse space.

Clearly, the behaviour of the model is governed by a dominating re-enforcing loop, whose dynamics are determined by the external to the loop variables ICT_features (i.e. the degree of support to accessibility and structure of the discourse space), and dependence_coeff which denotes the degree of representation of existing organisational structures and dominant
argumentation repertoires/forms on the implementations of the collaboration technology.

After scaling the model appropriately, and after validating it by testing extreme conditions, simulations were executed to “empirically” investigate and reify the generic proposition of section 5. Figure 2 shows the effect of representational dependence (dependence_coeff values 1, 0.5 and 0.2 – the higher the value the more the dependence) on actor-network durability and consequently on the quality of the change effort. What is clear is that lower dependence values increase the durability of the network (assuming that the collaboration system fully supports the requirements for accessibility and structure of the discourse space (ICT_features value of 1).

Figure 2: Effect of variable dependence_coeff on actor-network durability

Figure 3 below shows the effect of ICT_features on the effectiveness and the efficiency of change. Assuming medium representational dependence (dependence_coeff value of 0.5) and varying the ICT_features from 0.2 to 1 through 0.5, we observe that in the long run the more extensive implementation of the characteristics of the ICT collaboration artefact the more its contribution to the actor-network durability (traces 1, 2, and 3, respectively).
Hence, we can say that these results support our generic proposition of section 5, which can now be stated in more precise way, as below:

**Proposition 1:** Built-in argumentation systems in computer-supported collaboration environments that support wider employee accessibility and structure the discourse space when employed in a change effort can contribute to the outcome of the effort in a positive way.

### 6. Conclusions

In this paper we examined the role of built-in argumentation systems in software platforms that are used for computer-supported collaboration in organisational settings undergoing strategic change. Using an actor-network-based frame of analysis, and by employing system dynamics modelling and simulation, we examined the role of different argumentation system features, such as providing wide accessibility and structuring the discourse space, as well as different representational modes of
organisational power structures have on the effectiveness and the efficiency of change. Based on the analysis presented in the paper, we can conclude that built argumentation systems which provide an enhanced and independent from existing positional power structures and dominant forms of argumentation discourse space contribute positively to the quality of the change effort.

References


An approach to facilitate decision making in an integrated design environment

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Abstract:  
Increased use of high end technology combined with an effort to respond to customer needs and specifications suggests that it has become the standard for design engineers to select a lead design among many possible alternatives, by considering multiple criteria from different domains. This process of decision making not only considers evaluation measures with respect to design alternatives, but also considers the uncertainties and randomness caused by environmental factors, human behavior, and nature of the data. While it is not possible to eliminate all the causes of uncertainty, a good portion of decision uncertainties are tied to the “Decision Maker (DM)”. The DM’s uncertainty usually reflects itself in the weight assessment phase, where the background of the DM is the sole point of influence. In addition, personality and disposition of the DM, the process that the DM follows in keeping the decisions consistent with the initial goals may lead to ill conceived solutions. To eliminate the effect of the DM’s personality a weight assessment technique is proposed in this study. This Hierarchical Weight Assessment (HWA) technique, assigns weights based on the design attributes’ hierarchy and certainty equivalence. The use of the HWA method will be demonstrated with a Gear Pump center housing design selection example, where design alternatives are evaluated with respect to different evaluation measures. To be able to fully assess the effectiveness of the proposed HWA method, the case study is performed with both deterministic and probabilistic data, followed by sensitivity analysis.

Keywords:  
Decision-making, Weight Assessment, Design, Hierarchy
1. Introduction

Decision making has gained tremendous importance as more engineering decisions are being based on multiple criteria in an effort to respond to market needs and to surpass competition. Hazelrigg (1998) highlighted the decision rule as: identification of options, determination of expectations on each option and an expression of values. Wan and Krishnamurty (2001) stated that the preferred decision is the option whose expectation has the highest value. In decision problems, knowing the exact value of each alternative will enable the DM to rank the alternatives properly. However not all decisions are performed under utter certainty therefore inconsistencies may occur when ranking alternatives.

In multi criteria decision making, weight assessment may differ from one DM to the other based on the DM’s personality, decision conditions and environmental factors. Over the years researchers mentioned the importance of rationality of the “DM”. Hazelrigg (1998) stated that an irrational person would not make a decision that is compatible with his/her stated preferences, where Franssen and Bucciarelli (2004) approached the matter from a different perspective stating that deciding whether or not to be rational is a decision itself, and in engineering design to be rational means to be instrumentally rational. Thurston (2001) stated that the decision theory is built on a set of axioms of rational behavior whereas Thornton (2001) examined DM’s behavior from optimistic and pessimistic perspectives.

Utility theory is a vastly used tool in decision making, and was first introduced by Von Neumann and Morgenstern (1947). Keeney (1973) used utility theory to perform a multi objective decision analysis to select strategy for developing the airport facilities, and Keeney and Raiffa (1976) used a utility model to perform the decision process, however it was assumed that the DM’s preferences are certain, and values are deterministic. Nikolaidis (2007) examined reliability design methods and used utility theory to develop a decision method. Wassenaar and Chen (2001) concluded that when using utility theory with three or more alternatives with multiple attributes, normalizing procedures, weighting methods, ranking methods and multi attribute utility functions can be used but cannot guarantee unambiguous alternative selection. Michalek and Papalambros (2004) proposed an iterative method for finding weighting coefficients whereas Zhang, Chen and Chong (2004) asked DMs to express their preferences on a variety of criteria using any of the offered preference formats, while the DMs can enjoy the flexibility in expressing their opinions with their most favorite formats, in the proposed method uniformity, aggregation, and exploitation would generate valid decision results. Salo and Hamalainen (2001) presented the PRIME method, which seeks to strike a balance between the theoretical soundness of the tradeoff
method and the functionality of decomposed ratio judgments. Alfares and Duffuaa (2008) proposed an empirically developed method where the weight is expressed as mathematical function of its rank. Kirkwood (1997) presented the use of a value based alternate approach, where the weight values may change based on the initial preference selection. The objective of this effort is to examine vastly used weight assessment methods and propose a new weight assessment method to address how realistic does each weight assessment method perform under deterministic and probabilistic environments while taking the DM’s preferences into consideration.

For approaches such as the Swing Weight (SW) method and the Analytical Hierarchy Process (AHP) the DM’s judgment on weight assessment is based on the ratio properties. Von Winterfeldt and Edwards (1986) proposed the SW approach, where the attributes are graded between 0 – 100 points depending on their relative importance from one over the other. The SW method depends highly on the DM’s judgment, therefore the outcome of the weight estimation is subject to change based on DM’s rationality.

\[
\sum_{i=1}^{n} w_i = 1 \quad i = 1,2,\ldots,n
\]  

Saaty (1990) proposed the AHP, where a multi criteria decision making problem is divided into groups of hierarchical pair-wise decisions. Both the SW and the AHP are built on the fact that the DM has enough information and knowledge to perform comparisons among alternatives; however this is not always the case. In some decision problems, the DM might only be able to provide ranking of the criteria as oppose to pair-wise comparing them.

Today’s developed rank order methods base on the Equal Weights (EW) method proposed by Dawes and Corrigan (1974). The basis of the equal weights approach is that the summation of all weights should add up to one, and the numerical weight values should be equal. The EW method provided weight estimation based on number of criteria considered for the decision process. Even though this method has been used to solve several decision problems, the outcome will only change if more or less criteria are used to perform the decision process.

\[
w_i = \frac{1}{n}, \quad i = 1,\ldots,n
\]  

When calculating the weights for EW method as shown in Equation 2, \(n\) denotes the number of evaluation measures and \(w_i\) is the weight value.
Einhorn and McCoach (1977) proposed the Rank Sum method (RS), where the hierarchical importance of attributes is weighted accordingly to their ranking in the hierarchical order. The RS method takes hierarchical ordering of weights into consideration and bases the weight estimation process on that ordering.  

\[ w_i = \frac{2(n - i + 1)}{n(n + 1)}, \quad i = 1, \ldots, n \]  

(3)

For the RS method weight calculation, Equation 3, n, and \( w_i \) denotes the number of evaluation measures and the weight value each measure respectively.

Barron and Barrett (1996) developed the Rank Order Centroid Method (ROC), where the proposed ROC formulation considers attribute weights with the ranking information. The ROC Method provided a weight estimation technique that takes hierarchical ordering of criteria into consideration and provides a steeper outcome than the Rank Sum method.  

\[ w_i = \frac{1}{n} \sum_{l=i}^{n} \frac{1}{l}, \quad i = 1, \ldots, n \]  

(4)

Once the weights are obtained, sensitivity analysis will be carried. Liberatore and Nydick (2003) defined sensitivity analysis as an information provider on how changes to the components of a model impact the output solution. All the existing methods do provide a valid way to estimate the weights, however not all methods are applicable for both deterministic and probabilistic conditions. In this paper, the authors propose a weight assessment method, which will be able to provide reliable weight values for both deterministic and probabilistic cases, followed by sensitivity analysis.

2 Hierarchical Weight Assessment Method

The Hierarchical Weight Assessment (HWA) Method is built on the roots of an alternate approach proposed by Kirkwood (1997). This alternate approach states that the overall value of the decision will be the same regardless of changes in the number of evaluation measures and provides a way to determine the weights. Kirkwood’s method is based on moving the preferred evaluation measure from its least preferred value to its most preferred value. In Kirkwood’s approach, it is the DM’s call to determine the order of the evaluation measures that will be moved from their least preferred to their most preferred levels, which may change from one DM to another, resulting in differences in weight assessment. It was also proposed that the second most preferred evaluation measure should be moved from its least preferred to its intermediate value. Doing so will fail
when there are more than three alternatives since no computation method was provided for the “intermediate level”.

In the proposed HWA approach, a preset evaluation measure selection template is used. The template provides a roadmap of which equations will be built in which order. With the use of the HWA approach it is also possible to perform weight assessment independent of the nature of the data. In manufacturing and production applications having a deterministic value is not always the case; the dimensional values, stress values, time and cost may have probabilistic distributions. Based on this, the ideal weight assessment technique should work for both deterministic and probabilistic cases. In this manner, the certainty equivalent (CE) will be utilized to demonstrate the HWA method. Weights will be calculated and compared both for deterministic and probabilistic values using the SW, EW, RS, and the ROC methods. Comparison of the weights obtained from different methods will demonstrate how the weight assessment varies between methods.

2.1 Building Hierarchical Weight Assessment Method

In the proposed HWA approach, scenarios are built based on the CE of the expected utilities. The number of equations to be built in the HWA method is determined by the number of unknown weight values. Creating same number of equations as the unknowns will provide a solution for each unknown. If there are four evaluation measures considered for a decision making problem, three of those equations will be based on the value and the last one will be the summation of all weights to unity. Equations 5a-b-c show the overall equality of the value functions, the formation of value equivalence and summation of the weights respectively.

\[ v(A_1, A_2, A_3, \ldots)_i = v(A_1, A_2, A_3, \ldots)_j \]
\[ (\mu_1u(CE)_i + \mu_{n2}u(CE)_2 + \ldots)_i = (\mu_1u(CE)_i + \mu_{n2}u(CE)_2 + \ldots)_j \]
\[ \sum_{\mu=1}^{n} \mu = 1 \]

Table 1 shows how the scenarios are built; where \(\mu_1, \ldots, n\) denotes the weight for each evaluation measure, \(n\) being the number of evaluation measures where \(CE_M, CE_H, CE_L\) denote the median, highest, lowest CE values respectively.
The calculation of certainty equivalence values differ based on whether lower or higher values are preferred.

\[
CE = \left\{ \begin{array}{ll}
-\rho \ln E[\exp(-x/\rho)], & \rho \neq \text{Infinity} \\
E[x], & \text{otherwise}
\end{array} \right.
\]

\[
CE = \left\{ \begin{array}{ll}
\rho \ln E[\exp(x/\rho)], & \rho \neq \text{Infinity} \\
E[x], & \text{otherwise}
\end{array} \right.
\]

Equations 6a-b show certainty equivalent calculation when higher and lower amounts are preferred, respectively where x being the current value. Both calculations have two variations depending on the exponential constant (\(\rho\)). For deterministic values \(\rho\) always equals to infinity and for probabilistic distributions \(\rho\) takes a value other than infinity. Calculating \(\rho\) is based on if lower or higher values are preferred and can be obtained by setting \(v(x) = 0.5\), \(v(x)\) being the value function. In Equations 7a-b, “low” and “high” denote the lowest and the highest possible level that x can take; using these equations \(\rho\) can be obtained to be implemented in Equations 6a-b.

This approach enables the DM to define the upper and lower limit of the collected samples based on standard deviation and enables the DM to implement the sample mean to the formulation.

### 3 Case Study: Gear Pump Center Housing Design Selection

External gear pumps are the most common type of gear pumps used in hydraulic applications. The Liquiflo Gear Pump (Liquiflo Manual, 2005), its simplified design, the solid model along with the design alternatives are shown in Figure 1. This illustrative example will focus on the design selection associated with the center housing design alternatives. The first design alternative (D1) is a two-piece design with 4 screw-holes, the
second design alternative (D2) is a one-piece design with 8 screw-holes, and the third design alternative (D3) is a one-piece design with 4 screw-holes. Since proper alignment of the gear-train, steady flow-rate and prevention of leakage are all tied to center-housing, the alternatives will be evaluated for five different evaluation measures: manufacturing time, maximum stress, weight, manufacturing cost and confidence level.

In this case study the weight assessment will be performed for deterministic values (Part A), and for probabilistic values (Part B) followed by a comparison of the HWA method with other weight assessment methods and a sensitivity analysis.

Manufacturing time, maximum stress, weight and manufacturing cost can be directly measured and calculated, however confidence level cannot be directly measured from the design. The confidence level is defined as the design engineer’s confidence in the design alternative to provide the expected results. Each design alternative’s confidence level will be obtained with Failure Modes and Effects Analysis (FMEA). The FMEA calculations are a combination of design FMEA and manufacturing FMEA for each alternative. The design FMEA will focus on design irregularities and failures and the manufacturing FMEA will focus on whether the manufacturing method is meeting the requirements, and if the selected manufacturing operation is causing additional failures. Figure 2 shows how the design and manufacturing couples are formed, \( F_N \) denotes the failures where \( D_N \) denotes the design alternative and \( M_N \) denotes the manufacturing technique. From the outcomes of Figure 2, a detailed
couples table can be formed as shown in Table 2. The table shows the utility values for the design alternatives and manufacturing techniques and a combined utility of these two utilities as the confidence level. As it can be concluded, Manufacturing technique 1 (M1) provided the highest utility values for all design alternatives and for the remainder of the paper M1 will be used.

![Figure 2: Design - Manufacturing Couples for FMEA](image)

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>U(RPM)D</th>
<th>U(RPM)M</th>
<th>Confidence Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1-M1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>D1-M2</td>
<td>0.00</td>
<td>0.96</td>
<td>0.00</td>
</tr>
<tr>
<td>D2-M1</td>
<td>0.74</td>
<td>0.64</td>
<td>0.47</td>
</tr>
<tr>
<td>D2-M2</td>
<td>0.74</td>
<td>1.00</td>
<td>0.74</td>
</tr>
<tr>
<td>D3-M1</td>
<td>1.00</td>
<td>0.96</td>
<td>0.96</td>
</tr>
<tr>
<td>D3-M2</td>
<td>1.00</td>
<td>0.50</td>
<td>0.50</td>
</tr>
</tbody>
</table>

3.1 Case Study A: Deterministic Design Selection Process

Deterministic approaches consider design measures to be single valued. Even though it is almost impossible to have deterministic values in manufacturing applications, in some cases for ease of calculation and decision-making, single values are considered. Deterministic values for all evaluation measures are shown in Table 3.
In order to implement the HWA method for this deterministic design selection process, the design engineer needs to obtain certainty equivalents of the value functions. Certainty equivalents are calculated using Eqs. 6a-b and 7a-b followed by Equations 5a-b-c and Table 1. The HWA method can be carried out for any hierarchical ranking.

Two different hierarchical rankings have been considered in this case study and their outcomes are shown in Table 4. From the outcomes it can be concluded that the calculated weight values are consistent with the defined hierarchical rankings, and the steepness of the weight values subject to change as the hierarchy changes.

### Table 3: Deterministic Design Values

<table>
<thead>
<tr>
<th>Evaluation Measures</th>
<th>Lowest</th>
<th>Highest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mfg. Time (min)</td>
<td>28</td>
<td>32</td>
</tr>
<tr>
<td>Max Stress (MPa)</td>
<td>90</td>
<td>110</td>
</tr>
<tr>
<td>Weight (grams)</td>
<td>262</td>
<td>340</td>
</tr>
<tr>
<td>Mfg. Cost ($ )</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Risk Priority Measure</td>
<td>290</td>
<td>560</td>
</tr>
</tbody>
</table>

Weight calculation using the HWA method itself will not provide if the proposed method is valid. Therefore the same problem will be solved by the SW, EW, RS, and ROC weight assessment methods for both rankings. Tables 5 and 6 show the weight values for all methods for the 1st and the 2nd ranking respectively.

### Table 4: HWA Ranking Comparison

<table>
<thead>
<tr>
<th>Evaluation Measures</th>
<th>Case One</th>
<th>Case Two</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hierarchy</td>
<td>Outcome</td>
</tr>
<tr>
<td>Mfg. Time (Min.)</td>
<td>1</td>
<td>0.671</td>
</tr>
<tr>
<td>Max. Stress (MPa)</td>
<td>2</td>
<td>0.168</td>
</tr>
<tr>
<td>Weight (grams)</td>
<td>3</td>
<td>0.092</td>
</tr>
<tr>
<td>Mfg. Cost ($)</td>
<td>4</td>
<td>0.034</td>
</tr>
<tr>
<td>Risk Pr. Measure</td>
<td>5</td>
<td>0.036</td>
</tr>
</tbody>
</table>

### Table 5: Weight Assessment Method Outcomes–1st Ranking (Deterministic)

<table>
<thead>
<tr>
<th>Evaluation Measures</th>
<th>Rank</th>
<th>SW</th>
<th>EW</th>
<th>RS</th>
<th>ROC</th>
<th>HWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mfg. Time (min)</td>
<td>1</td>
<td>0.40</td>
<td>0.20</td>
<td>0.33</td>
<td>0.46</td>
<td>0.67</td>
</tr>
<tr>
<td>Max Stress (MPa)</td>
<td>2</td>
<td>0.24</td>
<td>0.20</td>
<td>0.27</td>
<td>0.26</td>
<td>0.17</td>
</tr>
<tr>
<td>Weight (grams)</td>
<td>3</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.16</td>
<td>0.09</td>
</tr>
<tr>
<td>Mfg. Cost ($)</td>
<td>4</td>
<td>0.12</td>
<td>0.20</td>
<td>0.13</td>
<td>0.08</td>
<td>0.03</td>
</tr>
<tr>
<td>Risk Priority Measure</td>
<td>5</td>
<td>0.04</td>
<td>0.04</td>
<td>0.07</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>
It can be seen in Table 5, that the SW method’s outcome was based on the DM, who chose from a 0-100 scale (100,60,50,30,10) respectively. The EW method considered all the evaluation measures are equally important, eliminating the uncertainty of the DM. The RS method provided a somewhat flat output; all the weights are almost same increment apart from each other. The ROC method makes up for the steepness missing in the RS method. The proposed HWA method provided the steepest weight assessment. When the rankings have changed (Table 6), it can be seen that the weight values obtained through the SW, EW, RS and ROC methods are re-distribution of the same weight values obtained in the 1st ranking (Table 5). On the other hand the HWA method did not re-distribute the pre calculated weight values, instead provided a new set of weights based on the new ranking and the CE values. Even though the RS and the ROC methods both considered the hierarchical rankings, HWA method provided both hierarchy and value based outcomes.

### Table 6: Weight Assessment Method Outcomes–2nd Ranking (Deterministic)

<table>
<thead>
<tr>
<th>Evaluation Measures</th>
<th>Rank</th>
<th>SW</th>
<th>EW</th>
<th>RS</th>
<th>ROC</th>
<th>HWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mfg. Time (min)</td>
<td>4</td>
<td>0.12</td>
<td>0.20</td>
<td>0.13</td>
<td>0.09</td>
<td>0.06</td>
</tr>
<tr>
<td>Max Stress (Mpa)</td>
<td>3</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
<td>0.15</td>
<td>0.11</td>
</tr>
<tr>
<td>Weight (grams)</td>
<td>1</td>
<td>0.40</td>
<td>0.20</td>
<td>0.33</td>
<td>0.45</td>
<td>0.59</td>
</tr>
<tr>
<td>Mfg. Cost ($)</td>
<td>5</td>
<td>0.04</td>
<td>0.20</td>
<td>0.07</td>
<td>0.04</td>
<td>0.01</td>
</tr>
<tr>
<td>Risk Priority Measure</td>
<td>2</td>
<td>0.24</td>
<td>0.27</td>
<td>0.27</td>
<td>0.25</td>
<td>0.23</td>
</tr>
</tbody>
</table>

In the second part, probabilistic distributions for the design alternatives will be used. The distribution range, standard deviation of the sample set and the mean value of the distribution will be taken into consideration.

Obtaining the weight values using the HWA method requires the DM to individually set the limits of the distribution range for every single evaluation measure.
For this case study the values that fall into ±3σ range from the sample mean will be considered. Table 7 shows the design values, sample means, standard deviations and the ±3σ range limits for the evaluation measures, and Table 8 shows the utility values along with sample mean, range and standard deviation for the design values.

### Table 7: Values, limits, $\sigma$ - Probabilistic Distribution

<table>
<thead>
<tr>
<th>Evaluation Measures</th>
<th>Design 1</th>
<th>Design 2</th>
<th>Design 3</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mfg. Time</td>
<td>32</td>
<td>31</td>
<td>26</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>31.95</td>
<td>30.97</td>
<td>27.99</td>
<td>Sample Mean</td>
</tr>
<tr>
<td></td>
<td>0.296</td>
<td>0.295</td>
<td>0.2643</td>
<td>St. Deviation</td>
</tr>
<tr>
<td></td>
<td>99</td>
<td>110</td>
<td>90</td>
<td>Mean</td>
</tr>
<tr>
<td>Max. Stress</td>
<td>98.98</td>
<td>109.94</td>
<td>90.05</td>
<td>Sample Mean</td>
</tr>
<tr>
<td></td>
<td>0.327</td>
<td>0.31</td>
<td>0.2907</td>
<td>St. Deviation</td>
</tr>
<tr>
<td></td>
<td>97.999-99.951</td>
<td>109.018-110.875</td>
<td>89.179-90.923</td>
<td>Low Lim - Upp Lim</td>
</tr>
<tr>
<td>Weight</td>
<td>262</td>
<td>311</td>
<td>340</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>261.94</td>
<td>311.07</td>
<td>339.98</td>
<td>Sample Mean</td>
</tr>
<tr>
<td></td>
<td>0.3179</td>
<td>0.315</td>
<td>0.2973</td>
<td>St. Deviation</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>9</td>
<td>9</td>
<td>Mean</td>
</tr>
<tr>
<td>Mfg. Cost</td>
<td>14</td>
<td>9.04</td>
<td>0.69</td>
<td>Sample Mean</td>
</tr>
<tr>
<td></td>
<td>0.2396</td>
<td>0.3151</td>
<td>0.251</td>
<td>St. Deviation</td>
</tr>
<tr>
<td>Risk Priority Measure</td>
<td>1120-560</td>
<td>380-360</td>
<td>120-290</td>
<td>Value</td>
</tr>
</tbody>
</table>

### Table 8: Utility Values for the Probabilistic Distribution

<table>
<thead>
<tr>
<th>Evaluation Measures</th>
<th>Design 1</th>
<th>Design 2</th>
<th>Design 3</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mfg. Time</td>
<td>32</td>
<td>31</td>
<td>26</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>0.013</td>
<td>0.253</td>
<td>1</td>
<td>Utility</td>
</tr>
<tr>
<td></td>
<td>0.296</td>
<td>0.265</td>
<td>0.2643</td>
<td>St. Deviation</td>
</tr>
<tr>
<td></td>
<td>99</td>
<td>110</td>
<td>90</td>
<td>Mean</td>
</tr>
<tr>
<td>Max. Stress</td>
<td>98.98</td>
<td>109.94</td>
<td>90.05</td>
<td>Sample Mean</td>
</tr>
<tr>
<td></td>
<td>0.327</td>
<td>0.31</td>
<td>0.2907</td>
<td>St. Deviation</td>
</tr>
<tr>
<td></td>
<td>97.999-99.951</td>
<td>109.018-110.875</td>
<td>89.179-90.923</td>
<td>Low Lim - Upp Lim</td>
</tr>
<tr>
<td>Weight</td>
<td>262</td>
<td>311</td>
<td>340</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>261.94</td>
<td>311.07</td>
<td>339.98</td>
<td>Sample Mean</td>
</tr>
<tr>
<td></td>
<td>0.3179</td>
<td>0.315</td>
<td>0.2973</td>
<td>St. Deviation</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>9</td>
<td>9</td>
<td>Mean</td>
</tr>
<tr>
<td>Mfg. Cost</td>
<td>14</td>
<td>9.04</td>
<td>0.69</td>
<td>Sample Mean</td>
</tr>
<tr>
<td></td>
<td>0.2396</td>
<td>0.3151</td>
<td>0.251</td>
<td>St. Deviation</td>
</tr>
<tr>
<td>Risk Priority Measure</td>
<td>1120-560</td>
<td>380-360</td>
<td>120-290</td>
<td>Utility</td>
</tr>
</tbody>
</table>
The comparison of different weight assessment methods for probabilistic values with the 1st and the 2nd hierarchical rankings (Tables 9, 10) can be concluded that the SW and the EW methods provided the exact same numerical values as the deterministic cases, suggesting that both of these methods don’t consider involvement of probabilistic distribution. The RS and ROC methods provided a completely new set of weights for the both rankings; however the outcome weights failed to follow the hierarchical ranking. The HWA method provided the steepest weight distribution when compared to the other methods, and for both cases, the weight values followed the initial ranking.

<table>
<thead>
<tr>
<th>Evaluation Measures</th>
<th>Rank</th>
<th>SW</th>
<th>EW</th>
<th>RS</th>
<th>ROC</th>
<th>HWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mfg. Time (min)</td>
<td>1</td>
<td>0.40</td>
<td>0.20</td>
<td>0.25</td>
<td>0.38</td>
<td>0.69</td>
</tr>
<tr>
<td>Max Stress (Mpa)</td>
<td>2</td>
<td>0.24</td>
<td>0.20</td>
<td>0.25</td>
<td>0.25</td>
<td>0.16</td>
</tr>
<tr>
<td>Weight (grams)</td>
<td>3</td>
<td>0.20</td>
<td>0.20</td>
<td>0.22</td>
<td>0.18</td>
<td>0.09</td>
</tr>
<tr>
<td>Mfg. Cost ($)</td>
<td>4</td>
<td>0.12</td>
<td>0.20</td>
<td>0.18</td>
<td>0.14</td>
<td>0.03</td>
</tr>
<tr>
<td>Risk Priority Measure</td>
<td>5</td>
<td>0.04</td>
<td>0.20</td>
<td>0.07</td>
<td>0.05</td>
<td>0.03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<tbody>
<tr>
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<td>0.20</td>
<td>0.19</td>
<td>0.15</td>
<td>0.05</td>
</tr>
<tr>
<td>Max Stress (Mpa)</td>
<td>3</td>
<td>0.20</td>
<td>0.20</td>
<td>0.23</td>
<td>0.20</td>
<td>0.12</td>
</tr>
<tr>
<td>Weight (grams)</td>
<td>1</td>
<td>0.40</td>
<td>0.20</td>
<td>0.22</td>
<td>0.41</td>
<td>0.59</td>
</tr>
<tr>
<td>Mfg. Cost ($)</td>
<td>5</td>
<td>0.04</td>
<td>0.20</td>
<td>0.16</td>
<td>0.11</td>
<td>0.01</td>
</tr>
<tr>
<td>Risk Priority Measure</td>
<td>2</td>
<td>0.24</td>
<td>0.20</td>
<td>0.13</td>
<td>0.13</td>
<td>0.23</td>
</tr>
</tbody>
</table>

3.3 Sensitivity Analysis

Sensitivity analyses will be carried out for evaluation measures to examine how sensitive the weight values are to the changes in the utility values.
3.3.1 Deterministic Weight Assessment

The outcome result of the sensitivity analyses suggest that for weight, manufacturing cost and confidence level, the HWA approach provided the most suitable weight values, whereas for the manufacturing time and maximum stress the EW method provided more favorable weight values. Figure 3 shows the manufacturing cost’s sensitivity graphs for all weight assessment techniques considered.

Figure 3: Comparison of sensitivity analyses graphs for manufacturing cost
Probabilistic Weight Assessment

For the probabilistic case the HWA approach provided the most consistent weight values with the initial hierarchical rankings, as well as provided the most desirable weight values when compared to the other methods. Figure 4 provides the sensitivity graphs for maximum stress for all weight assessment methods.

The HWA approach proposed in this paper provided the most suitable weight values for both deterministic and probabilistic distributions than the most of the vastly used weight assessment techniques. Considering the hierarchal and value aspects together in HWA provided a solid weight assessment technique. The overall comparison of how favorable is weight assessment techniques with respect to each other for deterministic and probabilistic cases are summarized in Table 11.
There are significant uncertainties and randomness attached to weight assessment when it comes to decision making. Some of these uncertainties come from the probabilistic nature of the data whereas some come from the decision maker’s characteristics and rationalism. In this paper the authors proposed a novel weight assessment method called the Hierarchical Weight Assessment (HWA), which bases the weight assessment on hierarchy of the criteria and the certainty equivalence values of the alternatives.

The case study examined in this paper, highlighted that not all weight determination methods provide reliable outcomes both for deterministic and probabilistic data. Among the weight assessment techniques that provide weight estimation both for deterministic and probabilistic values, the HWA method stands out in terms of providing flexibility to the decision maker to define the upper and lower limits for each design option for each evaluation measure.

The proposed method provides a methodical means of weight assessment for the DM, and gives the design engineer the freedom to define all attributes for all evaluation measures independent from each other.

### References


A design principle is defined as a general and scientific rule, which can be commonly used in all design activities. Therefore, design engineers are trying to find design principles and establish scientific ways for design. Analytic design is a design activity using scientific principles or processes with rigorous methods to achieve a good design. The utilized principle or method is a design methodology. For conceptual design, analytic design methodologies are defined by examining the common aspects in good designs. Axiomatic Design (AD) is typical for the analytic design methodology. In the last decade AD has been proved to be a valuable methodology for designing very complex products and systems. However, AD methodology may be of great worth even for simpler products. In addition to the axiomatic approach to design, there are many other methods that are based on an algorithmic approach to design. In algorithmic design, the design process is identified or prescribed so that it leads the designer to a solution that satisfies the design goals. This paper demonstrates the effectiveness of two methods, one algorithmic like the Systematic Design (VDI) and one non algorithmic like Axiomatic Design, in designing an innovative product - a hail cover for car protection and compares their evaluation.
Keywords: Systematic Design, Axiomatic Design, design principles, mechanical product design, innovative product, case study

1. Introduction

The last decade a large number of design methodologies have been developed. The distinctions between these methodologies are not clear: they overlap and use different definitions of key concepts such as function, demand or process. Reviews of design methodologies (Bjärnemo, 1983; Finger and Dixon, 1989) have resulted in the classification of various methodologies. However, the classifications have not led to the development of more powerful or unified methodologies or in a reduction of the number of competing methodologies, although many methodologies have similar aims, structure and inherit design knowledge. In this paper, we apply a research method, suggested by Kaulio and Rosenblad (1995) and Malmqvist et. al. (1996), that hypothesizes that a pair-wise assessment of design methodologies may be a more effective approach towards these goals, by enabling a more focused analysis of the process steps and concepts of the methodologies. The method can be used for a comparative analysis of two methodologies, given that these propose similar actions and process steps and have been developed independently. The methodologies must further have the same goal, describe the same phenomena at the same level of analysis, and be articulated to such a degree that a comparison is fulfilled.

This preliminary analysis will focus on the advantages and disadvantages between two methods. This enables a future investigation into the possibilities of unifying these methodologies. Kaulio and Rosenblad applied their approach in a study of two methodologies for requirements engineering, Quality Function Deployment (QFD) and the “User-Oriented Product Development” while Malmqvist et. al. applied their approach in a study of Inventive Problem Theory (TRIZ) vs the Pahl-Beitz systematic approach.

We are here focusing on conceptual design. The methodologies that are studied are the Axiomatic Design theory (AD) of Suh (1990) and the Systematic Design approach of Pahl and Beitz (SD) (1995).

The basis for the comparative analysis is obtained by the descriptions of the methodologies and designs of a new product. The descriptions are from the available literature and cover topics such as scope, basic design process model, problem formulation and knowledge base. The structure of this paper is as follows: AD and SD are described in sections 2 and 3, respectively. The comparative analysis via a case study follows in section 4. Discussion and Conclusions are summarized in section 5.
2. The Axiomatic Design (AD) Methodology

According to N. P. Suh, the design process takes place in four domains (Fig. 1): Customer, Functional, Physical and Process. These domains create demarcation lines between four different kinds of design activities (Suh 1990). The number of domains always remains at four, but the nature of the design elements in each domain changes depending on the field of the problem (Gebala and Suh 1992). Associated with each domain are the design elements: Customer Attributes {CA}s or needs which are satisfied by selecting an appropriate set of Functional Requirements {FR}s and constraints {C}s, which in turn are embodied into Design Parameters {DP}s. These {DP}s are achieved by a set of Process Variables {PV}s that provide control over the physical parameters.

![Diagram of the four domains of the design process](image)

**Figure 1**: The four domains of the design process

The basic postulate of the axiomatic approach to design is that there are fundamental axioms that govern the design process. Two axioms were identified by examining the common elements that always are present in good designs:

Axiom 1  (Independence Axiom): Maintain the independence of the functional requirements.

Axiom 2  (Information Axiom): Minimize the information content of the design.

The Independence Axiom states that the independence of FRs must always be maintained. The functional independence enables each FR to be satisfied without affecting any of the other FRs, and the design remains as uncomplicated as possible. Figure 2 shows the axiomatic design steps.
Design Analysis

Define Design Parameters to satisfy Independence Parameters

Are Design Parameters enough?

Yes

Do some Design Proposals satisfy the Independence Axiom?

Yes

Pick the most superior design using the Information Axiom

No

Determination for final Design Proposal

Figure 2: The axiomatic design flowchart (Liang Hou et. al. 2007)

3. The Systematic Design (SD) Methodology

The systematic design (SD) was developed in the 1970’s by the German professors Pahl and Beitz. SD divides the design process into main phases like task clarification, specifications definition, conceptual design, embodiment design, detail design, as Figure 4 shows.

When designing, the designer usually follows a path consisting of certain fundamental activities – problem and requirements formulation, search for alternative solutions, evaluation, documentation and estimation of the results. Design methodologies support this process by providing specific design methods and design knowledge. The SD phases-stages partitioning guide the designer into a decision path, as Figure 3 shows. Note that SD points out that the delimitations between the phases are approximate and therefore the need for iteration and recursion.
4. Comparing AD and SD methodologies via the design of a new product

4.1 Case study

The problem of car protection during a hail storm is appeared. The momentum of the falling hail is high enough to cause serious damages at the surface of the car. The hail cover’s application success depends on two
main factors: a) the prevention of the contact between the hail and the surface of the car, and b) the application of the cover on time, just before the hail storm begins.

The conventional car covers offer satisfactory protection from humidity, sun radiation and heat. They are made by fabrics that give specific characteristics at the car cover in order to protect the car from the above factors. The problem is that these car covers are not stout enough to protect the surface from the falling hail.

For all the above, it has to be designed a new hail cover, which allows its immediate and effective application just when the hailstorm begins, so the hail doesn’t come in touch with the surface of the vehicle. In particular, it has to be a flexible, stiff, heavy-duty, waterproof and fire resistant car cover, which will not need any specialized treatment and after its use it can be removed and stored easily. Figure 5 gives a view of this cover.

The customer attributes (CAs) or overall requirements are summarized as follows:
- low cost
- easy and fast placement
- light (low weight)

4.2. The Axiomatic Approach to the Hail Cover Design Process

To approach the design process for an innovative hail cover from the Axiomatic Design view, the FRs and DPs should be defined. These parameters represent the process itself. After that, the design matrix between FRs and DPs should be arranged in order to identify the relationship between them.

1st level analysis

The Functional Requirements and the corresponding Design Parameters at the 1st level analysis for the conventional hail cover design process are defined as:

<table>
<thead>
<tr>
<th>FR</th>
<th>DP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection of the vehicle from the hail fall</td>
<td>Design of a cover which protects the vehicle from the hail fall</td>
</tr>
</tbody>
</table>

2nd level analysis

Since the relationship between FRs and DPs at the first level is not detailed enough to provide the desired result, further decomposition of the FRs is required. The FRs and DPs for this level are defined as:
The design equation is defined as follows:

\[
\begin{bmatrix}
FR_1 \\
FR_2
\end{bmatrix} = \begin{bmatrix} X & 0 \\ X & X \end{bmatrix} \begin{bmatrix} DP_1 \\
DP_2
\end{bmatrix}
\]

### 3rd level analysis

Both FRs and DPs need to be decomposed. DPs are now selected in order to satisfy the 2nd level FRs.

<table>
<thead>
<tr>
<th>FR</th>
<th>DP</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR11= Flexible</td>
<td>DP11= High modulus of elasticity (Young)</td>
</tr>
<tr>
<td>FR12= Ecological</td>
<td>DP12= Possibility of recycle the material</td>
</tr>
<tr>
<td>FR13= Proof against attrition</td>
<td>DP13= High modulus of hardness</td>
</tr>
<tr>
<td>FR14= Resistance on fire</td>
<td>DP14= High index of fire resistance</td>
</tr>
<tr>
<td>FR15= Waterproof</td>
<td>DP15= Hydrophobic</td>
</tr>
<tr>
<td>FR21= Easy and fast placement – collection of the cover</td>
<td>DP21= Minimum time and number of persons for the cover placement</td>
</tr>
<tr>
<td>FR22= Possibility of activation method selected by the user</td>
<td>DP22= Activation automatically or manually</td>
</tr>
<tr>
<td>FR23= Wind resistance</td>
<td>DP23= Safety joints</td>
</tr>
<tr>
<td>FR24= Minimum requirement of cover service</td>
<td>DP24= Limitation of electronic/electrical and mechanical parts</td>
</tr>
</tbody>
</table>

The present FRs need not be composed any further, so they form the terminal nodes of the hierarchical tree, as Figure 4 shows.

### 4.3. The Systematic Approach to the Hail Cover Design Process

The Systematic Design (SD) starts with the clarification of the task, as Figure 3 shows. This phase involves the collection of information about the demands and wishes that the cover should meet. This phase results in a
detailed design specification matrix. Table 1 shows a view of the Design Specification Matrix of the proposed cover.

The conceptual design, as Figure 5 shows, starts by an analysis of the specification of Table 1 in order to identify the essential problem(s) to be solved. The design problem is then formulated in a neutral solution form. This makes the solution space as wide as possible, which serves to dispel prejudices which may tempt the designer to decide on a certain solution before other alternatives have been considered. The problem may then be decomposed into sub-problems and the function structure (or several alternatives) established. Solutions to the sub-functions are then sought. Morphological matrices as Table 2, are used to combine sub-function solutions into system solutions. Promising system solutions are then developed further into concept variants. Finally use-value analysis, according well known directives as VDI 2221, is used to evaluate the concept variants, and the “best” concept is selected for further development. Here, the use of use-value analysis helps ensure that a rational, objective decision is made. SD emphasizes heavily the importance of decisions taken in the conceptual design phase, since it is very difficult to correct fundamental shortcomings of the concept in the later embodiment and detail design phases.

![Functional Domain and Physical Domain diagram](image)

**Figure 4:** FRs and DPs hierarchical tree. (Decomposition process)
Table 1: Design Specification Matrix

<table>
<thead>
<tr>
<th>Demands/Wishes*</th>
<th>Material</th>
<th>Application – Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>▪ Flexible</td>
<td>▪ Easy placement, collection</td>
</tr>
<tr>
<td>D</td>
<td>▪ Proof against attrition</td>
<td>▪ Stability, endurance and resistance to the wind</td>
</tr>
<tr>
<td>W</td>
<td>▪ Fireproof</td>
<td>▪ Small need for maintenance</td>
</tr>
<tr>
<td>W</td>
<td>▪ Waterproof</td>
<td>▪ Ability to choose the way of activation</td>
</tr>
<tr>
<td>D</td>
<td>▪ Ecological</td>
<td>▪ High modulus of elasticity</td>
</tr>
<tr>
<td>D</td>
<td>▪ Flexible</td>
<td>▪ Recyclable material</td>
</tr>
<tr>
<td>D</td>
<td>▪ Proof against attrition</td>
<td>▪ High modulus of hardness</td>
</tr>
<tr>
<td>W</td>
<td>▪ Fireproof</td>
<td>▪ High fireproof index</td>
</tr>
<tr>
<td>W</td>
<td>▪ Waterproof</td>
<td>▪ Hydrophobic material</td>
</tr>
<tr>
<td>W</td>
<td>▪ Ecological</td>
<td>▪ Minimum required time and number of persons for the application of the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Automatic or manual activation</td>
</tr>
<tr>
<td>W</td>
<td>▪ Easy placement, collection</td>
<td>▪ Restraint number of electrical/ electronical/ mechanical parts</td>
</tr>
<tr>
<td>D</td>
<td>▪ Stabilization</td>
<td>▪ Low cost</td>
</tr>
<tr>
<td>D</td>
<td>▪ High fireproof index</td>
<td>▪ Light (low weight)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Easy and fast placement</td>
</tr>
</tbody>
</table>

Note: * D: demand, W: wish

Table 2 Morphological Matrix

<table>
<thead>
<tr>
<th>Functions</th>
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This preliminary analysis has compared AD and SD theories on the design of a new product during the conceptual design stage. AD and SD differ concerning scope, problem formulation and certain design methods. All or a part of the customer attributes (customer domain) of the AD could be the design demands and/or wishes of the SD approach. For example the customer attributes concern the easy placement and the low weight for the hail cover are functional requirements (FRs) that will be fulfilled with the appropriate material choice. Other attributes like price could be characterized as constraints. The constraints include financial and/or technological factors. Although, financial factors play main role in all issues of the cover design, technological ones govern issues in the production domain mainly.

Additionally, in each of the four phases of the SD approach the AD Axioms could assist a designer in accomplishing his design task. In particular, Independence Axiom will assist for the achievement of uncoupled or decoupled designs among the domains, while the Information Axiom in the achievement of designs or processes with less information content.

However, a design methodology that unifies AD and SD may become more powerful by exploiting the strengths of each methodology. This is under investigation by the current research team. The unification of various...
design methods seems to be a very competitive and attractive area for the future design theories researchers.

References


Intelligent Integrated Vision System for Indoor Robotics Applications

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Abstract:
In the last few years, a remarkable increase of robots’ usage in domestic environments has been observed. A wealth of research is devoted in building new frameworks capable of assisting people in everyday life. Furthermore, systems introduced into domestic environments, aim to substitute humans in house chores such as tidying child’s bedroom after a party or collecting clothes before they enter the washing machines. The need of robots working closely to human beings makes a necessity the usage of intelligent sensorial system. In this work we present a novel intelligent integrated vision system that is able to: reconstruct the 3D working space of a room; recognize objects and estimate their pose; perform edge detection and extract the optical flow of a moving subject.

Introduction
During the last decade, vision systems have flourished and become the most efficient framework for production lines’ surveillance and for working spaces’ observation. Due to the fact that they provide several vital attributes, more and more industries tend to introduce new vision systems into domestic environments. Moreover, this movement is enforced by the need to substitute human beings in house chores such as tidying child’s bedroom after a party or collecting clothes before they enter the washing machines. Furthermore, it is apparent that, one of the most challenging problems that arise is the human machine interaction. To this end and with a view to the adequate fulfilment of the aforementioned challenge, sensorial systems should be able to accomplish several computer vision tasks. The reconstruction of the 3D working space, object recognition and pose estimation, edge detection and optical flow extraction of a moving subject constitute the major problems that vision systems must solve. Optical flow and feature extraction algorithms are utilized with a view to a
robust detection engine construction. As a result detected moving targets can be easily avoided or manipulated.

The proposed intelligent sensorial framework consists of a four-camera architecture capable of providing essential visual information of a scene for domestic robotics applications. Furthermore, the cameras (Grasshopper by Point Grey Research) are able to capture images up to 1280x960 pixels resolution and are connected to the PC via a firewire port. The data transmission is established with the IEEE 1394b transfer protocol. Each of them is installed on one of the four corners of a room – working space. This geometry ensures the adequate cover of over 97% of the working’s space volume. Moreover, this vision system is implemented in an indoor environment for simple pick-and-place tasks. Furthermore, it is based on novel image processing techniques that are beyond the current state-of-the-art in the computer vision field.

Robots working in an indoor environment must be able to navigate comfortably in the room, avoid obstacles or even humans in both static and dynamic environments. For this reason the vision system should robustly and effectively reconstruct the 3D surface of the working space. Three-dimensional reconstruction of surfaces from multiple images has been a central research problem in computer vision for a long time. Early work on this area is focused on developing stereo algorithms mostly for stereo camera configurations. However, due to considerable advances in computational power, contemporary vision systems using multiple cameras are becoming increasingly practical and feasible. Example of multi-view vision systems include the Vi Room which is a low cost synchronized multi-camera system developed by (Svodoba et al., 2002), the Cognitive Multicamera System developed by (Zimmermann et al., 2006) and the UD Multi Camera Project developed by (UD Graphics Lab of Stanford University, 2006). These systems are able to capture multiple synchronized images of indoor scenes and they were developed mainly for tracking applications without providing any knowledge for the structure of the 3D environment. Going from binocular to multiple views has the advantage of potentially increasing the stability and accuracy of the reconstruction, according to the baseline increase. In case of a system like the proposed one the algorithm must be able to handle occlusions, especially if the views are widely separated.

The pose estimation problem appears in many sectors including photogrammetry, robotics, computer graphics and computer vision. The relation between the images with a known geometry is defined by a rigid transformation. The required data for solving the pose estimation problem are given in the correspondences of a 3D point in object coordinates, projected to a 2D point onto the image plane (Lu, 2000). Initial studies of this field suggested the use of methods based on geometrical projections
Parallel lines in the natural environment such as those of a railway, when projected onto the 2D image plane are intersecting in a spot known as vanishing point (Gallagher, 2002). As a result, an image representing a scene of the real world contains more than one vanishing point. The efficient detection of the latter can be used for the estimation of the camera’s rotation matrix (Gallagher, 2005) and the exact objects’ pose as well (Segvic, 2001).

Recognizing objects in a scene is fundamental task in image understanding and still constitute one of the most challenging tasks. This process is responsible for the object indexing needed for the adequate fulfillment of manipulation tasks. Every pattern recognition technique is directly related to the decryption of vital visual information contained in the natural environment. During the past few years, researchers emphasized in building new recognition frameworks based on appearance features with local estate. Current state-of-the-art object recognition techniques rely on local appearance based features extracted and organized by detectors and descriptors respectively. Algorithms of this field extract features with local extent that are invariant to possible illumination, viewpoint, rotation and scale changes. In addition, several techniques that enforce the crucial role of local features in demanding pattern recognition application were presented (Liao, 2007, Rothganger, 2006). One of the most efficient object recognition schemes, that is adopted for the purposes of the proposed intelligent vision system is the Scale Invariant Feature Transform (SIFT) (Lowe, 2004). The latter was selected among a set of high-level algorithms, such as Speeded Up Robust Features (SURF) (Bay, 2008), to describe patterns and objects.

The remainder of this paper is structured as follows: In Section 0 we give a short introduction to the field of optical flow and edge detection. Furthermore, we also present experimental results of the implementation of two favored image processing techniques. The proposed pose estimation technique along with several experimental results is demonstrated in Section 0. Moreover, the 3D reconstruction technique adopted along with the corresponding results is presented in Section 0. Additionally, essential information concerning the object recognition scheme and how it is trained for the purposes of the intelligent vision system is presented in Section 0. System architecture and hardware details are presented in Section 0 whilst, in the last Section 0 conclusions are made.

2. Optical Flow and Edge Detection

The displacement of an object inside a scene is figured at the motion field. Optical flow is an approach for analyzing the motion in a dynamic environment and computing the displacement, in pixels, of a detected target in consecutive time intervals. The main idea is the estimation of the
scene's motion, based on partial derivatives from image sequences. Generally, the optical flow field is the velocity field that represents the three-dimensional motion of object points across a two-dimensional image (Kearney and Thompson, 1987). Optical flow due to environmental changes should be correctly computed, in order to present only significant motion changes. For instance, the optical flow should not be sensitive to the variation of illumination and negligible objects, such as shadows or external shapes. In any case, optical flow estimation requires a number of assumptions to be met. These assumptions are defined after analyzing the environment's contents. An indoor's machine vision system meets different assumptions than an outdoors one. For example, an indoor's system is more stable to illumination changes and it is not affected by the weather alterations.

The computation of the optical flow is based on two basic assumptions where the first is referred to invariant illumination and the second to uniform displacements. We perform a $1^{st}$ order Taylor series expansion for every pixel $I(x, y, t)$, where $x$ and $y$ are the coordinates and $t$ the time interval. Finally, we obtain the image velocity or optical flow for a pixel $I(x, y, t)$ which is written as:

$$I_x = \frac{\partial I}{\partial x}, I_y = \frac{\partial I}{\partial y} \text{ and } I_t = \frac{\partial I}{\partial t}$$

(1)

The equation is written more compactly as:

$$(I_x, I_y) \cdot (U_x, U_y) = -I_t$$

(2)

$$\nabla I \cdot \dot{u} = -I_t$$

(3)

where $\nabla I$ is the spatial intensity gradient and $\dot{u}$ is the image velocity or optical flow of pixel $(x, y)$ at time $t$. The equation provides only the component in the direction of the brightest gradient. The completely solution is specified by the approach of (Horn and Schunk, 1981). In our system we apply a well-known algorithm for calculating the optical flow. The Lucas-Kanade two frame differential method is favor among many similar approaches found in the literature, as it can be easily implemented and provides robust results in real-time (Baker et al., 2004). In Figure 1 the results of applying the algorithm in a sequence of images are presented.
Edge detection is a pre-processing method used to locate boundaries and shapes in an image. Brightness sharp changes or discontinuities characterize edges in a grayscale image. The discontinuities might come from changes in the shape, depth, surface color or the illumination. There are many factors for causing edges in a scene. Over the past two decades, the challenge in the edge detection field was the efficient implementation of a detector. The most popular detectors presented in the literature have been developed by Harris, Canny and Sobel (Harris, 1988, Canny, 1986). In our system, the Harris corner detector is being employed due to its strong invariance to illumination changes, scale, rotation and image noise (Schmid, 2000). The Harris corner detector implements shifted patches and an auto-correlation function for finding possible corners in an image. It is assumed a point \((x, y)\) and a displacement \((\Delta x, \Delta y)\), the auto-correlation function is written as,

\[
c(x,y) = \sum_{W} [I(x_i, y_i) - I(x_i + \Delta x, y_i + \Delta y)]^2
\]

where \(I\) indicates the image function and \(W\) is windows centered at point \((x, y)\) and \((x_i, y_i)\) are points inside the window. The approximation of the displacements is done by a \(1^{st}\) order Taylor expansion and afterwards the function is written as:
\[ c(x, y) = \left[ \begin{array}{c} \Delta_x \\ \Delta_y \end{array} \right] c(x,y) \left[ \begin{array}{c} \Delta_x \\ \Delta_y \end{array} \right] \]  

(5)

where, matrix \( c(x,y) \) reflects the intensity structure of the examined region. The eigenvalues of \( C \) matrix determine a pixel as a corner. In the first case, small eigenvalues mean that auto-correlation function is flat and there is not edge. In turn, a high eigenvalue and the other low indicate that auto-correlation function is ridge shaped and there is an edge. In the third case, both high rates of eigenvalues mean sharply peaked auto-correlation function and this denotes a corner. Experimental results of the \textit{Harris} corner detector in an indoor scene are shown in Figure 2.

\textbf{Figure 2:} Edge detection using \textit{Harris} corner detector for an indoor scene

\section{3. Pose Estimation}

The pose estimation process of the proposed vision system incorporates the Grasshopper cameras whose essential calibration is performed offline. Using geometric constraints for a known pattern the intrinsic and extrinsic camera parameters are recovered. During this process the intrinsic parameters of the camera are computed in a matrix. From these parameters the image is rectified from the curvatures introduced by the lens. In Figure 3 some images captured before calibration and the rectified ones are depicted.
The visual pose estimation is feasible only after the acquired image sequence rectification. The relationship between a 3D object projected onto the 2D image plane is described by the transformation matrix. The rotations and translations are based on identification of the image features and their 3D respective ones. The solution of this non-linear problem is given by adopting homogenous coordinate matrices and homographies (Lingrand, 2000). The whole process is implemented with the OpenCV library (Open Source Computer Vision), which is open source and provides all the needed functions and algorithms for the relevant tasks. The first prototype for the assessment of the visual pose estimation system was achieved by identifying a chessboard with known geometry. The algorithm identifies the platform by recognizing all the features, i.e. the corners of the chessboard squares. Possible occlusions affect directly the algorithm that is not able to further process the image, as all of the features need to be identified. In Figure 4 this drawback is illustrated; in one case the thumb occludes the bottom-left square of the chessboard, preventing thus the pose estimation, whilst in the other the pose estimation is performed unimpeded. The final rotation and translation matrices are estimated by OpenCV library.
4. 3D Reconstruction

Generally, a 2D image taken from a single camera provides vital visual information concerning the $x$ and $y$ coordinates of what the image represents. For the computer, it is just a large collection of pixel intensity values. The reconstruction engine acts as a black box, which receives 2D images and results 3D models. This configuration works well both in fixed and dynamic scenes. The proposed vision system of four cameras, which is used for capturing the working environment, transfers their image data to the reconstruction workstation iteratively. Many aspects of this procedure can be changed using on-the-fly capabilities of the hardware, such as the access to the internal memory of the cameras for providing immediate feedback in case of faulty image transmission. The final scope of the 3D reconstruction application is offering additional information about the objects and their specifications located inside the working space. A sequence of 2D images is captured from the four cameras in a way that significant overlaps in image contents occur and then used to find correspondences between them.

A prevalent 3D reconstruction pipeline is comprised of the following: acquisition of wide baseline images, detection, and description of discriminative features, obtaining dense correspondences and finally production of the 3D model of the scene. The proposed vision system captures high resolution images provided by four high quality industrial cameras mounted on the four respective corners of the ceiling inside an ordinary room. This is a novel multiple camera configuration which can provide unique viewpoints and better coverage of the room's volume. Generally, corresponding points in different images are found by simple comparing intensity values of the pixels over a small region around a point. However, not all points are suited for this type of comparison. When a
point cannot be discriminated from its neighbourhood it is almost impossible to acquire a unique match with a point in another image. We use a sophisticated state-of-the-art method developed by (Lowe, 2004) in order to extract a set of points using a feature detector that applies Gaussian masks over the image and characterizes the neighbourhood of the pixels with the histogram of intensities.

In addition, we compute dense correspondences among pairs of images and we also apply trilinear constraints in order to process additional information from another camera. The trifocal tensor developed and analysed by (Torr and Zisserman, 1997) is used because of its unique characteristic to predict and transfer corresponding points of the two views to the corresponding point in the third view. Thus, we attain robust point correspondences between the three views of the four cameras in the room. Finally, we compute multiple trifocal tensors over the four triplets of images and a dense point cloud is gradually produced. The final outcome shown in Figure 5 is more robust than the point-wise correspondences between stereo pairs of images that is commonly used and produces sparse and inaccurate point clouds.

5. Object Recognition
Object recognition in cluttered real world conditions requires local image features that are unaffected by nearby clutter or partial occlusion. The
features must be at least partially invariant to illumination, 3D projective transforms and common object variations. On the other hand, the features must also be sufficiently distinctive to identify specific objects among many alternatives. The difficulty of the object recognition problem is due in large part to the lack of success in finding such features. The two sub mechanisms responsible for the detection and extraction of interesting keypoints are the detectors and the descriptors. Generally, the main idea behind interest location detectors is the pursuit of points or regions containing unique information in a scene. Thus, regions in a scene that enjoy solitary quality and quantity of information can be easily detected. In turn, a descriptor organizes the information collected from the detector in a discriminating manner. Thus, high dimensional feature vectors corresponding to locally sampled feature descriptions are produced. In other words, an object or parts of it located in a scene are represented by descriptors. Methods comprising of both a detector and descriptor are known as two-part approaches.

*SIFT* and *SURF* constitute the dominant two-part approaches in the field of object recognition. Although, in the proposed vision system the *SIFT* is adopted due to the fact that outperforms *SURF* as it was shown in (Kouskouridas et. al, 2009). Furthermore, features extracted via *SIFT* provide robust matching across a substantial range of affine distortion, change in 3D viewpoint, addition of noise and change in illumination. Complex and challenging object recognition tasks can be adequately accomplished by matching individual features to a database of features from known objects using a fast nearest-neighbour algorithm. Moreover, extracted *SIFT* keypoints are utilized in demanding attention tasks where significant correspondences between several views of an objects much be estimated.

The proposed object recognition process, adopted by the intelligent vision system, is divided into two discriminate phases: The first one can be apprehended as the training session of our system. Initially, each candidate object is photographed under various viewpoints and illumination circumstances. These images are stored in a large database whose quality and quantity directly affects recognition’s performance. A short part of our database is shown in Figure 6. Figures captured under altering geometry constrain and illumination conditions ensure the possibility a trained object to be found in a scene. Moreover, with a view to such a system be applicable in real-time situations, we built an online search engine that takes place in the next stage. The most important issue that someone should keep in mind is the fact that, this phase is executed while the system remains offline. As a result no computational time is taken into account.
| Figure 6: A short part of the constructed database. Here 5 different objects are shown: A book, a modem’s box, Point Grey’s box, a SKAG dossier and a wireless’ box. |
In the second phase, the online search engine takes place where an image captured by the Grasshopper cameras is compared to several others contained in the database. Especially, for each image SIFT features are extracted and stored in temporary files for further exploitation. An object is recognized when common matches between the cameras’ image and to those in the database are found. It is apparent that this process eliminates wrong matches during the aforementioned comparison. In Figure 7 the results of the proposed method, under possible partial or total occlusion, are shown.

6. System Architecture and Hardware Details

The proposed vision system comprises of five Grasshopper cameras dispersed in different positions. The Grasshopper camera manufactured by Point Grey Research is able to capture images up to 1280 X 960 pixels resolution and it is connected to the PC via a firewire port, using the IEEE 1394b transfer protocol. As far as 3D reconstruction and object recognition are concerned, they are based on four cameras installed in the four corners

1 More results and videos demonstrating the recognition process executing in real time can be found at: http://www.youtube.com/watch?v=jPE4ogG4FSY
of the working space. The last camera, which is responsible for the pose estimation task is installed on the ceiling and is fixated towards the ground. The proposed algorithms exhibit in parallel on a typical PC with a core2duo 2.2 GHz processor, 2 GB RAM and Windows XP operating system. The training session of the object recognition task is performed in MATLAB. The last is preferred from other programming tools, due to the fact that, it offers users-friendly environment and convenient image processing functions. The database constructed comprises of 30 images, 6 per object that correspond to 60° viewpoint changes. Finally, SIFT and Lucas-Kanade methods are utilized as modified versions in order to accomplish real time execution performance.

7. Conclusions

In this paper we have proposed an intelligent integrated vision system for indoor robotics applications. The main idea underlying our system is that it can substitute humans in time demanding tasks. Moreover, it can be used for surveillance and control applications and, therefore, it can reconstruct the 3D surface of a room’s volume, recognize objects and estimate the movement and the pose of natural or artificial agents within the working space. It was shown that this framework is able to adequately accomplish all the demanding and challenging tasks derived from the human machine interface.

Acknowledgments

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The systemic marketing and the application of PRMs
(Partner Relationship Management) improving the efficiency of a virtual enterprise

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Abstract (only):
A virtual enterprise is possibly one of the most profitable businesses of the near future. Its existence and its function are ruled to a large extend by the principles and the values of a classical business, although having some essential differences that we can call “success or failure details”. One so demanding business functionality could not be separated from the idea of marketing. In this particular presentation, we will analyze how the techniques of classical marketing can be combined harmoniously together with innovative marketing ideas. Furthermore, we will examine how the resultant marketing mix can be applied in order to bring money and success in a virtual enterprise. We will also mention some innovative marketing methods like: cohabitation marketing, the 7Ps and the 7S, strategies of discovering new markets and mining market opportunities. In addition, we are going to emphasize the importance of information within the bounds of a virtual enterprise, as well as the need of absolute control, organization, research and tightening business and customer structures.
In the practical part of my presentation, we will extensively demonstrate the Salesforce tool, which is a complete packet that is available at the moment. It’s an application for centralized and organized control, scheduling and valuation of all the processes, which can not only support but also improve how a business works, simplify and put an order to some upcoming chaotic business situations.
For the total integration of Salesforce packet, we will suggest an innovative addition that consists in finding the appropriate business partners of a virtual enterprise. The fact that such an enterprise is actually an association of many different companies, makes the partners’ selection and the harmonization of their relationships and interests some of the most determinant factors of success. These combined with the selection of the market opportunity are maybe the most important steps to success and will definitely increase virtual enterprise’s life circle. The importance of these ideas will be simulated with the Vensim PLE tool, in order to be proved practically and descriptively.

Keywords:
Virtual enterprise, marketing, simulation, Vensim
An actuarial model for the management of forest fire consequence propagation

Alkiviadis Aivaliotis

A website’s model-framework for green portals that promote forest recreation grounds near wetlands in Greece (ABSTRACT ONLY)

Antonios Athanasiadis, Zacharoula Andreopoulou

The programming environment of NETLOGO as a tool for introducing Greek high-school students to eco-systemic thinking

Aristotelis Gkiolmas, Anthimos Chalkidis, Dimitrios Stavrou, Kostas Karamanos, Constantine Skordoulis

Methodologies and a Guide for Municipal Solid Waste Landfills Site Selection

Konstantinos P. Anagnostopoulos, Athanasios Vavatsikos, Olympia Demesouka

Industry in Greece and environmental policy in the frames of social responsibility of enterprises (ABSTRACT ONLY)

Pascalia Vais, Athina Karakosta, Elisabet Ourgantzoglou, Georgia Stroubi
A system dynamics framework for irrigation water management in coastal Mediterranean regions

Trissevyene Yiannakopoulou

Systemic thinking and industrial ecology – the concept of eco-industrial parks

Georgios Gaidajis, Komninos Angelakoglou, Despoina Aktsoglou

Strategic management structures for Civil Protection (CP) services in Greece. A systemic approach of forest fire crises

Alkiviadis Aivaliotis, Savvas Makridis

Systems thinking and environmental assessment – Using the Life Cycle Assessment approach

Georgios Gaidajis, Komninos Angelakoglou, Despoina Aktsoglou
An actuarial model for the management of forest fire consequence propagation

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Abstract:  
A variational model is proposed containing all essential wildfire propagation physics. This novel approach is based on the optimisation of actuarial functionals of interest to civil protection managers. The cost functional is based on a Lagrangian one – dimensional model that captures the fundamental aspects of the forest fire phenomenon like the boundary layer structure of its emergency phase. The study of this initially very rapidly evolving temporal stage of the civil protection phenomenon in question attempts to go beyond the mere physics of wildfire front propagation, by using an actuarial approach to estimate the material consequences of the emergency on the affected area. The boundary layer structure of forest fire consequences that appears in the emergency phase, is also found in other catastrophic phenomena of interest to civil protection managers and is amenable to a special mathematical analysis (singular perturbation method) first used in hydrodynamics. This approach leads to a second – order ordinary differential (Euler-Lagrange) equation. Using arguments based purely on dimensional analysis, we arrive at characteristic non-dimensional numbers, which encapsulate the main features of the competing mechanisms (propagation vs. control) of wildfires. Some conclusions are drawn on the basic requirements for a successful emergency management of the situation (initial response of the civil protection forces), especially regarding the rural Fire Service operations, based on the derived time scales.

Keywords:  
Actuarial approach, boundary layer, civil protection, consequence management, emergency, forest fires

1. Introduction  
In the recent years, (Husted and Michailova, 2002, p. 61), it has become apparent that the individual still remains the main drive of success. There are two reasons for this; first, because individuals are intrinsically hostile to sharing their knowledge, and it mainly depends on individuals’ motivation to share it (Husted and Michailova, 2002).
“Efficient knowledge-sharing is a “contact sport,” involving direct contact and commitment on both sides of the exchange (Husted and Michailova, 2002, p. 63). Hence, understanding individuals involved in the human activity of sharing is the most essential step in effectively supporting it (Robertson, 2002).

The problem of forest fire (FF) propagation has been extensively studied using both stochastic and deterministic methods. The main thrust of mathematical research has been in solving the PDE system that describes mass/heat transfer and scalar consumption/production (of oxygen, carbon dioxide etc) resulting from fire growth. The detailed movement of the fire front (discontinuity) is predicted through numerical analysis of complex, deterministic models that can nonetheless generate stochasticity (like turbulence) via a number of nonlinear mechanisms.

This randomness makes forest fires unpredictable and thus difficult to manage. Stochasticity can also enter the problem as an inherent feature in models which include random inputs like meteorological conditions. The greatest difficulty is the synthesis (numerical construction) and analysis (computation of convergent moments) of the corresponding random fields, which are inhomogeneous functions of space and non-stationary functions of time.

In most cases these models are computationally intensive and require familiarity with simulation methods and interpretation skills that make them impractical for fire and civil protection services. The managers responsible for these operations focus on the development of Decision Support Systems (DSS) that offer operational (aggregate), real-time information and scenario building capacity to the decision maker.

For these managers, the most important piece of information is the potential impact assessment of the various forest fire scenarios, i.e an estimate of cost as a function of time, which describes how the evolving phenomenon inflicts damages or casualties that require fire service response (containment and suppression costs). Different researchers have recently attempted to study such functions using an actuarial framework. The emphasis in these papers is on financial and ecological loss (pointwise estimates) taking into account different resource valuation scenarios for each affected area.

The typical approach up until now has been to use semi-empirical descriptions of fire front propagation. The dominant mathematical model of fire front movement uses Rothermel’s physico-chemical closure assumptions in order to simulate its propagation speed (fire spread rate). The software packages BehavePlus 3.0 and FARSITE both use this model as their basis for the prediction of fire evolution in space or time. The inputs for these computational packages are different GIS data (e.g.
topography, vegetation etc) and/or meteorological feeds (e.g. wind speed, direction etc).

In the present paper we introduce the notion of civil protection cost functionals that quantify the respective consequences of the phenomenon during its emergency phase (e.g. material damages, fire-fighting costs) as functions of the affected (perturbed) area (X). This novel approach comes as a continuation of econometric models based on the construction of smooth maps by multiple regression (see [1] for similar mitigation cost functions of structural improvements and fuel treatments in forests). Such an approach has been taken in a different context using regression methods to quantify the effect of socio-economic variables on consequence indicators of wildfires. Recently mathematical analysts introduced the notion of the control cost functional (fire service response in terms of containment) studying a variational problem (minimization of the total cost of wildfire damages including timber destruction) constrained by the real-time construction of a fire barrier.

In the Emergency Management Service (EMS) sector, different services have different response times during the so-called emergency stage (initial phase of the CP operations) in dealing with dangerous incidents. In reality there is a minimum required response time that is de facto determined for the mission-critical service (first responder). In the case of forest fires, this would be the rural fire service since its response time affects the operations of all other EMS involved, but most importantly determines the possibility of an emergency escalating into a crisis.

Hence, its response time and the natural time scale of the CP phenomenon must be of the same order of magnitude if the EMS-first responder is to deal effectively with the initial phase of this incident (emergency). It makes sense to expect that the latter quantity is fixed by phenomenological considerations. E.g. in the case of a forest fire such a quantity could depend on a “fire inertia” (M) characterizing its inherent consequence propagation propensity. The small magnitude of (M), as we will see, implies the existence of a “Boundary Layer” near t=0. This rapid variation time interval corresponding to the (initial) emergency phase gives a distinct physical meaning to that first stage of the evolving phenomenon, to be discussed in the following sections.

2. Quantitative management tools for CP decision makers

In recent work emphasis is placed on Strategic Planning of Fire Management activities based on Burn Probabilities (i.e. a generalization of the concept of pointwise Annual Fire Ignition Frequencies) computed for each grid cell of the area in question. The goal has been to develop predictive models of forest fire consequences in the same area for different local conditions (e.g. weather). On-going research explores this possibility
as a way to describe the propagation of consequences in terms of the financial damage due to the fire emergency and the cost of the operations launched to deal with it. Meteorological conditions are considered therein as a random input to these models.

A different, variational approach was followed by other authors. In our own method, we will use a 1D variational model to describe the propagation of fire consequences, yielding a scalar ODE. The proposed method although it starts off as a “toy model”, has the potential of offering valuable insight on the interactions between the competing control mechanisms that influence forest fire growth, such as the

- Kind and quantity of available flammable material distributed over the terrain (depend on prior fuel treatment activities and topography)
- Response of the Fire Service (Fire Suppression – Containment actions during the emergency)
- Prevention – Mitigation works (such as observation posts, water tanks and forest roads constructed long before the wildfire season)
- Weather (e.g. local wind – precipitation – temperature conditions).

All control measures have a cost that is normally covered by public authorities. Thus their influence must be included in a cost functional, especially if we wish to accurately estimate the CP consequences of an incident. An example of such an optimal control functional in a variational context is given in the case of fire containment, using a man-made barrier to block the spreading forest fire. Optimal control in that case is achieved through minimization of the total incurred cost, including that of fire damages and barrier construction.

The fundamental variational principle proposed in the present paper is based on the assumption that all decisions made by the competent managers as well as all actions taken by the tactical forces (on-site) are rational and correct (based on exact, timely and complete information as well as on adequate resources for responding to the emergency). In other words, the FS response is always geared towards optimally confining the propagating forest fire.

This is of course a theoretical abstraction, not easily realizable in the field. Still, the concept of optimization is not only relevant in all of our practical CP considerations but pervasive in operations research as in all natural sciences. The underlying laws of mechanics (Hamilton’s least action), optics (Fermat’s least time) and many other principles of physics are all fundamentally variational. The systemic approach taken in this paper aims at encapsulating the basic real-time mechanisms that operate during a fire emergency. The present work is in the spirit of similar systemic efforts based on 2nd order ODEs that model the (time-series) development of forest fire regimes, i.e. the long-term behaviour of
wildfires in different geographical zones.

3. The mathematical model

The main on-site observations made during the Emergency (initial) phase of such incidents are:

- the rapid spreading of FF due to the fact that there is no counteraction during the first stage of its evolution since the Fire Service (FS) has not yet intervened
- if there is no prompt response or the FS intervention is inadequate then an escalation takes place (Crisis phase or FF intensification)
- if the Crisis remains out of control, the outcome of FF propagation is a Disaster (Run-away effect, eventually affecting nearby urban areas).

The 4 main physical factors that drive the spread of forest fires are:

- Meteorological conditions (including feedback from the emerging fire weather)
- Type and state of timber (physico-chemical properties of fuel)
- Surface density of fuels
- Wildland topography.

We introduce a new Variational Principle that will utilize the total cost functional defined as follows

\[ h(x, \dot{x}, t) = <VaR> \]

To compute this actual, time-evolving cost (h) we need to estimate the expected value (ensemble average) of the Values at Risk (VaR) random process, which is a purely actuarial quantity that describes the systemic interdependencies between the various stakeholders (fire service, civilian population, local economic & environmental concerns). This estimation can be performed either through stochastic simulations or using physical modeling. We will follow the latter approach in the present paper.

To come up with an equation that describes the time evolution of a FF, we need to employ a fundamental optimization principle corresponding either to cost minimization for natural fires or to cost maximization for deliberate incidents.

We define a cost rate functional (L) as the Lagrangian of our problem, i.e.

\[ h(x, \dot{x}, t) = \int_0^t L(x, \dot{x}, t') dt' \]

yielding an “action” integral, that is the cost functional (h) to be optimized through its first variation:
\[ \mathcal{G}(x, \dot{x}, t) = 0 \]

This equation, as we know from classical mechanics, produces the 1D Euler – Lagrange ODE:

\[
\frac{d}{dt} \left[ \frac{\partial L}{\partial \dot{x}} \right] - \frac{\partial L}{\partial x} = 0
\]

This is in general a nonlinear, second order, forced ODE with time-dependent coefficients. Assume, without any loss of generality, that (L) can be written in a “particle dynamics” form:

\[ L(x, \dot{x}, t) = T(\dot{x}) - V(x, \dot{x}, t) \]

where the potential functional (V) includes the meteorological and fire fighting parameters at play. The 2 most crucial actuarial parameters of our model are:

- the resource value surface density (d), which quantifies all kinds of flammable materials at risk in the field (measured in €/m²)
- the fire inertia (M), which depends on fuel type, its temperature & humidity as well as on forest topography (measured in sec €/m²).

If we expand the “kinetic energy” term (T) using a Taylor series around (0):

\[ T(\dot{x}) = d\dot{x} + \frac{M}{2} \dot{x}^2 + H.O.T \]

then the aforementioned actuarial parameters appear naturally as the (positive, constant) coefficients of this quadratic approximation. The functional (T) thus contains 2 cost-generating terms (damages) plus a series of higher order terms (H.O.T), which can be ignored for the small spreading rate scenario. This yields

\[ (M - V_{xx})\dddot{x} - V_{x\dot{x}} \ddot{x} + (V_x - V_{x\dot{x}}) \dot{x} + (V_{\dot{x}} - V_{x\dot{x}}) x = 0 \]

We realize at this point that the first order term is unphysical since it corresponds to cost dissipation (an impossible real-time effect for an irreversible process such as fire). We can remove this using the ansatz:

\[ V_{\dot{x}\dot{x}} = 0 \]

in order to simplify our ODE, which finally reads
We can assign to the coefficients \((a,b)\) physical significance by viewing \((a)\) as the Fire Service response function (man-made forcing of the ODE) and \((b)\) as the natural effect of meteorological phenomena on fire propagation, such as wind advection \((W)\) of the fire front or rainfall rate \((R)\).

If we want to further simplify our model, we can linearize it assuming that \((a)\) depends only on \((t)\), and \((b)\) is a quadratic function of \((x)\). This latter assumption reduces the scope of our study by excluding megafires, i.e. cases where \((x)\) becomes extremely large, thus allowing the following Taylor series approximation

\[
b(x,t) = p(t)x - \frac{g(t)}{2}x^2 + H.O.T
\]

Note that in general \((b)\) can produce a rather rare, time-dependent, negative forcing effect in the RHS of our ODE through the introduction of a precipitation term \((p)\). This forcing will depend (if non-zero) on the rainfall rate \((R)\), measured in units of speed. Finally, the resulting ODE becomes

\[
M\ddot{x} - g(t)x = f(t)
\]

with

\[
f(t) = a'(t) - p(t)
\]

The former formula is Schrödinger’s equation with forcing \((f)\). The RHS forcing term \((a)\) introduces the time scale of the Fire Service response into our model through the characteristic frequency \((\omega_0)\) of \(f(t)\), with \(f(t)<0\) (for fire suppression-containment) and a positive constant amplitude \((f_0)\) measured in \(\epsilon/\text{sec m}^2\). The latter quantity measures the FS capacity while \((\omega_0)\) measures its readiness.

The initial conditions (ICs) that complete our ODE problem are

\[
\dot{x}(0)=0, \quad x(0)=A
\]

where the initial FF spreading rate \((A)\) is a positive constant measured in \(m^2/\text{sec}\).

Proceeding with the non-dimensionalization of the problem, we introduce the following scales based on the fundamental dimensional quantities \((f_0, d, W)\):
This rescaling yields as ICs: $x(0)=0, \dot{x}(0)=\zeta$, where

$$\zeta = \frac{f_0}{dW^2}A$$

This formulation also produces a leading order term (L.O.T) of the ODE that scales as

$$\frac{M}{f_0}W^2\ddot{x}$$

Assuming that this rescaling leads to $O(1)$ terms for both RHS and LHS of the equation, since we have divided them by $(f_0)$, then the (squared) non-dimensional number which appears as a L.O.T coefficient

$$\delta^2 = \frac{M}{f_0}W^2$$

yields the (non-dimensional) BOUNDARY LAYER (BL) THICKNESS ($\delta$) of our problem. The 3rd and last non-dimensional number ($\sigma \tau$) appears in the RHS of the ODE in the form of

$$\sigma \tau = \frac{f_0}{d\omega_0}$$

i.e as the rescaled version of the Fire Service response cost density rate (FS expenditures per unit area and unit time during fire-fighting operations).

The other 2 characteristic numbers ($\delta, \zeta$) determine the features of our BL solution $(x)$. We thus note the important fact that the parameters describing an emergency (like its potential duration or intensity) are endogenous by nature, since they do not depend on the response time of the reacting forces, here expressed through $(\sigma \tau)$ or $(\omega_0)$. 
The small magnitude of (M), as we see in hydrodynamics [vii], implies the existence of a “Boundary Layer” solution for (x) near t=0. Its thickness (δ) is a measure of the potential duration of the (initial) emergency phase if there is no immediate FS response. We will examine some quantitatively important features of this solution in the next section.

4. Results

According to WKB theory, this ODE develops a Boundary Layer (BL) near (0) with thickness (δ). Its amplitude (intensity of the solution) is given by the non-dimensional formula:

\[ \text{Amplitude} \approx \delta \zeta \]

More generally for such a problem, inside the BL region, its non-dimensional solution can be approximated by

\[ x(t) = \delta \zeta \sinh(t/\delta) \]

If we utilize the 2\textsuperscript{nd} Initial Condition of the ODE \[dx/dt (0) = A > 0\], we derive a formula for the (positive, dimensional) characteristic surface of the affected area

\[ \text{Amplitude} \approx AWd\sqrt{Mf_0}^{-3/2} \]

This yields the consequences’ order of magnitude for the escalating FF, to be faced during its impending crisis phase.

Identifying the BL thickness as the duration of the emergency phase for the propagating fire, we can estimate through (δ) its (positive, dimensional) characteristic time scale, i.e.

\[ \text{Temergency} \approx Wd\sqrt{Mf_0}^{-3/2} \]

This time scale should be matched by the response time of the competing control mechanism (Fire Service), if any effective counter-action is to be taken. Hence, a prerequisite for launching a successful fire-fighting operation is the necessary but not sufficient condition

\[ \text{Temergency} \approx T_{response} \approx \omega_0^{-1} \]

To compute the Crisis duration (Tc), i.e. the time interval during which a major escalation may unfold if the initial emergency actually
remains out of control, we use the asymptotic matching region \((\sqrt{\delta})\) of the WKB theory [xvii] as its first approximation, or in dimensional form

\[
T_c \approx 4\sqrt{M} \sqrt{W} f_0^{-5/4} d
\]

A notable corollary of our model is that the Crisis duration is greater than that of the Emergency phase.

5. Critique of the results – Benefit to managers

The current lack of simple and usable quantitative tools for supporting decision makers [ii] in their analysis of the different alternatives they face during
- fire risk management
- operational management of fire-fighting activities
- strategic management of FF crises

has created the need to develop mathematical models based on probabilistic measures, specifically tailored to the (Civil Protection-Forest Service) managers’ needs. This goal can be achieved using actuarial methods to quantify all kinds of possible consequences (losses, damages, expenses) in monetary terms. Having this approach in mind we have developed here a simple ODE model that resulted in:
- an Emergency phase, as the necessary first step through which the consequences of a forest fire are propagated
- a clear mathematical explanation of the emergency evolution in time based on a new and distinctive physical mechanism (“boundary layer”)
- the differentiation between the first 2 consecutive stages (Emergency and Crisis), both discernible phases of the same FF propagation phenomenon, where the Crisis is identified by the ‘asymptotic matching region’ of the inner and outer ODE solutions
- a realistic escalation process, where all phases are potentially leading to new (graver), sequential (in time) Civil Protection situations that follow the fundamental logical schema:
  \text{Emergency} < \text{Crisis} < \text{Disaster}
- the possible appearance of a Disaster stage, which is the last, most intense in terms of consequences but nonlinear phase of the time evolution that cannot be described by our linear ODE model
- a crisis phase much longer than the emergency one for \(0<\delta<1\).
- This last remark has important implications in decision-making since it is contrary to the widespread belief that all Crises are extremely short periods of time, which hinder decision-making by creating a feeling among managers that they have “run out of time” [viii].
6. **Final Remarks - Conclusions**

The current lack of usable operational tools for fire risk management creates the need to develop a simple measure \( i \) of consequences based on the different incurred costs. Recent advances in calculating Burn Probabilities \([xiii]\) provide us with more informative and robust metrics, all coming from the discipline of actuarial risk analysis.

The possibility of developing better risk assessment models for Forest Fires (FF) using the so-called dynamic indices has been explored in the context of operational (day-to-day) FF management research in Southern Europe. The tools so far developed for this purpose are mostly based on the notion of the Risk Index \([xix]\). This positive number (usually scaled from 0 to 100) is a measure of the likelihood of forest fire initiation at a specific location (surface grid cell). The obvious problem with such a norm is that it does not take into account the way fire consequences are propagated through space (or equivalently the propensity of fire spread evolving in time). In order to be able to do just that, the competent manager must also possess information at least about the different assets at risk in his area of responsibility as well as an estimate of the vulnerability of these assets to the forest fire hazard. For CP purposes this factor is described by the distance between the fire source and various settlements or critical infrastructures of local communities.

Ultimately this effort aims at producing better forecasting tools not only for fire ignition but most importantly for fire spreading. This more general issue involves not only our capability of predicting forest damages but mainly the need of Civil Protection (CP) managers to quantify the consequences of an evolving fire emergency on the local societies at large, depending on the varying parameters of the different response scenarios (like alternative fire suppression - containment decisions and other CP operational choices). Of course if one wishes to go beyond the operational probabilistic estimates of fire occurrence for each forest grid cell and study the consequences of the CP phenomenon (especially their time evolution on the local population, economy and environment) then it is necessary to move from a simple numerical measure of forest fire risk (FFR Index of Ignition - mainly dependent on the status of the threatened vegetation) to a more complex norm like the Burn Probability \([i]\), which also takes into account the likelihood of a surface grid cell to be in the propagation path of a moving fire front.

The approach taken here is based on summing up some of the incurred Financial Costs using appropriate functionals (i.e. functions of functions). In the aforementioned work of San Miguel Ayanz \([xv]\), the main goal was to produce new FFR indices which could serve as operational forecasting tools. These so-called “integrated” indicators are based on a fusion of standard operational data (e.g. current state of vegetation and local
meteorological conditions) with fixed socio-economic characteristics (such as the vulnerability of local infrastructures, utilities and other financial assets). This combination may lead to more realistic risk assessments and thus to better, more up-to-date estimates of possible CP consequences for alternative response scenarios, based on different fire fighting - local government decisions.

The new stimulus coming from the present paper is our focus on actuarial notions of forest fire risk (especially of the “Value at Risk” – VaR random field), that can help us quantify consequences on the affected communities in terms of financial costs born after a forest fire emergency arises i.e. the costs of Fire Service Response as well as all incurred Material Damages. The term “material damages” is assumed to also cover value loss of affected residential areas and infrastructures in addition to that of the forest region. The term “Fire Service Response” includes the real-time containment and suppression costs of fire fighting operations.

Computational work has been performed [i] on estimating the connection between the financial (ex ante) cost incurred before a forest fire emergency arises (the so called “mitigation cost” covering mainly fuel treatment strategies) and the potential material damages caused by various forest fire scenarios. The actuarial approach taken in that paper involved the computation of a complex metric of consequences from different forest fire propagation possibilities in the Wildland Urban Interface (WUI). A strategic management tool for Forest Fire Risk Assessment (similar to FFR indices) in the WUI is developed therein based on the financial cost estimate of material damages inflicted by the CP phenomenon on these mixed regions, as it is altered by different mitigation scenarios, i.e. choices of strategic parameters like forest fuel treatment intensity. Damage probabilities (due to randomly initiated forest fires) are studied by CP management planners in order to a priori choose the best parameter values that minimize total financial loss over the entire affected area leading to a cost – benefit analysis. This approach will be in the near future an indispensable decision support tool for all effective quantitative management of similar CP phenomena. This cost – benefit analysis could also include discounted values of the resources at risk using actuarial projections.

In this paper a mathematical description of emergency situations was given based on actuarial-physical modeling. Our approach led naturally to the important result that an Emergency situation has in fact a Boundary Layer structure. The proposed variational model contains all essential wildfire propagation and confinement mechanisms. This novel approach was based on the optimisation of actuarial (cost) functionals of interest to civil protection managers. The cost functional produces a Lagrangian one –
A dimensional model that captures fundamental temporal aspects of forest like the boundary layer structure of its emergency phase.

The study of this initially very rapidly evolving temporal stage of the CP phenomenon in question attempts to go beyond the description of wildfire front propagation, through the actuarial approach that estimates different material consequences of the emergency on the affected area. In that way it was possible to draw some quantitative conclusions on the basic requirements for a successful emergency management of the situation (initial response of the civil protection forces and especially the rural Fire Service operations). The most important of those was the derivation of the characteristic time scales for the emergency and crisis phases, i.e. of operational-strategic parameters that are equally important to CP Managers and Fire Fighters alike.

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A website’s model-framework for green portals that promote forest recreation grounds near wetlands in Greece

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Abstract (only):
During the last years, Information and Communication Technologies (ICTs) have had a key role in all aspects of life, as ICT applies to many issues of modern life and supplies information practically and simply. Within that framework, the Internet can play a key role within the identification of regions and the promotion of local advantages, such as the enhanced natural environment that can also be the means to identify the region as a tourism destination for various target groups. Specifically, forest recreation is an alternative way of entertainment, which becomes very popular nowadays. The promotion of forest recreation grounds can be achieved adequately through practical applications within the internet such as websites that contain the related information or dynamic “green portals” in a wider aspect.

This paper aims in the exploitation of the potential of the Information and Communication Technologies (ICTs), through the World Wide Web, as a means for regional development. Specifically, a model of website, that promotes a forest recreational ground which adjoins to water lands, is proposed. Its purpose is to bring forward a model-website environment for promotion of the natural environment of a certain forest recreational ground related to water. This can be a recreation ground near a water spring, a lake, a river, an artificial dam etc. That particular model also intends in presenting the social effectiveness of the ground towards the local population and the region-society in general. The built up of such a website will be the spine of this research in order to achieve the best way of promoting a tourist development of the area using the philosophy of sustainable “multi-use” forestry and respect the native landscape.

Internet technology and HTML programming were used in order to design and develop a user-friendly framework. The project was entirely developed by using Dreamweaver MX 2004, which is a Graphical User Interface-GUI program that also allows code and script writing. There were also used other software, such as Photoshop and Flash for image processing and graphic design.
The website’s content and framework were designed according to the basic web design principles that were located in the bibliography, since it addresses to a range of end-users, not all of them computer literate. This website’s model aims to combine all the desirable characteristics of content with the desirable traits of a well designed website, such as the aesthetics, the effectiveness, easy navigation, the usefulness and the short download time for each page. The model’s structure, which acts as a green portal of local aspect, contains several individual web pages classified in specific thematic unities. The main purpose was to create a website that aims in the recognition of an area, as it contains reliable information about the available tourist and recreational activities, the cultural events, the natural history and the natural resources of the area. The whole project emphasizes in the diffusion of rich and reliable information, aiming at user-friendly structure that attracts the visitor. The main advantage of the website is the fast and easy updating of site contents that allows the web administrator to supply users with the latest comparative information about the forest recreational ground. Moreover, the capability of data gathering by the use of web-polls and questionnaires combines a special interface between the website and the user. The model is appropriately designed to facilitate potential users to easily find the needed information and study the material. This model can be used by municipalities of Greece as it assembles all the desirable characteristics of content. A website based on the proposed model could be exploited as an independent website or as a chapter placed among a greater web portal. Finally, a simulated model website was developed in order to test and demonstrate the extent of usability, navigability and accessibility of the intended model. This website is related to the forest recreational ground of Thermi’s dam in the region of Thessalonica- Greece. This website called “tofragmatisthermis.gr” presents and analyzes the social, environmental and cultural offer of this recreation ground to the local society.

**Keywords:**
Wetlands, forest recreation ground, regional development, dynamic modelling, simulation based design
The programming environment of NETLOGO as a tool for introducing Greek high school students to eco-systemic thinking

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Abstract:
In this paper, the capacity and effectiveness of the NetLogo programming environment is investigated, as regards assisting students, of the Greek Upper Secondary Education, to understand how some simple ecosystems are structured and to model the behaviour of such ecosystems by conceptualizing their Complexity. This paper is part of a wider research on teaching Ecosystem Complexity to high-school and university students with the use of Information and Communication Technologies (ICT’s). Two specific models from the NetLogo Models’ Library are used: the “Wolf Sheep Predation”, and its variation, the “Wolf Sheep Predation (docked)”. Both simulate evolving ecosystems, developed, nevertheless, as two different versions: the former being a visual representation of the co-evolution and co-existence of three different populations; wolves, sheep and grass, connected with prey-and-predator relationships and the latter being a graphical representation of two of these populations; wolves and sheep, together with a simple systemic model of their interactions and evolution. The two models were introduced in the classroom on the basis of a newly developed teaching methodology. Two groups, each consisting
of five students, of the 2nd class of the Greek Lyceum (aged between 16 and 17) participated in the investigation. Four one-hour teaching sessions were carried out with each group. Each group was informed about the systemic behaviour of the simple ecosystem with wolves and sheep (and optionally grass) and, in turn, about their prey-and-predator relationship. The students were then asked to run the simulation and study the resulting graph. They were then instructed to change the parameters of the platform, in order to study the resulting complex behaviour. The students were then asked to express their opinions, thoughts and predictions, based on the results attained. In each teaching hour, both groups of students were given specifically designed worksheets which were progressively updated during the experiment. The worksheets, completed by each student, were studied and evaluated. Post-instructional evaluation, of the two groups, was also conducted both orally (by means of cassettes) and in written form, through the use of an evaluation sheet. The findings of this research proved to be encouraging in that students developed a greater understanding of the complex behaviour of ecosystems.

**Keywords:** ecosystemic-thinking, education, NetLogo, classroom, complexity.

1. Introduction

The aim of the current research was to investigate whether High-school students’ ability to achieve systemic thinking, and in particular ecosystemic thinking, could be enforced and enhanced with the use of specific software. Systems’ thinking is defined as the ability to understand and interpret complex systems (Evagorou, et al., 2009). Ecosystems are considered complex systems with respect to their three essential properties (Levin, 1998): (i) sustained diversity and individuality of components, (ii) localized interactions among these components and (iii) an autonomous process that selects from these components – based on the results of local interactions – a subset for replication or enhancement. Taking these properties into consideration, it becomes apparent that eco-systemic thinking is a perfectly valid expression of systemic thinking. Even in the case that the famous alternative definition of Complex Adaptive Systems (CAS’s) given by Holland (1995) is used, attributing to such systems four basic properties: aggregation, non-linearity, diversity and flows, it is again obvious that ecosystems are indeed complex (adaptive) systems and thus, eco-systemic thinking is a form of systemic thinking.
In this respect, the current research examines if students, of Greek Upper Secondary Education, can understand the systemic features of a simple model-ecosystem, consisting of only one prey and one predator. The definition of what “learning about the systemic nature of ecosystems” actually means, is given as: “The main goal of having students learn about systems is not to have them talk about systems in abstract terms, but to enhance their ability (and inclination) to attend to various aspects of particular systems, in attempting to understand or deal with the whole” (American Association for the Advanced of Science, AAAS, 1993; p.262), and is employed in this research.

2. Method

2.1 The objectives

A number of methods and tools have been developed, in order to reveal students’ and teachers’ conceptions of simple dynamic systems and ecosystems (Sweeney and Sterman, 2007). There is evidence that even laypeople that have completed Secondary Education cannot easily define the structure or understand even the simplest simulations of ecosystem dynamics (Jensen and Brehmer, 2003). Therefore, our strategy was focused on four didactical objectives. Students should:

- Understand, through computer simulation, the meaning of the entities composing the modeled ecosystem,
- Be able to conceptualize the effects that parameter changes have on the modeled system.
- Be in a position to reproduce, on paper, a similar model, using the same set of symbols as the ones they were faced with, originally. The only things altered are the names of the constituents of the model.
- Develop the ability of constructing a similar ecosystem dynamics’ model, given only the parts of it.

A secondary objective was to be able to realise that while intervening on an (eco)system, the parts of it that are affected are much more than the ones that we initially see.

2.2 The instrument

As a working environment for teaching students, the programming language/environment NetLogo was used (Wilensky, 1999) (version 4.0.4). NetLogo is a programming tool suitable for simulating, studying and understanding of complex systems. It is a modern variation of the Logo programming language, simulating the function of Multi-Agent-Based systems. Each agent of NetLogo (typically called a “turtle”) follows
a simple set of rules, defined by the writer of the code. The abovementioned set of rules “guide” the agent in its motion among certain pixels of the screen, named now “patches”. The code additionally defines the action which the turtle should perform on the patch when it meets it, such as changing its colour.

The agents act, to a certain extent, independently from each other and yet the “turtle’s” choice of which “patch” to move to and what task to perform on it, is also determined by the “status” of the patch it arrives at – the degree of influence being usually determined by the programmer.

NetLogo provides an extensive “Models’ Library”, simulating a variety of complex systems. The two simulations used in the present teaching sequence come directly from this Models’ Library and they are: the “Wolf Sheep Predation” Model (Wilensky, 1997) and the “Wolf Sheep Predation (docked)” Model (Wilensky, 2005), which is a variation of the first, concerning more the dynamics of the system. In both these simulations, we have two kinds of agents: the “wolves” and the “sheep” (there is also “grass”, which can be optionally activated, only in the first of the two models, mentioned above). The agents are interconnected by relationships of a simple prey-and-predator nature. Both kinds of agent have also a rate of reproduction, imposed by the user of the simulation, and a rate of death, apart from the sheep deaths due to predation. The first model, “Wolf Sheep Predation” is used mainly to familiarize the student with the multi-agent simulation, in the sense that the students interact with it, change its parameters and see the results both on the simulation screen but also on the graph screen which, in turn, depicts the time-evolution of the populations. The focus of interest for the teaching sequence is the second simulation, called the “Wolf Sheep Predation (docked)” (Wilensky, 2005). When opening the corresponding file, the student is faced with two screens. The one is the typical NetLogo environment, depicted in Figure 1.

In the left part of this screen the typical agent-model of NetLogo for one-prey-and one-predator simulation exists. It is called “Agent Model” and the students may interact with it, as in the previous model, to visualize the time-evolution of the populations when altering parameters of the system. The right part of the screen is called the “Aggregate Model” and its evolution is only graphically depicted. This part of the screen describes the evolution of the two populations, based strictly on mathematical description, and provided, in turn, by a form of the famous set of the two Lotka-Volterra equations (Lotka 1956; Wilensky and Reisman, 1999, 2006).

Apart from this screen, another part of the second simulation is the screen called “System Dynamics Modeler”, created in a Java environment, which is shown in Figure 2.
Figure 1  A screenshot of the NetLogo environment. The “Wolf Sheep Predation (docked)”

Figure 2  A screenshot of the System Dynamics Modeler
This second screen is exactly the one that focus is given on, being directly related to the “Aggregate Model”. It represents the dynamic system-model of the prey-predator system, depicting additionally its interrelations, feedback loops and flows.

2.3 The sample and the settings

This teaching sequence was part of a wider research, concerning the teaching and learning of Ecosystem Complexity at the Upper-Secondary-Education student level, with the use of computers. For this research, a sample of 10 voluntarily participating students was used. The students belonged to two different schools, and were at the 2nd class of the Greek Lyceum (ages between 16 and 17). Their orientation was either the Technical or Science education, therefore guaranteeing a satisfactory background in Mathematics, Physics and Biology. The two schools were of neighbouring areas of Athens, Greece, and the two groups had similar socioeconomic status, gender mix and school-grade achievement. Each group was taught separately, by the same one of the researchers, for four teaching hours, and he provided each student with 4 worksheets – one for each teaching hour – which they completed during the process of the instruction. The students worked with computers, in groups of one or two, depending on computer availability. In addition to the printed worksheets, students’ answers, as well as the discussion in the classroom were tape-recorded.

3. The instruction process and the delivered material

The first two teaching hours were dedicated in familiarizing students with the NetLogo environment, particularly with prey-and-predator simulations. For this purpose, the “Wolf Sheep Predation” Model was used.

Within the first teaching session (teaching hour), the students were asked to handle each button in the NetLogo environment and try to learn its function. After each question on the worksheet, there followed a class discussion, mediated by the instructor. The following are sample questions from the first-hour worksheet:

- Question Number 3: ‘Run the simulation at a low speed (“lower”) and try to find out what the sliders “initial-number-sheep”, “initial-number-wolves”, “wolf gain from food”, “sheep-reproduce” and “wolf-reproduce” actually do. Write your answers down.’
- Question Number 4: ‘Now let us discuss and reach a common conclusion about the role of each of the sliders.’
Through some other questions, the students were introduced visually and verbally to the concept of “(eco)system instability”, since one population in the model occasionally becomes extinct.

During the second session, the simulation “Wolf Sheep Predation (docked)” was introduced. The participants were asked first to investigate the “Agent Model”-section of the NetLogo screen, which resembles the previous simulation. They interacted with this section, noticing the outcome in the simulation area and on the graph. Their attention was then driven to the right part of the screen, the “Aggregate Model”, having been now asked to find the meaning and the role of the sliders, noticing that the outcome of the user’s interaction with the system was shown only graphically. Simultaneously, the students were given on their computers’ screens a presentation about the Lotka-Volterra equations. The students were then encouraged to discuss their findings with the class. Furthermore, the students were prompted, by the worksheet, to write down or discuss verbally the relation and differences between the Agent and the Aggregate Model, observing the effects live, by pushing the “Compare” and “Step Compare” buttons.

In the third teaching session (hour), the class was introduced to the System Dynamics Modeler. The aim was to conceptualize the direct connection of this model with the Aggregate Models’ parameters and the way in which this relation is established. The students were asked what the arrows, boxes, “taps”, and lozenges actually mean in the Modeler, and how they could interfere with them (through the mouse of their PC). Towards the end of the worksheet, a first direct objective was achieved, seeing what the effect was on the System Dynamics Modeler, when they altered the position of a slider in the Aggregate Model Worksheet.

Question Number 6: ‘Fill in the gaps below and create similar sentences: “When I increase …………… in the simulation, in essence I make the box ………in size”. “When I reduce ……………in the simulation, in essence I make the arrow …………… in width.”, or “let less flow pass through the “tap” ……..” We also asked for verbal answers, which we tape-recorded.

Later in the same session, each student was given the opportunity to think and reconsider Question 6. The issue was whether only one thing is affected in the Modeler when one changes something in the NetLogo Screen, or more. Afterwards, the notion of “systemic thinking” and especially “ecosystemic thinking” was introduced, and its importance to the conservation of the Earth, as a whole. At the end of this third hour session, a paper was given to the students, reading:

“We should see the parts of an ecosystem as interrelated and not as separate entities (this is called “reductionist thinking”). It is easy to see
that human interference constitutes one of these parts and it can affect many more parts than those that we initially estimated!!"

In the last session, further skills of systemic thinking and modeling were developed, through the System Dynamics Modeler. Mainly, this session consisted of two stages. At the first stage, students were given a piece of paper other than the worksheet, which was identical to the model depicted in the modeler, but the terms – the words – had been removed (refer to Figure 3)

![System Dynamics Modeler without the terms](image)

**Figure 3** The System Dynamics Modeler without the terms

Here the students were asked to fill in the following words or phrases: Water deposits in an area / average rainfall rate in the area / birth rate in the area / water returning to the sea, the lakes or the under-surface horizon / consumption of water in cubic meters per person / population increase in the area / water increase in the area / peoples’ deaths in the area / population of the area / rate of deaths in the area. They do this in the way they think proper.

At the second stage, students were given the elements of the System Dynamics Modeler, as shown at Figure 4.
The elements of the Modeler

They were allowed to use each part freely, in order to create a description of the (eco)system: “The amount of solar energy entering the Baikal lake in Russia, in relation to the seaweeds growing and dying in this lake, and the photosynthesis they perform, engaging this energy.”

4. Results

Despite the limited size of the sample, which does not allow to draw general conclusions, this research depicted that the use of the NetLogo as a teaching environment, together with the System Dynamics Modeler, can help high-school students in understanding simple (eco)system structures, and in acquiring, or slightly improving, certain skills on models’ construction and representation. Similarly to the practices followed with modelling tools, other than the System Dynamics Modeler of NetLogo, such as the Stagecast Creator (SC) (Papaevripidou, et al., 2007), used for Primary School students, the oral answers of the students were used in the present survey as an encouraging feedback concerning the use of the software as a means of understanding the model. For example, the answer of a girl, Christine, of low school achievement, is quoted, within the tape-recorded discussion, following the aforementioned Question Number 6, in the third teaching session: ‘Yes, by changing the sliders’ positions in the Aggregate Model, I can better see what every shape in the System Dynamics Modeler means.’

In Question Number 7, of the same worksheet, where they were asked to reconsider their answer in Number 6, they were prompted to see the wider interconnectedness of the factors in this simple prey-and-predator population system. This is not at all easy for high-school students, as was shown in the research of Barman, Griffiths and Okebukola, recorded as “misconception no. 2” (Barman, et al., 1995). There students were found rather to believe that the change in one population affects only its closest prey and itself. In the answer to Question 7, a student, John, who is of a medium school achievement, is quoted:
‘It seems that one motion of the slider can change the whole system. So if we touch the “predator-efficiency”, we increase the number of births of wolves, thus we increase predation-rate of them which, in turn, increases the number of dying sheep. As a result, the number of wolves is increased in one hand, but the amount of sheep (food) is decreased, so the wolves will have problems. Many such changes are done.’

The concept investigated and aimed at improving here was one of the concepts of what White (White, 1997) calls “naive ecology”. The relations in this simple prey-and-predator system are strictly causal (‘the wolf eats the sheep thus sheep die’, or ‘the wolves have no sheep to eat, thus they gradually become extinct’) and the learners are asked to follow such causal relations, as far as they can, relatively to the initial point of focus, which could be everything (e.g. ‘wolves die’). White’s research also depicted that the persons cannot follow such a causal string of facts in ecology, too far from the point of origin.

The students’ answers were also close enough to the eco-systemic, holistic conclusion, before this was finally distributed to them written on paper, therefore their stands and attitudes seemed to be adequately investigated and, possibly, changed. Katherine, a student with school achievement belonging to the lower part of the sample, wrote:

‘This indicates that whatever we touch in an ecosystem, this also affects the other factors too, and, therefore, we must never change something that needs not be touched, because this would affect many more factors than the ones we initially estimated!’

The one of the two higher system-thinking objectives, which is to represent a system very similar to the one studied, but having differently named parts or terms, was satisfactorily achieved, as is represented by the Figure 5 given by Denis, who belonged to the medium area of the sample as regards school grades’ achievement.
This skill here refers mainly to the Systems-Based Inquiry (S-BI) protocol used by Sweeney and Sterman (2007), in ecosystems, and especially its first two parts:

‘Part I: Systemic scenarios: Participants consider system dynamics in [six] simple scenarios. These scenarios emphasize feedback dynamics.

Part II: Homology challenges: Participants imagine [six] related but different systemic scenarios. This requires participants to use homological reasoning.’ (Sweeney and Sterman, 2007)

Homological reasoning, as well as analogical system-thinking, both in their very simple expressions, was cultivated, to a certain extent, to all of the students, as Denis’s drawing (who reflects an average of the sample)
reveals. Passing to an ecological phenomenon other than “predation”, which is “water consumption”, the students appeared to be 100% correct in adopting the terminology and conceptualising the analogies.

Finally the other, even higher, system-thinking and system-constructing objective, aimed at, was to construct a model – again similar to the initial – having only the elements of it. Such modeling tasks are not easy, as researchers have shown (Hogan, 2000; Jensen and Brehmer, 2003). Hogan used only textbook-based teaching and asked the learners to construct simple food webs, in the sense of only putting the arrows in them (‘who eats what’), giving the reasoning for their choices. The results were poor. Jensen and Brehmen asked a sample of post-secondary-education individuals to study a predator-and-prey model very close to the one we chose. The task of the subjects was to control certain processes in the model, and it is depicted in Figure 6.

Specifically, the task here for the (undergraduate psychology) students, was to establish population equilibrium in this system. They tried this on the computer (changing only one numeric parameter, the “foxes”) and they relied either on mathematical approach or on negative feedback-loops. The results were again poor (less than 50% did it) and as one of the main reasons for this low performance, the authors give:

‘One possible reason why the rabbit–fox problem is difficult may be that it is not easily decomposed into subsystems or homomorphs. Since they are so closely intertwined, it is not feasible to split the system into a rabbit system and a fox system. Therefore it is not possible to simplify it. This may contribute to the difficulties in forming a clear-cut model of the system.’ (Jensen and Brehmer, 2003).

Therefore, one important competency in understanding an (eco)system, is de-composing it to its parts, which was what the half of our last activity was about. The other half of the activity is attempting, with these same parts, to build a similar ecosystem.
The subject-task interaction, as conceived by Jensen and Brehmer (2003)

Figure 6 The subject-task interaction, as conceived by Jensen and Brehmer (2003)

The sheet as completed by George (at left) and Christine (at right)

Figure 7 The sheet as completed by George (at left) and Christine (at right)

As a measure of the results of this last activity on the sample, two drawings are presented: Figure 7 depicts the model made by the highest-school-achievement student of the whole sample (George), as well as the
one made by the lowest-school-achievement student of the whole sample (Christine).

It can be noticed that, even though the “better student” has made a more flexible shape, and he adds even subtle and unneeded details, whereas the “weaker student” sticks more to the original and omits certain terms, the basic representation of this alternative ecosystem (“Lake Baikal and the seaweeds”) is essentially achieved in both drawings.

6. Conclusions

Secondary Education students, as well as from its results, it becomes apparent that the programming and simulation environment of NetLogo could be a very useful tool in assisting the students to acquire ecosystem modeling abilities. Recognizing the parts which constitute the model of a simple prey-and-predator system, attributing the proper names to the model’s parts of a similar ecosystem which, however, bears no relation to predation, and, finally, constructing another ecosystem’s model with similar structure as the prey-and-predator one, were all skills and abilities achieved by the use and interaction with two of the simulations among the ones that the NetLogo simulation tool provides with.

The core concept of the research performed here was that, by moving a slider or by changing a parameter in the NetLogo simulation environment, of an ecosystem, the student always interacts with something within the model of the system, which is represented by compartments and flows. Therefore, the students gradually become acquainted with the manners they can intervene with the modeled ecosystem, as well as with the extent to which this impact might reach. By this latter conceptualization, it was depicted that certain ecological attitudes and ways of reasoning, beneficial for the human-environment relationship, evolved.

It should be stressed that even the low-school-performance students reached a satisfactory level in their ecosystem modeling skills, as described in the research’s report, and this is considered to be a typical characteristic of learning by tools such as NetLogo.

References


Methodologies and a Guide for Municipal Solid Waste Landfills Site Selection

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Abstract:
The rapid growing population rates resulted in the need of developing efficient waste management systems, as the municipal solid waste (MSW) landfills that are already in use cannot meet regional landfilling demands. Although solid waste management is generally approved by developing countries as a measure of technical-economical systems evaluation, public opposition remains one of the major problems that local governments have to overcome. This opposition, widely known as NIMBY (Never In My Back Yard) phenomenon, inhibits MSW landfill siting near residential areas, increasing the difficulty of finding suitable sites. Apart from community opposition, a variety of factors must be included in the landfill site selection analysis in order to eliminate rising obstructions, as an inappropriate site may have negative economical, environmental and social impacts. For this reason, during the last years an intense effort to integrate Geographical Information Systems (GIS) with Multiple Criteria Decision Analysis Methods has been taken place. This synergy results to the so called MultiCriteria Spatial Decision Support Systems (MC-SDSS). The application of MC-SDSS enables the efficient management, elaboration and performance of spatial information, whilst site selection evaluation process is supported by the use of appropriate methodological frameworks. This study presents a bibliographical survey of the methodologies, in particular the decision rules and the criteria weights elicitation methods,
that have been used in landfill suitability analysis problems in the past. A real case study also serves as guide on how to carry out a suitability analysis for MSW landfills site, taking into account the accumulated experience over the past twenty years.

**Keywords:** MSW Landfill Siting, Spatial Decision Support Systems, Multicriteria Analysis

1. Introduction

Landfill site selection process is considered as one of the most critical tasks related to Municipal Solid Waste Management (MSWM), as far as we concern with the consequences caused to the natural environment and the social opposition that may evoked by landfill siting. In addition to lack of appropriate infrastructures, the urbanization pertains to waste management, raises severe issues concerning public health and residential area’s ecology. The situation in Greece is aggravating given the expected growth in rate’s daily generation of waste (0.16 kg/cap/day around 2010) (Mavropoulos 2000), and the fact that a huge amount of the annually generated waste is disposed in uncontrollable dumps. The realization of appropriate public works that provide effective management of the forthcoming regional landfilling needs is considered of high importance.

The construction of new landfills must comply with national and European regulations. In Greece the institutional framework (114218/1997 and its successors 69728/824, 17/5/1996) regarding the effective management of the solid waste have been legislated in order to comply with the European Union directives. According to them both criteria and constraints must be taken into consideration by engineers, planners and local authorities when landfill siting processes are taking place. Furthermore, technical specifications related to the design of new landfills and the remediation of old ones are provided. However, the national framework does not enforce strict constraints regarding the siting process, because the last may vary according to the study area’s characteristics. Furthermore, the site selection evaluation process does not fully depend on the prevailing regulations. It should also comply with numerous economic, environmental, engineering and sociocultural factors, aiming to minimize the opposition that may arise. In particular, the NIMBY ‘Never In My Back Yard’ phenomenon, namely the citizens raising opposition to landfills realization near residential areas, is ought to be responsible for the failures during the site selection process (causing huge economical, political, social cost) and thus the increasing difficulty for finding appropriate sites. Therefore, there is an urgent need for using methodologies that can assure an accurate decision making; and, on the
other hand, that can ensure environmental impacts minimization and public acceptance.

The spatial nature of the MSW landfills site selection imposes the combined use of GIS with decision analysis methodologies. This synergy results to the development of the so called MultiCriteria Spatial Decision Support Systems (MC-SDSS), which allow acceptable locations ranking according to their contribution in satisfying analysis objectives. MC-SDSS aim to the development of methodologies, rules and software that enable effective decision maker’s preference handling and Suitability Index estimations mapping.

2. Landfill Siting using MC-SDSS

The indisputable advantages derived by the synergy of GIS with the Multicriteria Decision Analysis Methods resulted to the publication of a large number of scientific articles during the last two decades. Granted the advances in computer science which resulted to the distribution of more user friendly GIS software packages during the 90s, many papers deal with the application of MC-SDSS in the landfill siting process. In the present study, sixteen articles published in the most important scientific journals were detected, in which the candidate landfill sites evaluation is conducted with the use of Spatial Multicriteria Decision Analysis Methods. The fact that 25% of them are published in 2008, outlines a dynamically evolving research area (Figure 1).

![Figure 1: Research Area’s Development over the Years](image)

The approach of the decision problem as an investigation process for possible locations that sanitary landfills can be placed reflects the
predominance of raster analysis over the vector ones with 81.25%. Without dispute the above is mainly owed to advances in remote sensing, digital image interpretation and processing research areas. On the contrary, there are few cases in which the landfill siting evaluation, being considered as a selection problem among a relatively small number of alternatives, is performed using vector datasets.

The Simple Additive Weight (SAW) method is the most commonly used decision rule among the articles with a percentage of 68.75. Among them only the 18.75% uses utility or fuzzy membership for attributes standardization. The predominance of the additive value function methods as the most favourite approach among the authors also arises by the used criterion weights elicitation methods. As it is shown in Table 1, AHP and Ratio methods are the most common practice (87.5%) in the examined articles.

3. Suitability Analysis Combining GIS, AHP and TOPSIS

The combined use of GIS and decision analysis methods broadens both the research area’s capabilities in a complementary way. This synergy provides a consistent framework for dealing with conflicting objectives, in structured or semi-structured spatially related problems, by taking into account stakeholders’ preferences. Recent developments in both fields expand the abilities of the Boolean overlay procedures, which are supported by the commercial GIS software packages, to the consideration of decision criteria as well. MultiCriteria Spatial Decision Support Systems (MC-SDSS) maximize the efficiency of the whole analysis, allowing the ranking of the acceptable solutions according to their relative importance in satisfying analysis objectives.

In the present paper Analytic Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) are combined in order to identify the appropriate sites for landfill implementation according to decision makers’ preferences. Developed by T.L. Saaty (1995), AHP is a multicriteria method for dealing with complex decision-making problems in which many competing alternatives (projects, actions, scenarios) exist. Alternatives are ranked, depending on how they contribute in achieving an overall goal, forming matrices of pairwise comparisons. AHP is based on a hierarchical structuring of the elements that are involved in a decision problem. The hierarchy incorporates the knowledge, the experience and the intuition of the decision-maker for the specific problem (Banai-Kashani 1989).
Table 1: Decision Rules, Criteria Weights Elicitation Methods

<table>
<thead>
<tr>
<th>Reference</th>
<th>Decision Rule</th>
<th>Criterion Weights Elicitation Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siddiqui et al. 1996</td>
<td>SAW</td>
<td>AHP</td>
</tr>
<tr>
<td>MacDonald 1996</td>
<td>WLC</td>
<td>AHP</td>
</tr>
<tr>
<td>Kao et al. 1996</td>
<td>WLC</td>
<td>RATIO</td>
</tr>
<tr>
<td>Baban et al. 1998</td>
<td>SAW</td>
<td>RATIO</td>
</tr>
<tr>
<td>Karkazi et al. 2001</td>
<td>WLC</td>
<td>RATIO</td>
</tr>
<tr>
<td>Leao et al. 2001</td>
<td>SAW</td>
<td>RATIO</td>
</tr>
<tr>
<td>Vatalis &amp; Manoliadis 2002</td>
<td>Compromise Programming</td>
<td>Not Defined</td>
</tr>
<tr>
<td>Kontos et al. 2003</td>
<td>SAW</td>
<td>AHP</td>
</tr>
<tr>
<td>Leao et al. 2004</td>
<td>SAW</td>
<td>RATIO</td>
</tr>
<tr>
<td>Kontos et al. 2005</td>
<td>SAW</td>
<td>AHP</td>
</tr>
<tr>
<td>Sener et al. 2006</td>
<td>SAW</td>
<td>AHP</td>
</tr>
<tr>
<td>Gemitzi et al. 2007</td>
<td>OWA</td>
<td>AHP</td>
</tr>
<tr>
<td>Chang et al. 2008</td>
<td>SAW</td>
<td>FAHP</td>
</tr>
<tr>
<td>Zamorano et al. 2008</td>
<td>SAW</td>
<td>RATIO</td>
</tr>
<tr>
<td>Delgado et al. 2008</td>
<td>SAW</td>
<td>RATIO</td>
</tr>
<tr>
<td>Sumathi et al. 2008</td>
<td>SAW</td>
<td>AHP</td>
</tr>
</tbody>
</table>

\[
(A - \lambda_{max}I)w = 0
\]  
(1)

\[
c_i = \frac{S_i^-}{S_i^+ + S_i^-}, \quad 0 \leq c_i \leq 1
\]  
(2)

\[
S_i^+ = \left( \sum_{j=1}^{m} w_j \times (s_{ij}^x - s_{ij}^x)^2 \right)^{1/2}
\]  
(3)

\[
S_i^- = \left( \sum_{j=1}^{m} w_j \times (s_{ij}^x - s_{ij}^x)^2 \right)^{1/2}
\]  
(4)

Hierarchy’s objectives and sub-objectives relative priorities are obtained by comparing every element in a branch against its peers with respect to the parent node. Technically this is achieved forming pairwise comparison matrices \( A_{ij} \) for every one of the hierarchy’s branches. Every element \( a_{ij} \) of the matrix represents the importance of the row element \( i \) over the element in the column \( j \). AHP provides decision makers with the nine level fundamental scale of preferences in order to establish the measurement of the dominance relation. Respectively the inverse relation \( a_{ij} \) equals to \( 1/a_{ij} \). Relative priorities \( w_i \) are then established as the right principal eigenvector \( \lambda_{max} \) (Eq. 1) of the pairwise comparison matrix \( A_{ij} \) (Saaty 1995). Alternatives rankings are obtained using the estimation of the relative closeness index \( c_i \) (Eq. 2) according to TOPSIS methodological
framework for synthesizing decision makers’ preferences (Yoon and Hwang 1995). The measure of relative closeness, for every one of the alternatives, is estimated via normalization of the proximity and the remoteness from the ideal and anti-ideal solution respectively according to the Equations 3 and 4.

Figure 2: The study area

4. Case Study

Evaluation criteria in GIS based suitability analysis are principally categorised as constraints, decision criteria, and decision criteria in which a threshold value is considered as constraint. Constraints aim to determine multicriteria analysis feasible solutions. On the contrary, decision criteria provide the analysis with the alternatives performance attributes. Effective handling of commensurate issues regarding the different scales of alternatives performance measurement is achieved through the transition from the attribute maps to decision makers preferential system mapping. This transitions is by the most part achieved using a/ Ratio (R), b/ Linear (L), c/ Utility Functions (UF), d/ Fuzzy Membership Functions (FMF), e/ Pairwise Comparisons (PC) and f/ Fuzzy Ratio (FR) as standardization (normalization) procedures.
In the present paper, a case study concerning landfill siting in the Evros prefecture is presented. Decision criteria weights are estimated using AHP, while the synthesis of the analysis factors is performed with the TOPSIS decision rule. The Evros prefecture is located at the northeast edge of Greece, occupying a total area of 4.242 km$^2$ with population of 149,354 according to the national census data. It borders with Turkey (Easterly), Bulgaria (Northly) and the prefecture of Rodopi (Westerly) (Figure 2). In the present study particular significance is given to the alternatives evaluation with respect not only to the nearby presence of infrastructures and residential areas, but also to the development prosperities insurance, which are mainly provoked by the protection of natural environment and resources.

Site suitability analysis is performed applying fourteen decision criteria, which form a four-level hierarchical model, as shown in Figure 3. According to the decision analysis model, the first level outlines the goal of site suitability for placing a landfill, the second and the third level depict the criteria and the subcriteria respectively, whereas the forth level represents the final recommendation. The applied criteria are related to geological, environmental, and available infrastructures considerations in the study area.
4.1 Technical Considerations

Technical considerations are addressed to the minimization of the costs regarding land acquisition and appropriate terraced works. They are formed using thematic data concerning the lithology, the slopes, the distance from the faults and finally the land uses.

Lithology

The area’s lithology is related directly to the excavations cost, therefore affects the final recommendation. Siddiqui et al. (1996), determine this criterion’s measure by applying the distance from the depth to bedrock. In the present study the evaluation is performed by classifying geological formations usually as porous loose rocks, semi consolidated rocks and hard rocks based on data provided by the Greek Institute of Geology and Mineral Explorations.

Table 2: Slopes Criterion

<table>
<thead>
<tr>
<th>Reference</th>
<th>SP</th>
<th>CC</th>
<th>TV</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siddiqui et al. 1996</td>
<td>PC</td>
<td>x</td>
<td></td>
<td>Descend</td>
</tr>
<tr>
<td>Kao et al. 1996</td>
<td>R</td>
<td>x</td>
<td>40 %</td>
<td>Descend</td>
</tr>
<tr>
<td>Leao et al. 2001</td>
<td>R</td>
<td>x</td>
<td>20 %</td>
<td>Descend</td>
</tr>
<tr>
<td>Vatalis et al. 2002</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Descend</td>
</tr>
<tr>
<td>Kontos et al. 2003</td>
<td>√</td>
<td>x</td>
<td>30 %</td>
<td>Descend</td>
</tr>
<tr>
<td>Leao et al. 2004</td>
<td>L</td>
<td>x</td>
<td>20 %</td>
<td>Descend</td>
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<tr>
<td>Kontos et al. 2005</td>
<td>R</td>
<td>x</td>
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<td>Descend</td>
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<td>Sener et al. 2006</td>
<td>R</td>
<td>x</td>
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<td>Descend</td>
</tr>
<tr>
<td>Gemitzi et al. 2007</td>
<td>FMF</td>
<td>x</td>
<td></td>
<td>Descend</td>
</tr>
<tr>
<td>Chang et al. 2008</td>
<td>√</td>
<td>x</td>
<td>12 %</td>
<td>Descend</td>
</tr>
<tr>
<td>Zamorano et al. 2008</td>
<td>L</td>
<td>x</td>
<td></td>
<td>Descend</td>
</tr>
<tr>
<td>Delgado et al. 2008</td>
<td>R</td>
<td>x</td>
<td>30 %</td>
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</tr>
<tr>
<td>Sumathi et al. 2008</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
</tbody>
</table>

SP: Standardization Procedures  
CC: Constraint Criterion  
TV: Threshold Values  
CT: Criterion Type

Slopes

In order to eliminate the ground formation cost and the risk of landfill’s derivatives leaking, only areas with flat ground or even with small land slope are considered suitable for landfill siting. These areas are given high grade of suitability, whereas all the others either are getting lower scores when they are not excluded from the landfill siting analysis. The slopes criterion is generally considered of great importance given that a large land slope may signifies unstableness, as well as construction and maintenance
difficulties (Kao et al. 1996). Furthermore, water contamination risk is raised when placing a landfill in high land slopes areas, due to possible drainage leachate to the flat areas and water bodies (Leao et al. 2004).

The importance of this criterion is depicted by the fact that it holds a substantially high rate (81.25%) among the articles (Table 2). From the literature review derives that there is no strict rule for excluding areas as unsuitable for landfill siting. The most conservative strategy is implemented by Chang et al. (2008), while in the study by Kao et al. (1996) locations with slopes even up to 40% are considered as suitable. Although the average threshold value is 25.3%, in the present study locations that exceed the 15% are not considered as feasible solutions.

Table 3: Distance from Fault Zones Criterion

<table>
<thead>
<tr>
<th>Reference</th>
<th>SP</th>
<th>CC</th>
<th>TV</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kao et al. 1996</td>
<td>√</td>
<td></td>
<td>0.08 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Karkazi et al. 2001</td>
<td>FMF</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gemitzi et al. 2007</td>
<td>√</td>
<td></td>
<td>1 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Zamorano et al. 2008</td>
<td>L</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delgado et al. 2008</td>
<td>R</td>
<td>x</td>
<td>0.1 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Sumathi et al. 2008</td>
<td>R</td>
<td>x</td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
</tbody>
</table>

Distance from Fault Zones

Areas with zones where geological fractures and fault zones exist are considered unsuitable for landfill siting. The reason why such areas are not included in the landfill siting analysis is the irreparable damage that may be caused due to the unstable formations. No matter how important this criterion may be, it holds a low percentage (37.5%) among the articles (Table 3), which can be explained by the low seismic risk in the study areas.

Table 4: Land Uses Criterion

<table>
<thead>
<tr>
<th>Reference</th>
<th>SP</th>
<th>CC</th>
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<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siddiqui et al. 1996</td>
<td>R</td>
<td>x</td>
<td>Water, Urban Areas</td>
<td></td>
</tr>
<tr>
<td>MacDonald 1996</td>
<td>R</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baban et al. 1998</td>
<td>R</td>
<td>x</td>
<td>Agricultural Land</td>
<td></td>
</tr>
<tr>
<td>Karkazi et al. 2001</td>
<td>FMF</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kontos et al. 2003</td>
<td>R</td>
<td>x</td>
<td>0.5 km from agricultural, breeding activities</td>
<td></td>
</tr>
<tr>
<td>Kontos et al. 2005</td>
<td>R</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sener et al. 2006</td>
<td>R</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gemitzi et al. 2007</td>
<td>FMF</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delgado et al. 2008</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Descend</td>
</tr>
<tr>
<td>Sumathi et al. 2008</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
</tbody>
</table>
Even though Evros prefecture is considered as area of low seismic risk, locations where active faults exist are excluded from the analysis. In the study possible damage to the civil works due to earthquake hazard events is achieved forming 0.5 km buffer zone from the main registered faults in the examined area.

**Land-Use**

This criterion completely depends on the study area’s spatial attributes and it focus on the high productivity areas protection, such as those where tourist, intensive agricultural and breeding activities are taking place. In order to inhibit landfills placing in such areas, the land uses in the study area are categorized and evaluated quantitatively. However, as there are not national and international legislations to comply with, this criterion is absolutely determined by decision makers’ preference and the study area’s characteristics. According to the literature review, this criterion is applied by the 62.5% (Table 4), resulting to the fact that the most suitable areas for landfill siting are considered to be low density agricultural and uncultivated territories, whereas mountainous and forests areas are excluded from the process.

According to the national framework (114218/97), areas that interfere with intense agricultural and cattle breeding activities are considered unsuitable for landfill siting. Evros is considered as a rural area, since the 40% of the population deals with stock farming and agriculture. In this paper, the analysis is conducted only in agricultural areas given that according to the literature review they are considered as the most suitable for landfill siting.

**Table 5: Distance from Residential Areas Criterion**

<table>
<thead>
<tr>
<th>Reference</th>
<th>SP</th>
<th>CC</th>
<th>TV</th>
<th>CT</th>
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</thead>
<tbody>
<tr>
<td><strong>a) Ascend Criterion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Siddiqui et al. 1996</td>
<td>PC</td>
<td>x</td>
<td>0.4 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Kao et al. 1996</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Baban et al. 1998</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Karkazi et al. 2001</td>
<td>FMF</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Leao et al. 2001</td>
<td>R</td>
<td>x</td>
<td>1 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Vatalis et al. 2002</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Kontos et al. 2003</td>
<td>R</td>
<td>x</td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Leao et al. 2004</td>
<td>UF</td>
<td>x</td>
<td>1 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Kontos et al. 2005</td>
<td>R</td>
<td>x</td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Gemitzi et al. 2007</td>
<td>FMF</td>
<td>x</td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Chang et al. 2008</td>
<td>FR</td>
<td>x</td>
<td>3 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Zamorano et al. 2008</td>
<td>L</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Delgado et al. 2008</td>
<td>R</td>
<td>x</td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Sumathi et al. 2008</td>
<td>R</td>
<td>x</td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
</tbody>
</table>
4.2 Infrastructures

Public acceptance and the reduction of transportation costs are prime objective of this group’s criteria. Consequently, not only distances from transportation and road network must be taken into consideration, but also distances from residential areas.

Distance from Residential Areas

This is one of the most crucial criteria in landfill siting analysis as they really affect public acceptance. This criterion has double meaning, because on the one hand is an ascend criterion concerning the public dissatisfaction from placing the landfill near residential areas, due to optical intrusion. On the other hand, distance from residential areas criterion can be thought as descend one in order to simulate the minimization of the transportation cost referring to the distance from the waste production source. The extremely high rate that this criterion holds (93.75%) (Table 5) outlines its role to the landfill’s efficient operation in conformity with public acceptance. The average threshold value for the constraint determination derived by the literature review is 0.87 km. Although in this study, according to Greek law (114218/97) and the European directives, a 0.5 km buffer zone is maintained around all residential areas.

Transportation Network

Given that landfill siting is only allowed in areas which have safe distances from the transportation network. This criterion holds a relatively low percentage of appearance (37.5%) (Table 6), despite its contribution to the project’s cost minimization. Another 37.5% maintained the use of the same buffer zones from the road and transportation network without any further discrimination. The distance from the primary road network and the railway line is an ascend decision criterion, as areas which are sited as far as possible from the primary road network and the railway line are considered the most suitable for landfill siting. Consequently, criterion goal is to avoid visual impacts and to reduce driver’s visual intrusion, due to wind-blown material (Baban et al. 1998). On the contrary, the distance from the secondary road network is a descend decision criterion, including
into the analysis the cost of wastes transportation from its source. Thus, sites near the secondary road network are considered as the most appropriate for landfill siting. As there are no national legislations or European directives to comply with, the buffer zones that were assigned in the study from highways, railways and the secondary or tertiary road network are 0.5 km, 0.5 km and 0.1 km respectively.

Table 6: Road Network Discriminations Criterion

<table>
<thead>
<tr>
<th>Reference</th>
<th>SP</th>
<th>CC</th>
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<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baban et al. 1998</td>
<td>R</td>
<td>x</td>
<td>0.2 km Major Road</td>
<td>Ascend</td>
</tr>
<tr>
<td>Karkazi et al. 2001</td>
<td>FMF</td>
<td>x</td>
<td>0.5 km Railway Line</td>
<td>Ascend</td>
</tr>
<tr>
<td>Kontos et al. 2003</td>
<td>R</td>
<td>x</td>
<td>Ascend</td>
<td></td>
</tr>
<tr>
<td>Sener et al. 2006</td>
<td>R</td>
<td>x</td>
<td>Ascend</td>
<td></td>
</tr>
<tr>
<td>Gemitzi et al. 2007</td>
<td>FMF</td>
<td>x</td>
<td>0.5 km Highways, Railways</td>
<td>Descend</td>
</tr>
<tr>
<td>Sumathi et al. 2008</td>
<td>R</td>
<td>x</td>
<td>0.2 km Major Highways</td>
<td>Ascend</td>
</tr>
</tbody>
</table>

4.3 Environmental

The prime object of the environmental decision criteria is to ensure protection against water resources contamination. Worldwide one by one the countries adopt strict regulations in order to ensure environmental awareness, citizens satisfaction and at the same time to avoid juridical implications.

Distance from Coastline

In order to protect the tourist industry, buffer zones from the coastline are considered in the 12.5% of the papers. In the analysis of Gemitzi et al. (2007), this criterion was applied as an exclusion one and a 3 km buffer zone was formed from the Greek borders. On the contrary, in Delgado et al. (2008) analysis, this criterion was applied as a decision one, using the linear standardization method. In the present study, a 3 km buffer zone was maintained around the Greek borders, namely, from Turkey (east) and Bulgaria (northwest), as landfill placing within these areas may affect the region’s tourist industry.

Distance from Surface water

In order to prevent the contamination of water bodies, landfills should be placed in an appropriate distance from them, so as to enable protection against any possible landfill leachate (Kao et al. 1996). According to the European directives, areas within a 0.5 km from the water bodies must be excluded, as they present high risk of contamination. The criterion importance is outlined from the fact that it is used by the 87.5% of the
articles (Table 7). In the present study, a 0.5 km buffer zone is maintained from rivers and lakes, whereas areas within 0.1 km from the streams were excluded from the analysis.

Table 7: Distance from Rivers, Lakes, Streams Criterion

<table>
<thead>
<tr>
<th>Reference</th>
<th>SP</th>
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<th>TV</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siddiqui et al. 1996</td>
<td>✓</td>
<td></td>
<td>0.8 km (Water Bodies) (Outside Wetlands)</td>
<td>Ascend</td>
</tr>
<tr>
<td>Kao et al. 1996</td>
<td>R</td>
<td>x</td>
<td>0.18 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Baban et al. 1998</td>
<td>R</td>
<td>x</td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Karkazi et al. 2001</td>
<td>FMF</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Leao et al. 2001</td>
<td>R</td>
<td>x</td>
<td>0.2 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Kontos et al. 2003</td>
<td>R</td>
<td>x</td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Leao et al. 2004</td>
<td>UF</td>
<td>x</td>
<td>0.3 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Kontos et al. 2005</td>
<td>R</td>
<td>x</td>
<td>(Outside Wetlands)</td>
<td>Ascend</td>
</tr>
<tr>
<td>Sener et al. 2006</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Qualitative</td>
</tr>
<tr>
<td>Gemitzi et al. 2007</td>
<td>FMF</td>
<td>x</td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Chang et al. 2008</td>
<td>FR</td>
<td>x</td>
<td>(Water Bodies)</td>
<td>Ascend</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.075km (Wetlands)</td>
<td></td>
</tr>
<tr>
<td>Zamorano et al. 2008</td>
<td>L</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Delgado et al. 2008</td>
<td>R</td>
<td>x</td>
<td>1 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Sumathi et al. 2008</td>
<td>R</td>
<td>x</td>
<td>0.1 km (Rivers)</td>
<td>Ascend</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.2 km (Lakes, Ponds)</td>
<td></td>
</tr>
</tbody>
</table>

**NATURA 2000**

This criterion points the necessary distance that a landfill must have from environmentally protected or sensitive areas, which portray exceptional ecological interest. Officially these areas are registered and protected by national and international conventions (e.g. NATURA 2000). The risk of environmental degradation is the reason why some of the papers are not only exclude these areas from the study area but also form exclusion zones in order to prevent the encroachment of any development into their vicinity (Baban et al. 1998). The importance of this criterion is outlined by the fact that it possesses a relative high percentage of appearance (68.75%). The mean buffer zone, that it is considered in the examined articles, is 1 km (Table 8). In this paper, according to the Greek law (114218/97), a 0.5 km buffer zone is formed.

**Groundwater Vulnerability**

Hydrogeology aspects ensure correct embankment design aiming to protect vulnerable groundwater aquifers and sensitive surface waters. In general, soils must be impervious and capable for removing pollutants. Aquifers classification with respect to the groundwater pollution is
performed after digitizing maps provided by the Greek Institute of Geology and Mineral Exploitation for the Thrace region. Aquifers are qualitatively evaluated with respect to their potential and productivity with concerns regarding overlaying conditions (Vavatsikos 2008).

Table 8: Distance from Environmentally Protected Areas

<table>
<thead>
<tr>
<th>Reference</th>
<th>SP</th>
<th>CC</th>
<th>TV</th>
<th>CT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siddiqui et al. 1996</td>
<td></td>
<td>√</td>
<td>1.6 km</td>
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</tr>
<tr>
<td>Baban et al. 1998</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Karkazi et al. 2001</td>
<td>FFM</td>
<td>x</td>
<td>Ascend</td>
<td></td>
</tr>
<tr>
<td>Leao et al. 2001</td>
<td>√</td>
<td></td>
<td>0.3 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Vatalis et al. 2002</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Kontos et al. 2003</td>
<td>√</td>
<td></td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Leao et al. 2004</td>
<td>√</td>
<td></td>
<td>0.3 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Kontos et al. 2005</td>
<td>R</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Gemitzi et al. 2007</td>
<td>√</td>
<td></td>
<td>0.5 km</td>
<td>Ascend</td>
</tr>
<tr>
<td>Montserrat et al. 2008</td>
<td>L</td>
<td>x</td>
<td></td>
<td>Ascend</td>
</tr>
<tr>
<td>Delgado et al. 2008</td>
<td>√</td>
<td></td>
<td>3 km</td>
<td>Ascend</td>
</tr>
</tbody>
</table>

5. Conclusions

GIS-based land-use suitability analysis extends the use of the traditional overlay operators to the consideration of decision makers’ preferences. Furthermore, it provides a consistent framework that ensures results accuracy with respect to regional landfilling demands. From the literature review derives that landfill spatial multicriteria decision analysis is a rapidly developing research area given that the majority of the articles have been published during last decade. Therefore the development of synergies with other multicriteria decision analysis approaches, such as UTA and Promethee methods, should be investigated in the nearly future. In addition, the development of computational tools in GIS environment is a hopeful prospect as it is expected to improve the accuracy of the site selection process.

In this work, a real world case study was presented in order to aid decision makers dealing with the landfill siting problem, namely the way the applied methodology and criteria should be managed. The described methodology combines GIS overlay analysis with multicriteria evaluation methods for a successful MSW landfill siting in the prefecture of Evros. Fourteen criteria were applied, forming a four level hierarchical decision model, which attributes adequately to the real magnitude of the landfill siting problem. AHP was used in order to elicitate criterion weights while TOPSIS was applied as decision rule enabling alternatives ranking.
according to the closeness and the remoteness from the ideal and the ideal solution respectively (Figure 4).

Figure 4: Feasible solutions (left), Suitability Index (right)

References


Industry in Greece and environmental policy in the frames of social responsibility of enterprises

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Abstract (only):  
Corporate social responsibility is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large. The corporate social responsibility has been combined with the globalisation and has been focused in three mainly sectors: the environment, the exploitation of workers and the bribery and the corruptness of enterprises.

The dimension of pollution in the modern industrial practice is combined with a total of obligations that they owe to undertake the industries. These obligations in their total constitute part of the corporate social responsibility. In the present project an effort is made to determine the policies of environmental protection by enterprises. The major problem of this study is not only the determination of the factors which prevent the effective protection of environment, but also the ones that strengthen it. Intention of this project is to enumerate the various practices with which the rehabilitation of environmental damage that has already been befallen can be implemented.

The type of questions which was used for the accomplishment of the research was the closed. The questionnaire was addressed to approximately 110 industries in North Greece. The results reveal that the specification of the variables that re-determine the environmental conscience of enterprises will be difficult and laborious.

Keywords:  
Corporate social responsibility, environmental policies, environmental conscience, rehabilitation, factors, ethics
A System Dynamics Framework for Sustainable Irrigation Water Management in Coastal Mediterranean regions

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Abstract:
In order to overcome irrigation water scarcity in Greece and other Mediterranean countries, the construction of dams and other irrigation projects is subsidized by national and/or European Union (EE) funds. However, these projects are often the cause of social conflicts, legal controversies and scientific criticism. In this work, a general System Dynamics framework for sustainable irrigation water management is presented for Mediterranean coastal agricultural regions, where aquifer and/or soil salinization have severe economic, social and environmental impacts. Three sub-systems, or sectors, are considered within this general framework: (1) Irrigation Water Available, (2) Irrigated Crops Profitability and (3) Irrigated Crops Area. Direct short-term subsidies to farmers may create a vicious irrigated crops expansion cycle by canceling out various costs (i.e. costs of water pumping) and, in this way conserve or promote Irrigated Crops Profitability. A stabilization and eventually reduction of Irrigated Crops will balance the water deficit and, at the same time, reduce soil erosion and agri-pollution.

Keywords:
Groundwater irrigation, System Dynamics, EU subsidies.

1. Introduction
In Mediterranean countries groundwater pumping for irrigation has been increased in the last 30 years, especially after EU subsidies enabled farmers to afford ground water drilling, pumping equipment purchase and annual pumping costs. The intensive use of groundwater resources has led to overexploitation of aquifers, water table dropping, saline water intrusion and salinization of coastal aquifers (see for example Petalas and Lambrakis, 2006; Martinez-Fernandez and Esteve-Selma, 2004). Lower piezometric levels involve higher pumping costs and narrowing of the range of alternative crops that may be irrigated with high salinity water. This may have long-term detrimental effects to local farmers and high economic, social and environmental impacts. Policy-makers, engineers,
scientists and the public usually follow a quite simplistic and fragmented approach for comprehending the relevant issues and for managing irrigation water. System Dynamics (SD) is suitable to investigate different irrigation water management options by bringing forward the nature of the rising conflicts and by helping in understanding how various time delays of physical processes, economic phenomena and policies interact with one another to produce the overall, often counter-intuitive behavior of water resources management. In this work, a limited literature review concerning groundwater irrigation management is presented in the form of concise causal loop diagrams. Moreover, various drivers and/or indicators of aquifer exploitation, proposed in the literature, are considered. This is a preliminary work which is to be followed by the development of a quantitative SD model aiming at exploring, in more detail, the various problems and issues involved in the sustainable groundwater exploitation in the Mediterranean.

2. The traditional (sustainable) irrigation loop

2.1 The balancing loop

Three sub-systems or sectors are considered within the general irrigation water management framework: (1) Irrigation Water Available, (2) Irrigated Crops Area, and (3) Irrigated Crops Profitability (Fig.1). Figure 1 represents sustainable irrigation water use in a certain area of the Mediterranean where traditional agriculture is practiced and there exist a steady-state equilibrium between irrigated crops and irrigation water available. If an expansion of irrigated crops happens for some reason (e.g. local increase in population), the natural vegetation cover will be reduced. A lowering of the natural precipitation, aquifer rate of recharge, soil erosion and groundwater available for irrigation are the results from the reduction of natural vegetation cover. Moreover, irrigation water demand is increased due to the expansion of irrigated crops. A reduction of the available irrigation water (e.g. lowering of the water table) along with soil erosion tend to reduce the profitability of irrigated crops because of the higher costs involved in water extraction and the need for agri-chemicals to counterbalance erosion. A lower profitability may cause an eventual reduction of irrigated crops (for example, shift to other, less water-demanding crops). Time delays of different magnitudes, in equilibrium with each other, are involved in this balancing cycle: The re-generation of vegetation cover and the re-establishment of the water table to its previous level may have a time delay of decades. Similar time delays exist in the change of the vegetation cover and the rate of soil erosion. However, irrigated crops use the available water within months (usually during the hot-dry summers). The decision to shift to other crops and different crop
development may have a time delay of years or months depending on the crop.

![Figure 1: The sustainable balancing cycle of irrigation water and crops](image)

### 2.2 The sustainable water budget

If we consider a simple permeable aquifer system before development, the recharge from rainfall is balanced by discharge from the aquifer. Therefore, for “virgin conditions”

\[ R_0 = D_0 \quad \text{or} \quad R_0 - D_0 = 0 \]  

where, \( R_0 \) is the “virgin recharge” and \( D_0 \) is the “virgin discharge”. At any point of the aquifer the Darcy’s law applies:

\[ d = KA(dh/dl) \]

where,

- \( K \) is the hydraulic conductivity (i.e. the ease with which the water flows through the sediments),
- \( A \) is the area through which the flow occurs and
- \( dh/dl \) is the vertical hydraulic gradient (VHG).

If VHG is positive, the water is upwelling from the groundwater into the surface; if negative, water goes down. By integrating the point discharge, we obtain the total discharge from the aquifer. If we initiate pumping (let us say from the middle of the aquifer) at any time we can write a new water balance:

\[ (R_0 + \Delta R_0) - (D_0 + \Delta D_0) - P = dV/dt \]

where, \( \Delta R_0 \) is the change in the virgin rate of recharge caused by pumping, \( \Delta D_0 \) is the change of the virgin rate of discharge caused by pumping.
pumping, $P$ is the rate of pumping and $dV/dt$ is the rate at which we are removing water from ground water storage.

Since, $R_0 = D_0$, Equation (2) becomes:

$$\Delta R_0 - \Delta D_0 = P = \frac{dV}{dt}. \quad (3)$$

For the groundwater management to be sustainable, the rate of water taken from ground storage must be zero (in other words, the level of the water table should be maintained), or:

$$dV/dt = 0. \quad (4)$$

In follows that, the groundwater sustainable management is directly related to stable ground water levels (otherwise the ground water stored will be depleted at some point of time in the future). Therefore, the sustainable water budget becomes:

$$\Delta R_0 - \Delta D_0 = P. \quad (5)$$

The quantity $(\Delta R_0 - \Delta D_0)$ is defined as the “capture”. For a sustainable ground water practice, the rate of pumping must equal the rate of capture, or:

$$\frac{dP}{dt} = \frac{dV}{dt}. \quad (6)$$

It is worth mentioning that the rate of recharge is not needed for determining if the management of ground water is sustainable or not. Recharge is affected by rainfall, vegetation cover, soil permeability and other factors. In most situations $\Delta R_0 = 0$; in other words, the change in the rate of recharge is not affected by the pumping and Equation (6) becomes:

$$\frac{dD_0}{dt} = \frac{dP}{dt}. \quad (7)$$

Therefore, in most cases, in order for a ground water management to be sustainable, the annual pumping must counterbalance the change of the annual virgin discharge, not the change of the annual recharge (Bredehoeft, 2002; Kendy, 2003; Ibanez et al., 2008). This implies:

$$P = \Delta D_0. \quad (8)$$

The above-mentioned criterion of ground water sustainability is different from the usual criterion of “safe yield” that allows water users to pump no more ground water than that which is replenished naturally (natural recharge). If pumping equals recharge, then, eventually, streams, marshes and springs may dry out, since natural recharge is balanced by natural discharge, evapotranspiration etc. (Sophocleous, 2000).

Moreover, Kendy (2003) argues that the pumping rate is, also, irrelevant for sustainable ground water pumping (Equation 7). On the contrary, sustainability (i.e. stabilizing ground water levels) begins not with reducing irrigation pumping per acre, but rather with reducing the total area of irrigated land. A similar conclusion was drawn both from real data and modeling in Spain (Martinez-Fernandez and Esteve-Selma 2004; Martinez-Fernandez et al., 2000). This happens because it is not pumping
per se that depletes ground water storage, but only the component of pumped water that evapotranspires and does not return to the hydrologic system. Moreover, there may exist another component of irrigation water that gets incorporated into products for export and is thus forever lost from the system.

3. Criteria of aquifer overexploitation

Ibanez et al. (2008) have developed a model in order to assess the general drivers of aquifer overexploitation in the Mediterranean where various physical, hydrological, and economic and social variables are considered. Of those variables, the long-term equilibrium or steady-state of two variables is important: the current number of hectares irrigated with water pumped from the aquifer \( U \) and the stock of accessible groundwater \( R \). A shift from traditional irrigation to pumping will reduce stock \( R \) from a “virgin” level to a lower one. This happens during a so-called transient period when the rate of pumping is greater than the rate of recharge. The question to be answered is “what are the values of \( U \) and \( R \) at which \( R \) will stabilize (even at a level lower than the virgin) and will not continue to decrease”.

The authors argue that, when the stock of groundwater, which corresponds to a zero average crop profit \( \text{rp}_0 \), is smaller than a critical ground water stock \( \text{rcr} \), then overexploitation may occur. In other words, if there is some profit coming from ground water irrigation, ground water will continue to be used. This may occur even if the water table falls below a critical level (which, of course, has to be determined).

Sensitivity analysis of the model indicates that, in addition to physical causes such as decrease of rainfall or aquifer capacity, economic parameters (due to direct money subsidies) are involved. These are:

- an increase in the average product price,
- a decrease of the average per hectare opportunity cost,
- a decrease of the average fixed cost per hectare (use of cheap labor), or
- a decrease of the maximum cost of pumping.

Therefore, in order to maintain a required pre-set profit level, these economic factors tend to increase the maximum number of arable hectares which might evolve into aquifer overexploitation.
4. The unsustainable irrigation loop

If we consider the above mentioned model, the balancing sustainable loop of irrigation may become unbalanced in two ways. First, by the construction of dams and other irrigation projects which aim at increasing the water available for irrigation by exploiting external water resources (Figure 2). These projects are materialized through money subsidies from the EU and/or national funds. In this way, the amount of water for irrigation

![Diagram of irrigation cycle]

**Figure 2:** The unsustainable cycle of irrigation water and crops.

Money subsidies that promote irrigation water use have short time delays and correspond to large rates of crop expansion and water use comes from surface water, water extraction costs become nil, profitability increases and irrigated crops expand further. It is noted, however, that irrigation projects need years to be completed.

Another way to alter the balancing loop is when water extraction costs are canceled out, through direct subsidies to farmers. These subsidies have usually time delays of months. Either way, both money subsidies retain or increase the profitability of irrigated crops and they may even cause further irrigated crops expansion; this will further decrease the natural vegetation...
cover. Moreover, the enhanced rate of soil erosion and enhanced rate of agri-chemicals use, which reduce profitability, are cancelled out by direct subsidies, thus constantly fuelling the positive loop of irrigated crops expansion which leads to more water demand, enhanced soil erosion and higher agri-chemicals use etc.

It is worth mentioning that another way to retain or enhance profitability (and, thus, promote unsustainable irrigation water management) is the use of the cheap labor provided (legally or illegally) by immigrant workers. However, this practice creates social problems affecting the social facet of sustainability.

5. Conclusions

In this work, a general qualitative framework as a synthesis for sustainable groundwater management in Mediterranean regions, is presented in the form of causal loop diagrams. Based on a simple water budget model, a theoretical dynamic model, that links groundwater used for irrigation on one hand, to agricultural economic parameters and data from the literature on the other, it is concluded that direct EU subsidies may lead to the overexploitation of groundwater.

This is a preliminary work aiming at developing of a system dynamic model for water resources management in the Mediterranean region of Thrace that will address real-life situations by incorporating economic, social and environmental issues.

References


Systemic Thinking and Industrial Ecology – The Concept of Eco-Industrial Parks

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Abstract:
A highly increasing number of agents have to deal with environmental issues due to an important increase of general concern. Industrial Ecology (IE) is a relative new theory including principles and tools for assessing and ameliorating the environmental performance of an industry thus leading to sustainability. More specifically, it is the shifting of industrial process from linear (open loop) systems to a closed loop system where wastes become inputs for new processes. In order to cope with possible problems, a satisfactory understanding of the connections that exist between different systems is needed leading to the conclusion that various aspects cannot be viewed in isolation. Based on this framework, IE handles environmental issues with a systemic thinking approach. One of the most studied and practical tools of Industrial Ecology are Eco-Industrial Parks (EIP). The basic concept of EIP is that in industrial systems, waste from a company is used as a resource by others, in parallel with ecosystems where the waste from one organism is used as input to other organisms. A holistic view is necessary in order to implement the principles of Eco-Industrial Parks. The aim of this study is to indicate how systemic thinking can lead to efficient and innovative solutions by using the Industrial Ecology concept and more specifically the EIP notion, as an example.

Keywords: systems thinking; industrial ecology; eco-industrial parks.
2. Introduction

Over the last two decades, the development of an Environmental Management System (EMS) was sufficient for an organization in order to demonstrate its commitment to environmental protection. Lately however, a shift has been observed from environmental protection to the issue of environmental sustainability and from economic performance for shareholders to sustainability performance for stakeholders. Thus, achieving sustainable development has become a major target for enterprises. Sustainability requires a consideration of the social or community dimension as well as ecological integrity and economic efficiency (Côté and Rosenthal, 1998). If the dynamic nature of environmental problems and the interdependence of ecological systems are additionally taken into consideration, it is obvious that a holistic approach in order to successfully implement sustainable strategies needs to be followed. As long as attention is limited to product and processes viewed in isolation, larger systemic problems, such as the accumulation of persistent toxic material, will not be addressed (Ehrenfeld and Gertler, 1997).

Despite the widespread incorporation of sustainable development into policy discourses, actually achieving the “win-win-win” scenario of economic, environmental and social development continues to be problematic (Gibbs et al, 2005). According to Industrial Ecology (IE) practitioners, a way to overcome these problems is by shifting the basis of industrial production from linear to a closed loop systems. IE is a relatively new concept developed by R. Frosch and N. Gallopoulos (1989) who claimed that an ideal industrial ecosystem would function as “an analogue” of its biological counterparts. In other words, in an industrial ecosystem, the waste produced by one company should be used as resources by another. No waste would leave the industrial system or negatively impact natural systems thus creating a closed loop system where all the energy needed would come from renewable energy. The elements of IE classified according to their operating level are shown on Figure 1.

From the IE tools described above, the Eco-Industrial Park (EIP) concept is considered by many IE practitioners as the key strategy for implementing IE. Although there is not a commonly accepted definition for EIP, the next one, proposed by Lowe et al (1996), is frequently used in literature. Specifically:

An eco-industrial park is a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resources issues including energy, water and materials. By working together, the
community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would have realized if it optimized its individual interests.

![Industrial Ecology](image)

**Figure 1:** The elements of IE classified according to their operating level (adapted from Lifset and Graedel, 2002)

This paper addresses the systemic view of EIPs and explains how the avocation with it, could highly help the industries to solve interdependent problems which could not be solved or even observed until now. Furthermore, some of the risks and benefits of implementing the principles of EIP are described, whereas the most important strategies and case studies from implementing EIP are given. Finally, a theoretical discussion about the potential of the development of an EIP in Greece is performed.

2. Eco-Industrial Parks – A systems approach

The general problem with some contemporary industrial practices is that they are wasteful in ways that are environmentally and economically costly (Carr, 1998). Today’s industrial system is a linear flow of resources based on fossil fuels, where unlimited raw materials are extracted, processed and delivered to the user for consumption, producing unlimited waste thus damaging the ecosystem.

So what an industry really needs is a tool for achieving sustainability through more efficient resource and waste use. Concerns about transportations, regulation, material use, scarcity and hazard, energy
management, pollution control etc. are usual. Furthermore, social issues such as relation with community or synergies with various stakeholders have to be taken into account. Some firm level strategies are also needed such as commitment for continuous improvement. As stated above, EMAS systems, ISO, pollution prevention (2P) et al. offer a way to increase the environmental performance of an industry. However most of them focus on specific issues such as accountability, conformation with regulations or they do not take seriously into account the economic or social aspect of sustainability. It is obvious that a more holistic tool has to be used.

Eco-industrial parks’ target is the limitation of this linear flow by closing every loop possible. In order to do that, the collaboration between different firms is needed. This is based on the fact that individual companies and corporations are parts of systems. They are dependent on others and must cooperate with them to survive (Côté and Rosenthal, 1998). Table 1 shows some of the basic principles for creating EIPs. It can be shown that IEPs principles cover a very wide variety of issues thus offering us the holistic tool we want to use.

Eco-Industrial parks incorporate many elements that emphasize the cycling and reuse of materials in a broader systems perspective. These elements include embedded energy and materials, life cycle perspective, cascading, loop closing, and tracking material flows (Chertow, 2004). A major question arises by examining an industry’s problems, is how systemic thinking which is incorporated into EIP principles manages these problems in a more efficient way.

First of all, closing loops means that an industry must thoroughly identify its inputs/outputs which consequently will lead to a better material use and waste management. Cooperation and small mental distance (meaning common targets) between industries plus data sharing are of the greatest importance for an EIP. By working together, industries seek a collective benefit of greater economic and environmental performance through efficient management of energy, water, and materials. For example, fly ash is a waste for many industries but for cement factory could be a useful input. EIPs are designed to produce minimal emissions, minimal noise and ground pollution, and minimal waste (Dunn, 1995). Thus a market perspective can be developed for wastes of industries that are members of an EIP.

In addition, regulation and pollution control problems could be solved innovatively, for example, by installing a common use water filter or a shared steam system. For EIP companies, a common environmental management approach can provide flexibility in meeting compliance goals, assistance in remediation efforts and by collective monitoring lower costs of environmental reporting (Cote & Cohen-Rosenthal, 1998).
Design of park infrastructure emphasizes energy and water efficiency, use of renewable energy sources, environmentally benign materials, and ease of disassembly and reconstruction (Lowe, 1997). In Kalundborg, Denmark, a well developed pipe system helps the distribution of heated water between different industries and stakeholders, including the community of Kalundborg. Also, due to the EIP principle of reducing transportsations to the minimum level, economical, environmental and safety benefits could be observed. Using pipes instead of trucks could have a significant impact to sustainable development.

### Table 1: Basic principles for creating EIPs

<table>
<thead>
<tr>
<th>Issue examined</th>
<th>Sub-issue</th>
<th>Explanation*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste treatment</td>
<td>Reduce environmental impact or ecological footprint through substitution of toxic materials, absorption of carbon dioxide, material exchanges and integrated treatment of wastes. Maximize energy efficiency through facility design and construction, co-generation, and cascading.</td>
<td></td>
</tr>
<tr>
<td>Facility design</td>
<td>Conserve materials through facility design and construction, reuse, recovery and recycling.</td>
<td></td>
</tr>
<tr>
<td>Environmental</td>
<td>Commitment for improvement</td>
<td>Continuously improve the environmental performance by the individual businesses and the community as a whole.</td>
</tr>
<tr>
<td>Regulation</td>
<td>Have a regulatory system which permits some flexibility while encouraging companies to meet performance goals.</td>
<td></td>
</tr>
<tr>
<td>Management system</td>
<td>Employ an information management system which facilitates the flow of energy and materials within a more or less closed-loop.</td>
<td></td>
</tr>
<tr>
<td>Social</td>
<td>Community involvement</td>
<td>Define the community of interests and involve that community in the design of the park.</td>
</tr>
<tr>
<td></td>
<td>Connections with stakeholders</td>
<td>Link or network companies with suppliers and customers in the wider community in which the Eco-industrial Park is situated.</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>Create a mechanism which seeks to train and educate managers and workers about new strategies, tools and technologies.</td>
</tr>
<tr>
<td>Economical</td>
<td>Audit</td>
<td>Use economic instruments which discourage waste and pollution. Orient its marketing to attract companies which fill niches and complement other businesses.</td>
</tr>
<tr>
<td></td>
<td>Marketing</td>
<td></td>
</tr>
</tbody>
</table>

(continued)
Present industry match: in terms of inputs and outputs.

Industries match

Present size match: companies should be of comparable size in terms of their material exchanges. This reduces the need to send materials to a party offsite, minimizing transaction costs and improving efficiency.

Close physical distance between firms: close physical distance minimizes loss of materials in exchange processes, reduces transportation needs and costs, and reduces operating costs.

Table 2

<table>
<thead>
<tr>
<th>Interconnected (Both Environment and Socioeconomy affected)</th>
<th>Industries match</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close loops</td>
<td></td>
</tr>
</tbody>
</table>


Furthermore life cycle perspective ensures that several issues in a product process, an industry or a facility will not be viewed in isolation. That means that material or energy hot spots can be observed. Industries are developing products using specific materials; however the replacement of some of them with new ones could increase the economical and environmental efficiency.

The existence of an EIP in a locality should add value to quality of life as well as jobs or indirect economic benefit to an area. Several agents such as government, regional authorities and local community, see EIPs as a viable and desirable strategy for restoring economic and public health. Good jobs and a good environment are not an esoteric concept but very real concerns (Cote & Cohen-Rosenthal, 1998).

Although EIP seems to have a great potential and produce several benefits, literature points out a significant amount of risk and challenges when implementing EIP, indicating that EIP is not to be taken hastily or for granted for success.

5. **Risks and challenges**

Many barriers to industrial park concept are identified and described in detail in the literature (Table 2). In addition to the usual problems of business development, these barriers are rooted in the operational, financial, and behavioral issues raised by the need to work across organizations (Chertow, 2007). The literature states that the main problem in the development of an EIP will be the establishment of the essential “symbiotic” exchange relationships between the companies participating in the project which is by many seen as the key factor for EIP success.
Table 2: Type of barriers to overcome for implementing EIPs principles

<table>
<thead>
<tr>
<th>A/N</th>
<th>Type</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Technical</td>
<td>It may be observed when an exchange is technically unfeasible</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It may be observed when an exchange might be economically unworthy or economically risky from a company perspective</td>
</tr>
<tr>
<td>2</td>
<td>Economical</td>
<td>The right people do not have the needed information at the right time</td>
</tr>
<tr>
<td>3</td>
<td>Informational</td>
<td>The intended exchange might not fit in the current corporate organizational structure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Misapprehensions and confusion may caused by the mix of several environmental laws and regulations</td>
</tr>
<tr>
<td>4</td>
<td>Organizational</td>
<td>The intended exchange might not fit in the current corporate organizational structure</td>
</tr>
<tr>
<td>5</td>
<td>Regulatory/legal</td>
<td>The intended exchange might not fit in the current corporate organizational structure</td>
</tr>
</tbody>
</table>

Developers, investors, property management, and company management will want to assess the potential risks of implementing a resource exchange strategy. Some of these challenges include (Lowe, 1997):

- Companies using each other’s residual products as inputs face the risk of losing a critical supply or market if a plant closes down or changes its product mix.
- Proprietary information could become available to competitors.
- Uneven quality of by-product materials could cause damage to equipment or quality of products.
- Exchange of by-products could lock in continued reliance on toxic materials.
- Possible innovations in regulation to enable EIP development may not be allowed by regulatory agencies.
- If the exchanges create too much interdependency among the companies, the failure of one or two critical links could damage the performance of the whole network in an EIP.

It is obvious that without a clear view and awareness of what an EIP can offer, and without taking into account the special characteristics of every EIP due to its dynamic nature, implementing EIP could lead to a failure.

6. Implementation of EIP

4.1 First Steps

Developing a resource exchange or other environmental initiatives in a broader industrial region may require creation of an organizing entity if
there is no industrial development authority. University researchers and personnel from economic development and environmental agencies have taken this responsibility so far. Local industry associations and multidisciplinary consulting organizations can also serve the organizing function (Lowe, 1997).

The planning and construction of an EIP involves a team of architectural, engineering, and business professionals. The role of landscape architects in the development of EIPs should be significant due to the need for appropriate physical planning and design services; such as site inventory and analysis, site planning, the design of proper circulation, grading and drainage, visual quality landscape elements etc. (Carr, 1998).

4.2 Strategies for EIP

The success of an eco-industrial park will not be simply a function of its environmental record but its ability to compete in the marketplace. Effective eco-industrial strategies provide a clear link to the marketplace (Cote & Cohen-Rosenthal, 1998).

In exploring strategies for the EIP, Lowe et al (1996) integrated the resource exchange concept into a comprehensive menu of strategies for improving environmental and financial performance. These strategies include (Lowe et al, 1996):

- A waste management utility in the park may assume responsibility for all wastes without present market value (with site-wide licensing/permitting).
- Facility design and construction emphasizes energy and water efficiency, use of renewable energy sources, environmentally benign materials, and ease of disassembly and reconstruction. Design of park infrastructure follows the same approach.
- Site-wide information services link the set of companies in a self-organizing system for managing their joint activities.
- The industrial park management company facilitates this information flow and picks up the management activities needing a central focus (such as infrastructure maintenance, the waste management utility, and provision of common services).

Lowe and Warren use the concept of an anchor tenant as a means to help to create a more definable set of possible connections (Lowe & Warren, 1996). According to that, an industrial ecosystem should involve at least one major firm exporting raw or processed materials, connected to one or more firms capable of utilizing significant portions of the major waste streams of the “anchor” industries. In turn, these would be linked to several “satellite” enterprises converting wastes into usable products.
Cooperation would be facilitated by a coordination mechanism and information sharing (Ayres, 1995).

The strategies that will be chosen and consequently the way the IEP principles will be implemented depend highly on the characteristics of the morphology of the park. Lambert and Boons (2002) separated parks in two categories (named Greenfield and Brownfield) based on the criterion if the development of a new industrial park or the revitalization of an old one is performed respectively.

4.3 Underling Situation

Today, there are almost 100 cases of eco-industrial development all over the world (Mouzakitis et al. 2003). The majority of them have been developed in the USA (42%) and Europe (36%, mainly in United Kingdom). Asia comes third (11%), whereas significant eco-industrial development is observed in Canada (6%). However significant number of these parks is still in the planning stage (Gibbs et al, 2002). Some well known EIPs are Kalundborg, Denmark, Parc Industriel Plaine de l’Ain, (PIPA) Lyon, Fairfield Ecological Industrial Park, Baltimore, Maryland, Brownsville Eco-Industrial Park, Brownsville, Texas and Red Hills Ecoplex, Choctaw County, Mississippi.

An idea of interconnections and waste exchange in Kalundborg is given on Figure 2. Some of the benefits of industrial symbiosis in Kalundborg include the reduction in fossil fuel consumption and air emissions. In particular the oil consumption has been reduced by 19000 tons per year, the coal consumption by 30000 tons per year (or 2%), the carbon dioxide (CO₂) emissions by 130000 tons per year (3%) and the sulfur dioxide (SO₂) emissions by 25000 tons per year (Gertler, 1995).
The amount of EIP seems small if we take into account that there are about 12,000 industrial parks and export processing zones around the world concentrating hundreds of thousands of industries and millions of workers into relatively compact areas (Cote & Cohen-Rosenthal, 1998).

Gibbs and Deutz (2007) conducted a comprehensive research between several EIP. Their findings indicated a large disparity between the ideals of IE and EIP in the reality. Indicatively they concluded that expectations must be realistic for the community and location in question. As part of that realism, the EIP must be designed to allow for a gradual approach and each phase needs to be financially viable. Furthermore they suggested that while materials and energy exchanges may be the ultimate goal of EIPs, given the difficulty in achieving these they should perhaps be seen as a medium to long-term target rather than as a key part of the initial development strategy. In all cases the most important factor in a project is its economic success (Gibbs and Deutz, 2007).
7. The Greek Potential

According to the National Statistics Office of Greece, in 2002, there were 879,318 enterprises in Greece with only 1,323 of them occupying over 100 workers (National Statistics Office, 2009). Furthermore, the GDP per capita in purchasing power standards in 2008 was under the EU27 average (Eurostat, 2009). In other words Greece is characterized by a relative medium economic performance whereas its economy is based mainly on small enterprises and public sector. Also a lack of heavy industries is observed. That can probably constrain the possible implementation of EIPs if we take into account the frequent use of those industries as a tenant anchor. If we take a look at the list of developed EIPs (Table 1), it can be observed that almost all of them are in the most developed industrial countries, indicating that a satisfying level of national economical development is needed as prerequisite to adopt EIPs strategies.

Still the development of EIPs in Greece should not be taken pessimistically. Several industrial parks are under construction or are to be constructed. Strategies for transforming a simple industrial park to EIP already exist, even for parks that are only staffed by small enterprises. Also a general informing campaign could be conducted in order to inform the industries, the municipalities and the government for the potential benefits of EIPs.

Taking into consideration the evolution of some EIPs, some draft projects could be prepared and examined for implementing EIPs principles in Greece. For example a voluntary interconnection among an oil refinery, a fertilizer company and the municipality of N.Karvali in Kavala, could be created in order to mutually benefit from the exchange of wastes. The oil refinery for instance, could sell sulphur removed from petroleum to the fertilizers company. Also the waste heat from the chemical company (fertilizers) could be used to generate steam for heating in various uses around the industry such as aquaculture, greenhouses and urban facilities in N.Karvali. This is a system used successfully in Ptolemaida where the energy plant provides heat to the municipality. As a result citizens pay less for heating and 42,000 tons CO2 are saved every year (Municipal Enterprise of Telethermanisia of Ptolemaida, detip, 2009). Yet, new facilities could be added to the present ones in this region. A wallboard production facility could help the two other industries to manage their wastes better and even present a profit. The refinery could send sulfur in form of calcium sulfate to wallboard producer, replacing the gypsum typically used. The fertilizer company could do the same. On the other hand, the wallboard producer could employ fuel gas from refinery in order to use it as a combustion fuel to dry the wallboards.
It is obvious that such ideas need further research in order to comply with safety and quality regulations and most importantly, to see if they are economically and environmentally worthy. Still, innovative solutions may be identified even at the very early stage of implementation.

8. Conclusion

Although still in its infancy as a field of study, industrial ecology is emerging as an exciting approach to the application of environmentally sustainable development. Eco industrial parks are an interesting tool of IE which promotes the cooperation between industries of different kind. Based on a systems approach, broadening the boundaries of the system examined, in this case through interconnection and waste exchanges of an industry with others, can highly benefit different agents in an efficient and innovative way otherwise stayed unidentified. Through extensive research of relative literature, it was observed that EIPs present a great potential in theoretical and academic level. However when it comes to implementation, things are getting more complicated. Achieving waste and energy exchange should perhaps be seen as a medium to long-term target rather than as a key part of the initial development strategy. In both ways EIP may lead to great solutions and is a subject deserves further analysis.

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National Statistics Office of Greece (2009),
Strategic management structures for Civil Protection services in Greece. A systemic approach of forest fire crises

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Abstract:
The present paper outlines the main issues Emergency Management Services (EMS) face as an integral part of the Greek Public Administration. We focus on the structure & functions of Crisis Management Groups (CMG) and the way they have affected Civil Protection (CP) response in recent real-life crisis situations. In particular, the problem of evacuating civilian populations threatened by an evolving forest fire is analyzed and some conclusions of general importance are drawn concerning the collective decision-making process for different Strategic Crisis Management (SCM) contingencies. Another crucial aspect of SCM is the need for effectively communicating early on to the citizens the possible need of evacuation without causing social unrest or panic as well as for making an evacuation decision immediately known to the public and accepted by those affected. The function of Crisis Communication is seen as a necessary tool for all Civil Protection managers, who are responsible for the timely implementation of CMG decisions. The need for the successful integration of Crisis Communication planning in all Strategic Management plans is highlighted along with the Information & Communication Technologies (ICT) currently utilized in Crisis Communication activities. The systemic nature of the SCM problem and the challenges ahead of CP services are emphasized as parts of the expanding field of Public Safety.

1 New affiliation: Ministry of Employment & Social Protection. Athens, Greece.
Keywords:
Public administration, civil protection, strategic management, crisis communication, forest fires, public safety.

1. Introduction

A goal of crucial importance for both CP services and for local communities is the successful management of crises like the possible evacuation of a densely populated area which is threatened by a forest fire propagating in its vicinity.

This scenario is commonplace in Greece, a country characterized by a plethora of mixed zones (forests adjacent to urban areas or residential communities dispersed inside a wooded region), which are affected by wildfires especially during the summer period. This problem is compounded by climate change and the sharp increase of local populations due to the tourist (especially in high season) influx, mainly foreign visitors, in many of the seaside resorts.

In such an eventuality, dealing with the destructive phenomenon of wildfires is a highly complex task since it involves the interaction of different services and scientific fields in the process of successfully containing this escalating emergency. Many recent wildfire incidents in Greece entailed large-scale destruction of forests (e.g. Island of Rhodes, July 2008), combined in other cases with high rates of property damage and sadly heavy casualties (e.g. megafires in Peloponnesus, August 2007) with a singularly disproportional increase of mortality (67 civilians). According to international accounts of this disaster, this Greek region lost 1.772.654 acres to the wildfires (55% being forests - wooded areas and 41% agricultural land). In the locally affected communities (mostly villages), 1,644 buildings were totally destroyed by the fire.

Here, we will focus on the human risk since the protection of citizens’ life and health is the primary concern of all EMS in CP. The nature of this challenge is systemic by definition since it involves a large number of different EMS, such as the local:

- Fire service
- Health service
- Civil Protection service
- Communication Liaison with the civilian population
- Police and traffic control.

Thus the major scientific fields, which interact by coming into play during the crisis management phase, are the following:

- Strategic Management (Decision-making structures and processes)
- Crisis Communication methods
Emergency Medical support
Operational planning (tools for successfully scheduling & co-ordinating all actions of the various players before, during and after evacuation)
Forecasting and Nowcasting software (including estimation of fire front propagation and prediction of meteorological conditions) combined with GIS, which serve as Decision Support Systems.

This high level of complexity creates problems of a systemic nature, i.e. challenges which are not amenable to either simple or monothematic solutions. On the contrary, the many interacting facets of the crisis, combined with the acute nature of the phenomenon, create an “explosive mix” of high-risk intertwined processes (sometimes leading to secondary crises), which determine the final outcome of this time evolution as a function of the quality of their individual management.

In fact, there are 2 distinct functions that can be characterized as mission-critical for the successful overall management of a possible evacuation situation, namely:

- Co-ordinating the different EMS through effective group decision-making
- Communicating with the public, especially before starting an evacuation operation.

The goal is to avoid turning such an operation (if launched) into a Search & Rescue (SAR) of civilians or even worse allow it to lead to a catastrophic scenario with many casualties or deaths.

Thus, the decision making problem we are faced with here (using Strategic Crisis Management for the co-ordination of different EMS/CP services) is not only scientifically important because of its systemic value but above all it is worth studying due to its applied nature and its crucial consequences on local societies.

2. Strategic Crisis Management (SCM) structures in Greek EMS

In Greece the field of SCM is a relatively new one in Public Administration. During the last 20 years there has been a concerted effort made towards setting up the necessary infrastructures for intersectoral co-ordination in key areas of State functions like:

- External relations: a Crisis Management Unit (“MONΔΑ ΑΙΔΙΑΧΕΙΡΙΣΗΣ ΚΡΙΣΗΩΝ”) is located at the Ministry of Foreign Affairs
- Defense problems: a National Operations Centre (“ΕΘΕΠΙΩ”) is located at the Ministry of National Defense
• **Internal Security situations**: a Crisis Management Council ("ΣΥΜΒΟΥΛΙΟ ΔΙΑΧΕΙΡΙΣΗΣ ΚΡΙΣΕΩΝ") is located at the HQ of the Hellenic Police (part of the Ministry of the Interior).

• **Civil Protection crises**: a Central Co-ordinating Group for Civil Protection ("ΚΣΟΠΠ") is located at the General Secretariat of Civil Protection (also part of the Ministry of the Interior).

The last 2 types of crises bear a striking resemblance since they share a number of common characteristics, the most important of which have to do with the fact that both are:

• **High-risk** situations threatening the life/health or property of citizens who face an **immediate** danger in peacetime.

• **Crises emanating from an initially local situation**, which escalates **very rapidly** into a **mass emergency**.

The exceptionally horizontal nature and **systemic value of the SCM field** is evidenced by its application in diverse situations ranging from crowd control to natural disasters. One should note though that the aforementioned Greek SCM structures are not necessarily the ones that deal with a crisis situation in practice. The gap between theory and reality appeared once more in December 2008, when a wave of riots broke out first in Athens and then propagated to the other major Greek cities. This crisis situation was handled not by the strategically competent “Crisis Management Council” of the Hellenic Police (as described above) but by a Political Executive Committee, the so-called Governmental Commission or “ΚΥΒΕΡΝΗΤΙΚΗ ΕΠΙΤΡΟΠΗ”. This was also the case during the forest fires of August 2007, when the Governmental Commission acted as an ad hoc Crisis Management Group. In the case of the city riots of December 2008, this ministerial commission held its first meeting 2 days after the incident that sparked the mass urban disturbances. In the clashes that had already taken place, 180 police officers were injured (mostly riot police units). The large-scale destruction of properties combined with extensive looting was the riots’ aftermath that mostly affected the urban populations.

The Governmental Commission, chaired by the Prime Minister with 7 Ministers as members, assumed the responsibility of managing both crises. This is a **collective executive structure** of the highest (political) authority in Greece, which takes all **major policy decisions**. Of course, by definition this body is not supposed to manage the real-time crisis situations that concern us here, because it lacks:

• The continuous and immediate **information input** necessary for taking timely and correct decisions.

• The previous **hands-on experience** in dealing with acute, mass emergencies.

Alternatively, in order to be able to perform this function successfully, all services involved should have prepared through **strategic planning** the
individual action plans to be followed by their respective Crisis Management Groups (CMG), if these had actually operated. All CMG actions must be prescribed in such plans, which should be integrated well in advance through interdepartmental consultations, exercises and operational co-ordination, normally leading to a unified SCM approach (harmonization).

3. Strategic crisis management of civil protection activities in Greece

The experience of the last 2 years in dealing with CP crises created by forest fires offered a series of lessons to all EMS concerned. The main point was the inadequacy of the current SCM structure comprised of a central state body (“ΚΣΟΠΠ”) and of locally operating public officials of the affected communities (mostly Mayors). This structure was in theory responsible for organizing and executing, among other CP actions, evacuations of local populations threatened by forest fires. The decision-making process bottleneck was painfully obvious during the summer megafires of 2007 in Peloponnesus, which resulted in the loss of 67 lives. There, a number of civilians fearing for their lives, without any co-ordination or information coming from the competent civil protection authority, fled their villages with their families. Many of them, disoriented and isolated, approached the fast moving fire front with tragic results. Having situations like this in mind, a bill was passed in December 2007 by the National Parliament transferring all evacuation responsibilities to Local Governments. Today in Greece the only competent decision-makers for evacuation-related matters are the Prefects, Mayors or heads of local communities, depending on the scale of the phenomenon that threatens their civilian population. The catastrophic results of the 2007 forest fires on the life, health and property of locals were immense. They can be categorized into the following types of consequences:

- material damages (destroyed homes, private properties and public utilities’ infrastructures)
- financial losses (decrease of tourism and agricultural production)
- environmental deterioration (hydrological problems due to ground erosion and groundwater pollution, deforestation)
- psychological effects on victims (especially the younger)
- loss of lives.

The CP services focus mainly on avoiding the latter. In practice this goal can be achieved for forest fires through effective crisis prediction and operational planning that must include a massive evacuation component. The responsibility for communicating early on the possible need of
evacuation to the citizens (without causing social unrest or panic) as well as for making a timely evacuation decision belongs to the elected officials of local governments. Here, the same problems that we previously encountered regarding central political decision-making in such crises arise again because these officials often lack the:

- continuous and immediate information input necessary for making timely and correct decisions, or the
- previous hands-on experience in dealing with acute, mass emergencies.

In order to be able to actually perform this function, the Greek legal framework on CP provides them with different teams of experts (the so-called “local co-ordination groups” or “ΣΤΟ” for municipalities and “ prefectural co-ordination groups” or “ΣΝΟ” for prefectures) having representatives of all EMS involved along with generalists from the local bureaucracy. These support teams cannot be considered as Crisis Management Groups (CMG) since they:

- have no decision-making powers
- include a large number of people (typically 15 persons each) making it difficult to co-ordinate their discussions or actions in a time of crisis
- lack the necessary organization and infrastructure that will allow them to receive and process quickly the necessary information about an evolving perilous situation.

This systemic problem is prevalent in all SCM structures for CP in Greece. This is why most important decisions to be taken are forwarded to the higher political level where officials of the central government are called (often with a time-lag) to decide on serious operational matters that will affect the situation in the field without having the direct information input or the necessary experience for managing such local CP crises. The “passing buck” effect propagating through all echelons of public administration usually ends at the ministerial level, or in the case of CP crises (like the 2007 forest fires that we examined earlier) it arrives at the Governmental Commission. This high-level political body, as in the case of the State response to the recent urban violence (December 2008) once more had to decide even for operational matters like setting priorities for ground forces or seeking international co-operation.

3. Proposals and future direction of strategic crisis management in Greek civil protection

The co-ordination deficit that all EMS face and the experience gained from the recent catastrophic events in the country, lead immediately after to the creation of a new SCM structure (Security and Civil Protection Council or
“ΣΑΠΠ”) within the Greek CP system. This new central body contains the following elements:

- A large number of sectors (total of 11 members) with a significant degree of inhomogeneity among them, including dependent fields like intelligence or civil/military emergency planning but also the Agricultural Police.
- A political - strategic orientation (e.g. the responsibility for the strategic planning of CP) but unclear managerial competences regarding SCM.
- A limited integration potential between similar services (like the National CP and Civil Emergency Planning or “ΠΣΕΑ”) due to their conflicting roles and its unclear authorization to enforce the necessary service integration.

The negative Greek experience of the 2008 events (riots in Athens and forest fires in Rhodes) must have played a crucial role in the creation of this new SCM structure under the Minister of the Interior. Despite its inherent problems, this newly established Council creates new opportunities based on the:

- increased level of its authorization, since it includes many members of the political executive. Apart from the minister himself, deputy ministers participate in this body along with secretaries-general and other high-ranking officials of EMS
- common approach taken for Security and CP matters that fall under the care of the Ministry of the Interior
- possibility of exploiting synergies (in fields like logistics or research) that exist between different services in the Emergency Management Sector.

The main deficit of such a CMG is its lack of a Combined Operations Center (COC) that would allow it to function properly in a time of crisis. Such an infrastructure has been in the works for quite some time since 2004 as a successor to a similar COC that was operating during the summer Olympic Games of Athens in 2004. This infrastructure called the Olympic Strategic Security Center (“ΟΣΚΑ”) allowed the unified command, control, communication (using Tetra secure wireless networks) and co-ordination of different Security, CP and Emergency Management Services at the strategic level. Recently, the now unified Ministry of the Interior announced its plans for a National Center of Public Safety Operations (“ΕΚΕΤΑ”) that will co-ordinate public services in:

- disaster management (fire corps, coast guard)
- national defense (navy, air force, army)
- security (Hellenic police, Agricultural police, National Intelligence Service)
civil protection (General Secretariat of CP, Local Governments)
other EMS sectors like the National Health System (Hospitals), the
National Center for First Responders (pre-hospital care) and the
National Center for Social Solidarity (psychosocial support).

The Presidential Decree that will allow its operational launching is still
under revision due to the systemic complexities of the project. The final
success or failure of this effort made by the Greek Public Administration
will depend not only on the creation of such a COC but also on a number
of other crucial factors such as the:

- completion of a functional C4I national system (Command, Control,
  Communication and Co-ordination Integration) that was first launched
  in Attica during the Athens Olympics of 2004
- creation of a National System for the management of CP crises that
  will comprise flexible forms of the newly appointed Security and
  Civil Protection Council (with different members depending on the
  type of National/Regional emergencies) as well as decentralized
  CMG (instead of the existing “Co-ordination Groups”) in local
governments, which will operate strategically with a few specialized
officials
- successful inclusion of Crisis Communication functions in the plans
  of these CMG.

4. Communication principles & technologies for crisis management

Crisis Communication (CC) in its preventive form focuses on transmitting
messages that will enable citizens to protect themselves from all kinds of
possible dangers before a CP disaster actually occurs and after an early
warning has been given to the public (if possible). From a psychological
standpoint, such dangers are considered to be spreading rumours and mass
panic.

In the pre-disaster phase, CC plays a crucial role in proactively supporting
those citizens who could be affected by an evolving CP phenomenon. In
Greece, there is no common CC approach taken by the public authorities.
There are only ad hoc CC actions, usually after a CP disaster has become
unavoidable. Campaigns for sensitizing the public to the need for forest
fire prevention (i.e. systematic information dissemination aimed at fire
prone regions before an actual emergency occurs) are conducted by the
General Secretariat of Civil Protection. Unfortunately such measures have
not been developed for crises scenarios (e.g. evacuations of urban areas).
Communicating with the public, especially before the onset of a crisis, is
crucial to its successful management.

The responsibility for communicating early on the possible need of
evacuation to the citizens (without causing social unrest or panic) as well
as for making a timely evacuation decision known to them belongs to the elected officials of local governments in Greece. During the 2007 forest fires, an important communications deficit of the CP forces was highlighted by the Greek media. The necessary advanced warning that should have been given to the citizens who were in harm’s way was far from being effective. On the contrary, in a similar emergency in California (big wildfires of October 2007), the successful evacuation of 500,000 Americans out of the threatened areas in only 2 days was prepared through an automatic call center (“911 reverse calling”). The pre-programmed mass phone call relayed a simple voice message of evacuation to the civilian population with notable success.

In the Greek riots of December 2008 there was a surge of almost real-time information that was disseminated during the crisis phase using new technologies among participating youths and other interested citizens. In an odd way, this example of CC demonstrates most emphatically the competitive advantage new media have to offer when compared to more traditional channels (like TV and radio). These new, Internet based channels were:

- social networking sites (e.g. Facebook)
- multimedia platforms (e.g. Youtube)
- microblogs (e.g. Twitter)
- mass texting (SMS)
- wireless web access (WAP)
- continuous news updates (RSS feeds)

The power of these unconventional CC tools was evidenced not only by the fact that they successfully mobilised thousands of people but also by their pervasiveness with respect to the news transmitted to the general public from mainstream media, which based their reporting in numerous cases solely on information coming from those sources.

In every case the most challenging part of crisis communication (CC) management has always been “reacting - with the right response – quickly”. The use of Information and Communication Technologies (ICT) in the field of CP allows us to act promptly before, during, as well as after disasters. The challenge of our times is to harness the power of the new media (seen either as a threat or an opportunity) so that these unconventional CC tools may benefit the citizen.

Irrespective of the medium/channel chosen, the following principles on standardizing effective messages to the public, should be observed for CC:

1. Compact, short and self – explanatory form (in order for the message to be comprehensible to the citizens who operate during the emergency phase either in a state of duress or indifference). This can be achieved mainly through non-verbal image
communication (e.g. TV spots with simple maps and evacuation diagrams).
2. Repeatability – frequent transmission (for increased clarity and message uptake).
3. Reassuring character (communicated to the citizens by publicizing successful actions of the CP forces in dealing with the emergency).
4. Specific time line and maximum duration definition of expected disruptions (for the phenomenon per se as well as for its immediate consequences on society such as temporary public service interruptions and utilities’ downtime).
5. Timely communication (fast information relay due to the rapidly evolving emergency situation).
6. Credibility, i.e. the central source of the message should be at least a high-ranking state official with clear authorization to deal with CP emergencies.
7. Relaying the same centralised message (uniform projection) to the citizens using all competent public authorities (including local officials).
8. Message transmission by all available media, especially the local TV and radio stations (private, municipal, NGO-owned).
9. Multilingual content for all messages, especially if the target group is tourists or immigrants.
10. Emphasis on the need for self-protection measures to be taken by civilians.
11. Self-consistency and accuracy (being in agreement with all previous announcements of the CP forces as well as with real field facts already known to the citizens).
12. Completeness so that all developments, positive or negative, are fully realized by the citizens as things escalate to the Crisis phase. This also helps CP forces to gain the confidence of the public and retain much needed credibility.
13. Alerting citizens for the need to take urgent measures of civilian mobilization (if necessary) like evacuating, taking shelter etc. This is an option if there exists a carefully thought-out plan and the possibility of executing it (e.g. an evacuation is decided if there are a priori known, secure and well-monitored escape routes available to the public).

5. Conclusions
We noted earlier the similarities between CP phenomena like forest fire propagation and Public Safety crises such as urban disturbances. In both cases, the necessary Crisis Management Groups (CMG) should be created having the following features:
• Decision-making competences for strategic/political Immediate Decision Making.

• An average of five members per group for each type of CP emergency, containing the necessary expertise that corresponds to the phenomenon at hand.

• Rapidly reacting administrative support and effective information sharing – processing.

• CC competences and capabilities.

• Standard Operating Procedures (SOP) outlining the inner functions of the CMG for each type of emergency.

NB: The issues, priorities and opinions expressed in this paper do not reflect in any way the positions held on these matters by the authors’ hosting institutions or by any of the competent public authorities – Emergency Management Services (EMS) mentioned herein.

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Systems thinking and environmental assessment – Using the
Life Cycle Assessment approach

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Abstract:
Consumers are becoming eager to pay more for eco-friendly products whereas the
national and global regulation is getting more rigorous for industries harming the
environment. As a result, tools for assessing the environmental performance of
products or processes are becoming increasingly popular. Furthermore most
industries have their environmental performance expressed through the
reconciliation of their environmental management system with standards like ISO
or EMAS. These frameworks ensure the compliance with regulations however
may not be really effective due to the dynamic nature of environmental matters.
In other words a more systemic and holistic view is needed when trying to assess
the environmental performance. Life Cycle Assessment (LCA) is an analytical
tool for assessing the environmental performance of products or procedures in a
systems perspective. LCA takes into account all life stages of a product offering a
complete overview of the environmental performance. In this paper a brief
description of the LCA method is given whereas some case studies are presented
using relative LCA software. Results indicated that changing the boundaries of
our system can greatly affect the environmental performance of a product
indicating that the use of a systems approach for assessing the environmental
performance of products is critical.

Keywords:
Systems thinking; life-cycle assessment; environmental assessment, LCA
1. Introduction

In the beginning of the industrial era, the solution to environmental problems resulting from production processes was thought to be the reduction of the concentrations of harmful substances. Instead of releasing the emissions close to humans, pipes and chimneys were built. Later on, people saw that the consequences of the emissions were still present, so they tried to treat them with filters, chemical treatments or combustion. The wastes from the processes were now less hazardous but large amounts of it were produced. The next step towards environmentally friendly processes was to make the process itself cleaner and more efficient to reduce the amounts of waste sent to landfill and to lower the extraction of raw material from non-renewable resources. In our days instead of this process perspective, it is now more common to have a product perspective whereas sustainability is the ultimate goal for successful industries. For many products, the largest environmental impact does not come from production stage. For example, a car has the most significant impact on the environment during the years of use by the customer due to the fuel consumption. To make the car more environmentally friendly it will not be lucrative to make the process cleaner if the fuel consumption during use is not addressed (Carlson et al 2003).

Sustainable development concepts have resulted in increasing environmental pressures to improve the efficiency of products and processes in terms of resource utilization and reducing waste generation and emissions. Due to call for sustainability, industries and developers are challenged to incorporate systemic thinking into their environmental assessment of their products or processes. This is because environmental problems are too multidimensional and dynamic to be examined in isolation. These concerns have in turn focussed attention on the supply chains and life cycles in which minerals and energy resource processing take part, as resource processing represents particularly a critical stage for the potential release of gaseous, liquid and solid emissions, for it is here that chemical transformations often take place (Norgate et al 2007).

Under these circumstances, a number of environmental assessment tools and methodologies have been developed by the scientific community in recent years, and these include Environmental Impact Assessment (EIA), Ecological Risk Assessment (ERA), Material Flow Analysis (MFA), Materials Intensity per Unit of Service (MIPS), Cost Benefit Analysis (CBA) and Life Cycle Assessment (LCA) (Baumann et al 2004, Giurco et al 2000).

In this paper the Life Cycle Assessment (LCA) tool is presented. LCA was designed to evaluate and, if possible, reduce the environmental impact for the entire life cycle of a product, process or service. The reason for choosing this methodology is that it highly incorporates the systemic
thinking principles where an holistic view is fundamental. Thus, this approach can lead us to solutions may stayed unidentified due to improper boundaries setting of the system examined.

2. Definition and Steps

Life cycle assessment is a “cradle-to-grave” approach for assessing industrial systems. That means that it addresses the environmental aspects and potential environmental impacts (e.g. resource use and environmental consequences of releases) throughout a product’s (or a system’s) life cycle from raw material acquisition through production, use, end-of-life treatment and disposal (SETAC, 2009). LCA is considered by many as a complementary and comprehensive tool with respect to other environmental management systems (EMS) for supporting an effective integration of environmental aspects in business and economy (Frankl, 2002). Figure 1 presents some of the life cycle stages that can be examined in an LCA along with the inputs/outputs measured (EPA, 2006).

**Figure 1**: Life cycle stages and inputs/outputs (source: EPA 2006)

LCA was first introduced in the 1960’s and was evolved through the years due to concerns over the scarcity of raw materials and energy resources, world’s changing on demands, climatological changes, oil crisis, solid waste problems at al. Furthermore, a number of LCA case studies (handling with issues such as alternative containers besides glass bottle, different plastics, laundry detergent packaging comparison and disposable or not diapers) enhanced the evolution of the methodology. Key dates for LCA are 1997 when the development of the LCA standards (ISO 14040 series) began (1997-2002) and 2002 when the United Nations Environment
Programme (UNEP) joined forces with the Society of Environmental Toxicology and Chemistry (SETAC) to launch the Life Cycle Initiative, in order to implement and promote LCA.

Although LCA is not fully developed, some standard steps have been developed for those who wish to implement it (ISO 14040 series). These steps include:

1. **Goal and Scope description of the study:** During this step, the system, products or processes to be assessed are defined, a functional unit for comparison and the level of detail is chosen and the LCA boundaries are described. Some of the goals when performing an LCA are summarized by EPA (2006):

   - Support broad environmental assessments
   - Establish baseline information for a process
   - Rank the relative contribution of individual steps or processes
   - Identify data gaps
   - Support public policy
   - Support product certification
   - Provide information and direction to decision-makers
   - Guide product and process development

   Furthermore, setting the boundaries can greatly affect the results of an LCA. Mila et al (1998) applied LCA in the leather footwear industry. Results have shown that setting the boundaries is critical indicating cattle raising phase as a significant impact source. Depending on issues such as the goal of the study and the available data, boundaries are set accordingly. Systemic view is indispensable in this step.

   Then a functional unit has to be chosen. For example you cannot compare the environmental impact of a zipper and a button and decide which is better for the environment since they are not serving the same function. Thus a blouse using 8 buttons and the same blouse using a zipper, both made from the same wool and used for 5 years would be a suitable functional unit for comparison.

2. **Inventory Analysis:** In this step, the inputs (energy, raw materials used, etc.) and outputs (emissions to the atmosphere, water and land)
are quantified for each process or product included in the Life Cycle Assessment (Figure 1).

In order to perform an inventory analysis, a flow diagram of the processes being evaluated needs to be developed at first. Then the development of a data collection plan takes place followed by the data collection. Finally the results are evaluated and reported. Without an LCI, no basis exists to evaluate comparative environmental impacts or potential improvements (EPA 2006).

Although the inventory results are more detailed, it is not easy to interpretate these long list of substances (PRé Consultants, 2008). Thus impact assessment is needed to better understand the inventory results.

3. Impact Assessment: During this step, the effects of the resources used and emissions generated are grouped and quantified into a number of impact categories which may be weighted for importance. In other words the data collected in Life Cycle Inventory are translated into potential human health and environmental impacts. For instance, in this step questions such as what affects ozone depletion more; 100 tons of methane emissions or 150 tons of SO2, are answered.

In order to perform an impact assessment some impact categories must be chosen according to the needs of the study. Common used impact categories are global warming, acidification, photochemical smog, human health, resource depletion, land use, ozone depletion etc. Then these impacts can be weighted in order to quantify and compare different categories.

There are several impact assessment methods to choose from and it is up to the user to choose the most suitable one. For example a well known impact assessment method is Eco-indicator 99 (EI99). In the Eco-indicator 99 method normalization and weighting are performed at damage category level. There are three damage categories: Human health, Ecosystem Quality and Resources. A non-metric unit, called Points (Pt), is used in Eco-indicator to evaluate the impact of a product or process. More points mean worst efficiency for the environment.

4. Interpretation: During this stage, the results are reported in the most informative way possible and further improvements of the life cycle are performed. Furthermore, some tools such as contribution and sensitivity analysis, anomaly assessment, risk analysis etc. may be used.

Performing an LCA could highly benefit the user but could also be resource and time high-pressure. Depending upon how comprehensive an LCA is, gathering the data can be a really hard procedure thus greatly affecting the accuracy of the final results. Therefore, it is important to
assess the available data and the time needed to conduct the study. Also, LCA does not identify which product or process is the most cost effective in terms of monetary units or mechanical perspective. Therefore, LCA is a powerful tool to be used as a part of a general framework such as Life Cycle Management.

3. Implementation of LCA

As stated above, in order to perform a comprehensive LCA, a significant amount of effort and time is needed. However the development of relative softwares, has significantly simplified this procedure.

A study conducted for some of these softwares indicated some of their common characteristics. Most of them follow the 4 steps approach proposed by ISO 14040 series. Additionally they include a great amount of libraries and impact assessment methods to use. Thus, what you really have to do is collect the inputs/outputs of the process or products examined, or choose them from analytical lists incorporated into the software, creating a tree format with all the procedures and materials examined. Then by defining the impact assessment method, results are ready to be examined. In order to better comprehend the use of an LCA and more importantly indicate examples of problems that can be solved by using it, three different case studies are summarized below, the one created by the authors using the LCA software SimaPro 7.1.

Byung-Chul Choi et al. (2006) investigated the life cycle environmental impact of PCs and tried to determine the desirable recycling rate. The system boundary chosen, included pre-manufacturing (the electrical parts and components manufacturing), manufacturing, transportation, use, and disposal. The LCA was performed using two different recycling scenarios: one being that of the current recycling rate of Korea (46%), and the other being the ideal condition of a 100% recycling rate. Results indicated that the pre-manufacturing stage was a significant stage for all of the environmental parameters, besides human toxicity potential. Also, the use stage had a significant potential due to the electricity consumption produced by burning fossil fuel. The disposal stage's contribution to environmental impact was largest in human toxicity, and second largest in ozone layer depletion potential. Furthermore the PC recycling was shown to inhibit all environmental impacts with the exception of the ozone depletion and ecotoxicity potential. Finally, the PC recycling is recommended to be raised up to at least 63% in order to reduce the environmental burdens of a PC in other life cycle stages.

Not only products or industrial processes can be examined using LCA. For example Hischier and Hilty (2002), studied the environmental impacts of an international conference. Preparing and holding a 3-day
conference was chosen as the functional unit whereas the boundaries set are presented in Figure 2.

![System boundaries for the LCA of a characteristic conference](image)

**Figure 2:** System boundaries for the LCA of a characteristic conference  
(Source: Hischier and Hilty, 2002)

Results have shown that minimizing air travel is the only way to attain a significant reduction in environmental impact. Thus some solutions such as virtual conferences are proposed. However if the boundaries are bounded by excluding the travels, then the nylon bag at first and the printed proceedings inconsequential, are the most important factors affecting the environmental impact.

Finally, in order to further understand the implementation of an LCA, a simple case study was performed by the authors, using the SimaPro Library Project LCA Food DK, which consists of comprehensive data about food’s LCA. The issue examined was to find the most environmentally friendly choice among the ones described below:

- Baking self-made rolls (a kind of bread made of flour, rape seed oil, sugar and tap water) using a conventional oven. An example of some of the materials and processes included in our project are presented in Figure 3.

- Buying rolls from local bakery which is located 500m near our house. There are two ways to go there, by foot or using our car.
- Defrosting rolls bought from a supermarket and heat them in microwaves.

The impact assessment method used was Eco Indicator 99. The results are summarized on Figure 4.

**Figure 3:** Tree presentation of materials and procedures involved in our LCA using SimaPro 7.1
Summarized results for the LCA examined (note that less points mean better environmental performance)

From the above figures it can be observed that defrosting rolls bought from supermarket in the microwave is the best solution from an environmental point of view, whereas visiting local bakery is preferable from making our own rolls if we go there by foot. As expected using a car has a significant impact on the environment even for small distances. The exhaust of fossil fuels, the use of land and emission of respirable inorganics are the major impacts resulting from the examined scenarios.

Conclusion

Systems thinking is a framework that is based on the belief that every issue is more efficiently examined as a part of a system rather than viewed in isolation. In that aspect environmental problems call for a systemic approach due to their dynamic nature and interrelatedness. In this paper the LCA tool is proposed for assessing the environmental performance of products or procedures, taking into account every step of their life cycle, from raw materials acquisition to end-of-life treatment. The avocation with relative case studies and LCA software indicated a great potential of using this methodology. Changing the boundaries of a system can greatly affect the results, thus the use of LCA can help identify environmental hot spots. However there are still many limitations and assumptions need to be made
for implementing LCA since it is still evolving whereas a significant amount of time and data may be needed.

References


## Topic:

### Tourism

An integrated information system for the tourism industry: a systemic virtual enterprise

**Nikitas Assimakopoulos, Nikolaos Dimitriou, Evangelos Varvitsiotis, Efstathios Sotiriou – Xanthopoulos**

Adding value to balanced scorecard development by integrating cause mapping and system dynamics, a win win scenario for e-tourism

**Jason Anagnostopoulos, Yannis A. Pollalis**

The role of crisis in hiring personnel in tourism industry

**Theodoros Athanasiadis, Andreas Katifes, Efstathios Lagoudakis, Alexandros Papagiannis**

Tourism clusters: management and technology challenges

**Mariza Tsakalerou, Stefanos Katsavounis**
An integrated information system for the tourism industry:
A Systemic Virtual Enterprise

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Abstract:
Due to the ever-increasing demands of the tourism industry, the complexity of the respective information management systems has skyrocketed, which is the main reason for more and more sophisticated information systems. By this, we refer to software that not merely performs reservations of specific kinds of tourism services (i.e. accommodation, transportation, etc.), but also is capable of coordinating tourism service providers so that the accessibility to these services will be fast, effective and secure.

One of the main premises to achieve this goal is the systemic design of a flexible architecture for the proposed integrated information system. First of all, the system integration has to do with the definition of procedures which cover not only one tourism service each time, but also a great number of them, coordinating in parallel all the enterprises involved. For example, instead of making separate reservations for accommodation or transportation and other services, there will be only one overall reservation
by enabling the dynamic packaging of the preferred tourism products. In order to achieve the desired integration level efficiently, the architecture of the information system should be flexible enough in order to be efficiently adapted to the changing requirements concerning both the preferences of the customer and the strategic and organisational requirements of each tourism service provider. Therefore, another premise is the extended flexibility of the overall system. All these aspects of the proposed system will result to the highest possible levels of quality of service provided to the traveller.

In the view to the development of such a system, this project presents a set of software programs which have to do with a Virtual Travel Agent (VTA). This VTA communicates with other tourism enterprises, which will be referred to as “Tour Operators”. In fact, they are usually NetBrokers for the negotiation between the VTA and the service providers. Given that the operation of the VTA is based on the Tour Operators, it is clear that the proposed integrated management system is a classic example of Virtual Tourism Enterprise. By coordinating the functions and operations of each Tour Operator, the VTA can provide integrated, fast, reliable and secure procedures to the customer.

The VTA is based on a flexible architecture, referred to as “Mechanisms – Policies Architecture”, according to which a business logic kernel provides basic procedures, known as “Mechanisms”, and one or more interfaces (i.e. customers' interaction software), which use the mechanisms in order to develop the overall procedures or “Policies”. Hence, the VTA can cover every customer's need, no matter what it is. In addition, the VTA can promise that there will be partial or – if possible – full support of the ever-changing strategic cooperations between the tourism enterprises (e.g. Aegean Airlines with Lufthantza), even if it means that some (rather minor) modifications of the software are necessary. This architecture was defined with the use of the Systemic Methodology DCSYM.

We strongly believe that this VTA will be the paradigm for a fully potent integrated information management system. We also stress that the software developed will pioneer new ways of the tourism industry management.

**Keywords:** Virtual Travel Agents, Tourism Industry, Strategic Cooperation, Integrated Management System, Systemic Design, DCSYM
1. Introduction

The ever-increasing traveller’s needs for better access to high quality services of the tourism industry has resulted in the development of many electronic travel agents in the Internet. These sites aim to be both competitive and efficient not only by upgrading themselves, but also by making strategic cooperations to increase the traveller’s accessibility. The matter that reveals is whether these strategic cooperations are sufficient in order to cover the tourist’s demands and, of course, whether these strategic cooperations can be supported by other tourism management systems.

In fact, because the requirements in tourism industry have skyrocketed, there is the need for a better-structured information system, as the simpler current solutions are not always able to cope with these increased demands, neither can be adapted to the new status quo of the tourism industry. Moreover, there is the need for an integrated information system, with the use of which the customer can have access to many different tourism services (e.g. Hotels, Airlines, Activities) without visiting many different sites. As it is clear, the integration and the flexibility are the most important attributes of the desired system, since they can be used to develop a most powerful system.

With all these in mind, the goal of the current project is to demonstrate a prototype of a flexible integrated tourism management system, as well as depict some comparisons with other sites already available.

2. Presenting “VE Travel” – “VITRO” software

2.1 Conceptual framework

In order to develop and implement the desired Virtual Tourism Enterprise, the definition of crucial parameters and specifications is of high importance. It is stressed that the proposed system should be based upon the increased traveller’s need for a fast, reliable and of high quality integrated VTA and should be able to provide full access to the tourism industry in a few steps.

Describing the conceptual framework, the first parameter has to do with the nature of the enterprise. Particularly, the desired system should be a kind of Virtual Enterprise, well-known as Virtual Travel Agent (VTA) (Sotiriou – Xanthopoulos, 2008). Generally, a Virtual Enterprise is a group of autonomous enterprises which are involved in the development of a common product, under the supervision of a coordinator, which is one of these enterprises – members. Concerning tourism industry, a Virtual Enterprise, particularly a VTA, will offer the integration needed, as the
desired level of integration can be achieved only by a cooperation between Tourism Service Providers (Hotels, Airlines, etc). This is the reason why we should use a VTA.

Another point has to do with the Distributed Artificial Intelligence, which is separated into two subdomains; Distributed Computing and Artificial Intelligence (Wooldridge, 2002). Distributed Computing is an area of the Information Technology according to which many times it is preferrable to use many computers connected to the Internet, instead of one only, in order to process or store a specific amount of data, especially when this amount is really huge. Concerning tourism industry, what is of high importance is the fact that even the most famous travel agency cannot provide such a great amount of information (Assimakopoulos et al., 2008). In practice, that means that we need the Distributed Computing, so that the desired system can provide a vast amount of information simply by acquiring it from many other agencies, which will be referred as “Tour Operators”. In fact, a Tour Operator is a Netbroker which is charged to accomplish the communication between the VTA and the Tourism Service Providers. Therefore, every enterprise which has the role of a Netbroker is a Tour Operator.

Concerning Artificial Intelligence, this domain will offer to the system the opportunity to display tourism services which are fit to the requirements of each individual. During the development of the proposed system, the BestFS algorithm (Vlahavas et al., 2006) is used so that the VTA can extract the most appropriate tourism services, according to specific traveller’s criteria.

As already described, a most important feature of the desired information system is flexibility. A very effective way to achieve this goal is to divide the whole system into many interacting and cooperating subsystems, each of which contains a specific type of procedures. Combining procedures of different types can result in the creation of a vast number of final operations, which means the development of a flexible management information system. This is a most important requirement because it is the Travel Agent that should coordinate the Tour Operators in an efficient way. Moreover, it is a matter of how the VTA will cover the increased requirements of the traveller. Therefore it is clear that, the procedures being static and “monolithic”, the VTA might not survive in the demanding environment of the tourism industry, as it cannot be adapted to both the requirements of the customers and the business logic of the Tour Operators.

A way to overcome this obstacle is to divide the whole system into three major parts (Sotiriou – Xanthopoulos, 2008). The first one is the “kernel”. We refer to a web service with the business logic of the VTA. It is remarkable that the business logic does not consist of the final
procedures of the VTA, but it includes some very basic procedures which will be called “mechanisms”. The second part is a set of interfaces, each of which is the communication medium between the traveller and the kernel. In addition, every interface combines the mechanisms provided by the kernel, in order to define “policies”, which are the total procedures of the VTA. The third part is the set of the Tour Operators. The mechanisms of the kernel will use and coordinate a number of procedures provided by some of the available Tour Operators. In this way, the VTA will include integrated procedures which allow the traveller to organise their trip without having to visit many sites. The above structure is known as the “Mechanisms – Policies Architecture” and will be thoroughly described with the use of DCSYM systemic approach.

Concerning the proposed software, the kernel will be the “VITRO” unix-based web service (Sotiriou – Xanthopoulos, 2008) and the interface will be the windows-based “VE Travel” web site (Assimakopoulos, Dimitriou, Theocharopoulos and Varvitsiotis, 2008), which is based on ASP .NET. In addition, a unix-based web service will simulate a Tour Operator for the needs of the smooth operation of the system. The whole software, which accompanies this paper, will run in a simple two-computer system.

Finally, for the consolidation of the mechanisms and policies, a description of the traveller’s basic requirements using a UML Use Case diagram is highly preferable. It is important to be stressed that, in this paper, we do not need more details about the processes, because not only they have already been mentioned in literature, but also they are not important for the customer; all the modules of the system behave to the layman as “blackboxes”, providing no information about their structure and therefore simplifying the way the traveller understands and uses the system.

In conclusion, the methodological steps in order to present the concept of the proposed VTA include:

- The mechanisms – policies architecture presentation, using DCSYM systemic methodology.
- The traveller’s Requirements Analysis, using UML Use Case diagrams.
- Brief presentation of the VE Travel site operation.

2.2 The mechanisms – policies architecture

The system (in a very simple version) including the kernel, an interface, a tour operator and some auxiliary subsystems is briefly depicted in Figure 1 with the use of the DCSYM systemic methodology. The description of
each subsystem is explained in the Table 1. Moreover, the hierarchy of the systems is clearly described.

Hence, as shown, the overall system consists of the customers and the cooperating enterprises, which are the VTA, the tour operators and the tourism service providers. The VTA includes the kernel, the interfaces – particularly the “VE Travel” web page – and auxiliary software such as the database software and the payment system. Details about the architecture of the Virtual Tourism Enterprise have already been analysed in the current literature (Sotiriou – Xanthopoulos, 2008).

What should be noted is the kind of data transferred, as well as the control flow between the subsystems. As it is well-known from Systemic Analysis, DCSYM methodology can describe not only the communication, but also the control between two systems. In this case, the communication is marked with red lines and is divided into three major categories:

- C: Smooth Communication
- U: Purposeful act
- G: General interaction

**Figure 8:** VTA Architecture using DCSYM
Table 1: Description of the systems

<table>
<thead>
<tr>
<th>System</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1S</td>
<td>Virtual Tourism Enterprise (the whole system)</td>
</tr>
<tr>
<td>11S</td>
<td>Cooperating enterprises</td>
</tr>
<tr>
<td>111S</td>
<td>Travel Agent – VE coordinator</td>
</tr>
<tr>
<td>112S</td>
<td>Tour Operator</td>
</tr>
<tr>
<td>113S</td>
<td>Travel service provider</td>
</tr>
<tr>
<td>1111S</td>
<td>Travel Agent Interface – “VE Travel” portal</td>
</tr>
<tr>
<td>1112S</td>
<td>Travel Agent Kernel – “VITRO” server</td>
</tr>
<tr>
<td>1113S</td>
<td>Auxiliary software</td>
</tr>
<tr>
<td>1A</td>
<td>Traveller</td>
</tr>
<tr>
<td>1121S</td>
<td>Tour Operator adapter</td>
</tr>
</tbody>
</table>

On the other hand, the control is marked with blue lines and has three types:
- C: Call – sending request
- R: Response
- G: General control

Thus, a typical scenario of the entire Virtual Tourism Enterprise operation includes the following steps:
1. The customer visits the VTA via the web portal (i.e. the interface) and poses her or his request.
2. The interface communicates with the kernel and uses a combination of some mechanisms, in order to accomplish the request.
3. The kernel, using some auxiliary programs, processes each request of the interface.
4. During this processing, the kernel communicates with the Tour Operators involved – if any – via their adapter (i.e. their input – output interface), using some of their procedures. These procedures will actually be integrated in a single process which will be a mechanism of the kernel.
5. The response of each involved Tour Operator is included in the result of the request processing.
6. The kernel sends respective responses to the interface, concerning the requests of the latter.
7. The interface combines the responses received and sends the final result to the client.
2.3 Requirements Analysis

The Figure 2 depicts the most important traveller’s requirements according to the current literature (Sotiriou – Xanthopoulos, 2008). In general, these requirements represent the most common procedures in which a traveller is involved in order to acquire information about the destination, to search for tourism services and to make reservations on them.

According to the current Requirements Analysis, the tourist wants to have access to every amount of information available concerning the tourism industry. A classic example is the piece of information provided about the destination where the traveller wants to go. Therefore, the Information Providing is an indispensable operation of the proposed VTA.

Moreover, according to the figure, the tourist desires to organise her or his travel basically in package holidays, by sending specific criteria, such as arrival and departure date and time, destination, persons’ number etc. There is a point, however, about package holidays which should be clarified; the traveller sometimes wants to organise their holidays on their own, instead of using a package holiday. For that reason, the package holidays are divided into two categories; the “Ready” and the “Custom” ones. Therefore, a traveller who wants to choose a package holiday can search for a Ready one. Otherwise, they can organise a Custom package holiday, which means that they can build their own package holiday!
During the traveller’s building a Custom package holiday, a basical function which should be available is the booking of the essentials, i.e. the hotel, the transportation and the vehicle rental. In addition, the traveller probably wants to arrange activities, events and tours. Thus, the VTA should provide such services as well. As already stressed, the display of alternative solutions for every service involved is a function of greatest importance. Of course, every search for services should include the respective availability limits, which represent the date until when each service is valid. For example, during the Moundial football championship in 2010, the traveller’s going to a football match is an activity which expires after the end of the championship. In other words, it has a specific availability limit which should be checked (Dorn et al., 2001).

Finally, the traveller wants to “edit” her or his service reservation, which means that, among others, there should be a function to cancel a reservation. The cancellation should be applied not only on future reservations, but also on the current. In other words, provided that an urgent situation occurs, the traveller should have the opportunity to cancel the vacations.
2.4 A brief presentation of the proposed Virtual Tourism Enterprise

In order to have an idea of the proposed system concerning the way the traveller can have access to it, a brief description of its functions is of high importance. As described before, the VITRO kernel will serve the “VE Travel” web site interface. It should be stressed that the site has been written in Greek. However, the amount of data provided is written in English.

In Figure 3, a part of the start page (“APXIKH” in Greek) is depicted. The start page is used for the flights booking as well. The main menu includes links to the initial (“APXIKH”) page, to the ready packages available, to hotel booking, to renting a car and to activities reservation. The site also provides a button for building our own package holiday.

As the kernel supports the reservation of package holidays instead of individual services, booking an individual service automatically creates a package holiday of one component only.

In Figure 4, the search for flights is described. Particularly, what is shown is the process of posing the search criteria. After logging on, the traveller poses the departure city (e.g. Athens), the transportation medium departure point (e.g. Eleftherios Venizelos airport), the destination (e.g. London) and the medium destination (e.g. Heathrow airport). In order to fill in the medium departure and destination point correctly, there is a box with three dots which triggers the acquisition of the airports.

Then, the traveller types the departure date and time ranges; as seen, one has the right to define a range of dates and times in order to have more results. In the same way, the arrival date and time are declared. Then, the number of persons and the maximum number of results are defined. In fact, this version of the interface can show only one result; the kernel is able to provide more than one. Finally, we declare that we want an A class seat.
Figure 10: The start page

![Start Page Image]

Figure 11: Flights search

![Flights Search Image]
Figure 12: Search results

The Figure 5 shows the result of the search. Particularly, there is the brand name of the service, the ticket price and the seat class. Of course, there is also the availability date and time. Below this piece of information, there are the fields which the traveller should complete in order to make a permanent reservation of the service. These fields are shown in Figure 6.

Figure 13: Reservation
In case there is the need for a multi-component custom package, a wizard for building one’s own package is used. In Figure 7, there is the initial step. Generally, this wizard includes the choice of the flight, the hotel, the activities and the vehicle. These steps are presented briefly in this section. Also, the intermediate steps are similar with the forms for booking individual services.

After making all the choices, the traveller completes the final form of the wizard, shown in Figure 8, for the permanent reservation.

Of course, there is the chance to search for ready package holidays. After setting search criteria which are similar to those for the services search, the traveller can acquire a result similar with this of Figure 9. As seen, the results include the destination, the tour operator, the package name, its price and a brief description. The availability date and time are also included.
**Figure 15: Final reservation**

<table>
<thead>
<tr>
<th>Φόρμα Τελικής Κράτησης</th>
</tr>
</thead>
<tbody>
<tr>
<td>Παράδειγμα: Κράτηση</td>
</tr>
<tr>
<td>Διεύθυνση: Αθήνα</td>
</tr>
</tbody>
</table>

**Figure 16: Searching ready packages**

<table>
<thead>
<tr>
<th>Μέχρι Οπότε</th>
<th>Πρόγραμμα</th>
<th>Φόρμα</th>
<th>Φόρμα Τελικής Κράτησης</th>
<th>Περιγραφή</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ράτσα</td>
<td>Κράτηση</td>
<td>Λάρισα</td>
<td>Κράτηση διαμερίσματος</td>
<td>Απόστροφς</td>
</tr>
</tbody>
</table>

| Διεύθυνση: Αθήνα | Λάρισα | Κράτηση διαμερίσματος | Απόστροφς |
3 The advantages of the Virtual Tourism Enterprise

It may be stressed that the proposed system is yet another site which is similar with that of Aegean Airlines or pamediakopes.gr. In fact, this system has a major difference from the other sites; it is an integrated Virtual Enterprise. In other words, it integrates the procedures and amount of data, in order to facilitate the traveller’s search for resources about tourism. This does not mean that the other sites are obsolete; on the contrary, they are the elements on which the proposed Virtual Enterprise is based. Therefore, they might as well cooperate with our VTA.

Because of this integration, the advantages of the entire VTA over the other travel sites are highly enhanced. But, first of all, the classification of the tourism enterprises is crucial for this point. On the one hand, there are the travel service providers, whereas, on the other hand, there are the travel agencies. However, many providers offer services of different kind (e.g. the Aegean Airlines offer hotel booking). It should be clarified that this kind of sites cooperate with other sites in order to provide a different type of service. However, these sites are not Virtual Enterprises, as the user is redirected from that site to another. Thus, there is no integration applied. This phenomenon is absolutely explained by the fact that the service providers are specialised on a specific type of service. For instance, Aegean Airlines is specialised on flights and not on hotels. Moreover, because the service provider can seldom be a travel agency and is sometimes a biased proxy, it does not cooperate with many other enterprises, providing, thus, limited results concerning the services of different type. Thus, because the specialized sites described above cannot be compared with this VTA, the paper is focused on the advantages of the proposed system over the stand-alone travel agents only.

A most important advantage is the fact that the traveller can build her or his own custom package, unlike most of the travel sites which provide only ready package holidays. Of course, our VTA is able to provide ready packages as well, either by browsing the packages stored in the database, or by receiving exact search criteria and finding the appropriate package holidays sorted by the total price. Furthermore, by the implementation of the appropriate interface policy, the system can provide the editing a ready package so that it can be customised according to the traveller’s preferences. This can be achieved by developing a custom package initially based upon a ready one.

Another most important advantage is the vast variety of solutions provided after a specific search. The traveller can search either for many different services of a specific type (e.g. many different hotels), or for many solutions concerning a specific service (e.g. rooms of a specific hotel). In both cases, Artificial Intelligence is applied in order to provide a
vast variety of suitable solutions. If there is no “direct” solution, the algorithm makes a “division” of a specific result (Sotiriou – Xanthopoulos, 2008). For example, if there is no flight from Athens to London, then the algorithm will search for two flights; one from Athens to a destination X (e.g. Rome) and another from X to London. Therefore, the range of the solutions becomes wider, so that the traveller has a better support for her or his decision making. What is more, the customer will be informed about the existence of any other enterprise involved in a reservation (e.g. of a flight). Hence, the variety of solutions may as well be increased by the possible cooperation strategies between providers of the same type (e.g. of Aegean Airlines with Lufthantza).

In parallel with the beneficial factors described above, there is another one which has to do with the price of the services provided. In physical travel offices, as well as in the ordinary travel sites, there is one or more tour operators, as the suppliers of the agency, which most of the times have their own profit from this supply. The reason is that such operators are other physical travel agencies. Hence, the price of each service increases, having as a result the decline of the possibility for the traveller to acquire inexpensive services. Indeed, although the travel web sites provide services at a lower cost than the other travel agencies do, the price set by the sites is sometimes much higher than the real price of the service, which is considered unfair by the tourists. On the other hand, the proposed system has the ability – and it is also designed – to cooperate majorly with tour operators which supply services with adding little or no additional price and, as already referred, are in fact the netbrokers of the Virtual Enterprise. This benefit is also supported by the fact that the operational cost of a VTA (and every Virtual Enterprise) is rather low.

4 Conclusions

With the proposed integrated Virtual Tourism Enterprise, the tourism industry can easily offer high-quality services in a most organised way. Particularly, apart from the fact that the traveller does not need to visit multiple web sites, this system is characterised with high reliability, speed, flexibility and accessibility. Each reservation is contiguous, i.e. every service is booked in the correct order with time spaces as short as possible, and optimised, i.e. every service is chosen from a list which is sorted from the best to the worst one.

The Systemic Analysis has helped us define the architecture of the system and pinpoint the methodology which is recommended for the implementation of the system. Particularly, the DCSYM Systemic Methodology can provide us a simple VTA use scenario and, therefore, can show us the necessary operations of the system.
As already explained, this VTA has some very important advantages over the other agencies. These benefits can be summarised with the following phrases; variety of package holidays reservation, variety of solutions and, finally, low prices. With these advantages, this system is a commercial proposition for a competitive VTA.

It is strongly believed that this combination of software will be the new status quo of a better tourism industry, which every traveller will trust.

References
Adding value to Balanced Scorecard Development by integrating Cause Mapping and System Dynamics, A Win Win Scenario for E-Tourism

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Abstract  
This paper aims to demonstrate the usefulness of an approach of tailoring Strategy Mapping and Balanced Scorecard Development in the particular organizational context. Such an approach is based on the particular benefits of the integration of Cognitive/Cause Mapping approach of Colin Eden and System Dynamics methodology. The integration of the above methodologies is particularly useful to elicit the knowledge of the mental models of the members of the management team, bring consensus and mental alignment, and identify the critical few objectives in which performance measurement indicators should be developed. Further to that, the integration of Cognitive / Cause Mapping and System Dynamics can be particularly useful to inform a much more valid model both in terms of client ownership but also in terms of representing reality. The above paper describes how Balanced Scorecard Development could take place in the particular context of ETourism in Greece and describes why this particular integration can be of the utmost important for the particular context. It can provide investigations on how to manage the rapid growth of an ambitious E-Tourism Marketing Destination Organization Endeavour and gain support from important stakeholders.

Keywords:  
Cause Mapping, Balanced Scorecard, System Dynamics, E-Tourism
1 Introduction

Performance measurement has rapidly evolved over the last few years (Eccles 1991) in the context of several academic disciplines such as ‘accounting’, ‘operations management’ and ‘strategy’.

Following the dissatisfaction of outcome financial indicators, a number of integrated performance measurement systems have been developed (Kaplan and Norton 1996, Lynch and Cross 1991) in order to give an overall view of organizations’ performance and guard against suboptimization (Ghalayini and Noble 1996). Based on the old maxim of Lord Kelvin that ‘you can’t manage something you can’t measure’, performance measurement as a practice has increased.

As a result, a number of performance measurement models/frameworks/process has been invented in order to identify the properties of the system as a whole (performance measurement system). Nevertheless, the anticipated outcomes of this performance measurement regime have not been the most successful. The reality has shown that great majority of the performance measurement systems have failed (Bourne et al. 2003). Moreover, it has explored that it is particularly useful to tailor the performance measurement system in the particular organizational context. This paper aims to explore how the integration of Cause Mapping and System Dynamics can be particularly useful for Balanced Scorecard Development.

The structure of this paper is as following. Section one describe the purpose of this paper. In Section two, the particular issues about existing gaps and neglected issues in performance measurement are explored. Section three, describes each of the above methods of Cause Mapping and system dynamics (Forrester 1961) and explore the benefits and shortcomings. Last but not least, Section Four aims to describe the particular organizational application and the achieved benefits of the process in terms of validity and ownership.

2. The Performance measurement regime

2.1 The evolution of Performance Measurement Frameworks

According to Ghalayini and Noble (1996), the performance measurement literature has had two main phases. The first phase took place from the late 1880s to the 1980s. During this phase, emphasis was placed on financial measures, such as profit return on investment and productivity. These performance measures, however, had limitations as they were based on outdated traditional cost management systems and lagging measures, were inflexible, and contradicted continuous improvement. The second phase
began in the late 1980’s and is ongoing. Growth in performance measurement literature followed (Eccles 1991; Neely et al. 2002). In the light of new performance measurement ‘innovations’, the nature of performance measures has also changed.

A number of authors have proposed the existence of a portfolio of performance measures (financial and non-financial) which can describe all the different aspects of organizational performance (Kaplan and Norton 1996). While such a proposition is practical and useful, the question is how somebody can be sure that the few selected performance measures are the right ones, and if all the above measures work towards the same direction rather than counteract one-another (Akkermans et al. 2005). In practise, the reality revealed that selection performance measures could be a particularly difficult process.

Balanced Scorecard and (Kaplan and Norton 1996) provides the rationale for the selection of different kinds of performance measurement indicators among four perspectives (financial, customer, internal business process, learning and growth) and highlights the causal linkage among those performance measures. The four perspectives are interrelated, one to the other, and to the overall strategy and vision of the organization. Should the organization accomplish overall strategy, emphasis should be given to the selection and management of measures of the four different perspectives. Nevertheless, Norreklit (2000) among others Akkermans et al. (2005) highlighted that the Balanced Scorecard does not have clear methodological underpinnings upon the development of clear cause and effect relationships development among performance measures. In the light of recent developments concerning the necessity of cause and effect relationships (Santos 2004) and identification of organizational objectives before defining performance measures (Otley 1999; Eden and Ackermann 1998; Neely et al. 2002; Kaplan and Norton 2004), a number of strategy mapping frameworks have been invented.

The Strategy mapping framework of Kaplan and Norton (Kaplan and Norton 2004) followed the perspectives of Balanced Scorecard but aimed to make clearer the argument concerning the selection of key objectives and the nature of cause and effect relationships. Strategy, in the context of strategy maps and Balanced Scorecard, is described in four levels of value-creation templates, operational management processes, customer management processes, innovation processes, and regulatory and social processes. Nevertheless, all of the above have applied like receipts which should be tailored to the particular organizational context. But, the above strategy mapping frameworks did not describe exactly how the strategy mapping process could take place.

By definition, a strategy is a mechanism through which a company may differentiate itself in its competitive arena (Zahn 1999). The strategy
mapping process should be the result of discovering insights and turning those insights into action. The cause strategy/cause maps of Eden and Ackermann (1998) are based on a clearer description of how strategy formulization and negotiation (Mintzberg et al. 1998) will take. The argument is explored below.

2.2. Critique to Strategy Map Development of Balanced Scorecard

Although strategy maps (Kaplan and Norton 2004) and success maps (Neely et al. 2002) describe the close connection between key objectives (Otley 1999) and performance measurement, it can be argued that they fail to describe a coherent clear process of how the identification of key objectives and their causal links will be developed and tailored on the specific organizational context (Akkermans et al. 2005). The aforementioned strategy map frameworks (Neely et al. 2002, Kaplan and Norton 2004) inform about the importance of the laundry list (Richmond 1994), thinking about ‘what’ strategic themes should be selected rather than ‘which’ particular objectives should be selected on the particular organizational context.

As recognized by a number of authors (Kaplan and Norton 1996, Akkermans et al. 2005), the process of effective strategizing (Zahn 1999) and performance measurement development (Kaplan and Norton 1996) is a matter of effective top management and tailoring effective strategizing on the particular organizational context. Therefore many authors (Santos 2004, Akkermans et al. 2005) have highlighted the role of system dynamics (Forrester 1961, Santos et al. 2002) and cognitive mapping (Eden and Ackermann 1998) to inform performance measurement development (Santos 2004, Akkermans et al. 2005) either independently or in the context of Strategy Mapping Frameworks. Those methods can offer rigor to the mapping process of strategy mapping frameworks, identify key objectives (Akkermans et al. 2005) and add value to ‘wellknown’ strategy mapping and performance measurement frameworks.

In line with the above, a number of authors have suggested that effective strategy making is dependent on the mental models of the management team (Senge 1991). A mental model should work as an information filter (Forrester 1994) through which individuals interpret experiences, evaluate plans, and choose among possible courses of action (strategies, goals, actions) about the future of the organization. The stream of experience and the process of sense making of individuals of the management team will influence the decision making and knowledge creation and will inform the effectiveness of those decisions (Mintzberg 1973, Choo 1996). Therefore, the mental models can inform strategies, goals and actions themselves. A cognitive map is a particularly useful way in order to comprehend the understanding or perception of individuals’
given situation (Eden 1988, Huff et al. 2002) and to explore the mental model of individuals. The cognitive mapping method can be also used in group workshops (Eden 1988, Eden and Ackermann 1998) where it can be particularly useful in exploring the cognitive processes associated with strategy formulation in groups. Therefore, the cognitive mapping method (Eden 1988) is a means to understand the mental models of individuals, and elicit their knowledge. While system dynamics, can be particularly useful for this purpose, its does not describe the particular way under which the process can take place. Further to that, both cognitive mapping but also system dynamics can be particularly useful for another reason in performance measurement.

Whereas much of the normative literature in performance measurement literature suggests that top management consensus is crucial for performance measurement development (Kaplan and Norton 1996, Kaplan and Norton 2004, Neely et. al. 2002), the above strategy mapping frameworks do not describe a clear way of how to achieve this. The strategy/cause maps (Eden and Ackermann 1998), as constructed by the different views of the participants’ works as a transitional object (de Geus 1988), helps negotiation among individuals. It works as a facilitative device which individuals can use to explore differences of opinion and build psychological and social negotiations (Eden 1988, Eden and Ackermann 1998), the meaning of which will be explained by and attributed to the meaning of the others. This is due to the fact that concepts belong to the others as well as to the individual viewing the map. Except, cause maps (Eden and Ackermann 1998) group decision making interventions of system dynamics (Richardson and Anderson 1995) have been used successfully to bring consensus and mental alignment.

The above strategy mapping and performance measurement methods (Kaplan and Norton 2004, Neely et. al. 2002) explored before do not highlight how to use the performance measurement information appropriately in order to improve organizational performance or possibly, what the ‘determinants’ for organizational performance are (Pettigrew et al. 2001). Thus, strategy and success maps do not provide information on performance measurement improvement.

As is explored by Neely et al. (2003), performance measurement systems function as conceptual models representing reality, but should take into account not only the process of describing (measuring) what is happening in an organizational system, but also, describe how to improve organizational performance (managing). With few exceptions (Santos 2004, Akkermans et al. 2005), the current performance measurement development processes do not specify how performance measurement systems will lead to the improvement of organizational performance or
why particular performance measurement systems work better than others (Pettigrew et al. 2001).

The identification of feedback loops can be particularly useful in identifying the few critical factors as explored in the cause loops diagrams (Santos et al. 2002, Akkermans et al. 2005). After that, performance measures could be distilled and inform performance measurement system development. The next section describes the methodologies of cognitive/cause mapping (Eden 1988) and system dynamics (Forrester 1961).

3. The methodologies of Cognitive Mapping and System Dynamics

3.1 Cognitive/Cause Mapping

To Eden (1988), cognitive mapping is a problem structuring method based on Kelly’s ‘personal construct theory’ (Kelly 1955). It explores a rich, means–ends hierarchical structure of representation of reality aiming to aid cognition of individuals about particular problems. A cognitive map is the perception or understanding an individual holds about a given situation (Huff 1990). It works as an distorted filter (Mintzberg et al. 1998) which helps decisions makers to organize the over abundance of information to which they are exposed. It could be either used individually (interviews) or for group sessions to inform cause mapping. A group – cause map in a strategic context represents a strategy cause map. The development of cause maps using the formalisms of cognitive mapping (Eden 1988) can be very useful in order to explore a rich representation of the situations individuals find themselves in. Thus, they exemplify why and how a situation have been problematic and describe the content and the context of the problems (Eden 1994). The benefits of such a process are described below. Strategy/Cause maps (Eden and Ackermann 1998) describe a negotiated process which can explore and communicate differences of opinions in a hierarchical format (goals in the top, strategies in the middle, actions in the bottom). As a result, the development of Strategy/Cause maps can identify how organizations can select ‘which’ rather than ‘what’ key objectives (Otley 1999) should be identified in the four Perspectives of the Strategy Maps (Kaplan and Norton 2004). While useful, this particular kind of mapping does not describe how to test the anticipated strategy.

3.2. The ‘premises’ of the system dynamics methodology

System Dynamics is related with the understanding of the behaviour of the problem and all the issues related with how this process could take place. The core theory of system dynamics is based on the concept of feedback and endogenous behaviour (Forrester 1961, Sterman 2000). The underlying premise of system dynamics is that behaviour arises from its causal
structure. The potential outcome of this process is to inform policy insights under which policy re-engineering may take place.

Originated system dynamics to information feedback theory (Richardson 1991), relies on assumptions about how human agents use information (Forrester 1961), how one can go about collecting data to construct models (Vennix 1994), how such models can be used to explore structural constraints (Forrester 1961) and help individuals to understand social problems by proposing a number of potential policy insights (Forrester 1994). As it is evident from the above the use of cause mapping and system dynamics can be very useful for the description of mental model, develop process how knowledge elicitation takes place and develop a process to identify improvement in the system.

3.3 The argument of multi-methodology

The use of multi-methods to elicit knowledge of complex social systems has been the interest of the field of operational research for a number of years (Flood and Jackson 1991, Pidd 2004, Rosenhead and Mingers 2001, Lane and Oliva 1998, Howick et al. 2006).

The integration of strategy cause maps (Eden and Ackermann 1998) and system dynamics is about combining the explicit social theory of knowledge elicitation from cause mapping (epistemology) with the realistic representation of system dynamics (ontological perspective) in Balanced Scorecard Development. The capacity of system dynamics as a testing device can be particularly useful in testing the assumptions of the strategy cause maps and, if possible, improving them. The purpose is to combine some of the characteristics of the process which could not achieved by each of the method individually.

4. The adding Value of Cognitive Mapping and System Dynamics for Balanced Scorecard in E-Commerce Context

4.1 The Context of destination Marketing Organization

Tourism is a global phenomenon and one of the fastest growing industries in the world. The rapid development of the World Wide Web has changed the way business is conducted and has resulted in a constantly evolving marketplace where everybody is interconnected and competes intensely on a worldwide scale. With regards to the Greek DMO website the findings indicated that its online marketing strategy was extremely poor (Tsiouka 2007).

Based on the limitations of Greek Marketing Destination Organization, one entrepreneurial management team aimed to develop a Greek Marketing Destination Organization website aimed at strengthening and differentiating the website’s presence in order to stand out from the
competition and enhancing the customer experience offered to attract and retain customers.

In order to achieve that, they decided to build a Balanced Scorecard Performance Measurement System in order to manage customer satisfaction along with others stakeholders. Moreover, if the business was going well, the Balanced Scorecard would be useful to ‘buy in’ the support of ‘external bodies’ in order to gain their support and invest in the business (i.e. business angels, venture capitalists).

4.2 Propositions of the adding value of the cause mapping and system dynamics for BSC development

The CEO and management team decided that the use Balanced Scorecard would be the most appropriate tool both because of its popularity but also because its convenience to get understood by everybody having or not business background. The process was the following.

The consultant contacted the gatekeeper (Richardson and Anderson 1995) and CEO of the company in order to come to grips with the problems at hand. During the initial discussion he understood that the key issue was how to manage fast growth web-site development following Get Big Fast Strategy (Oliva et al. 2003). Such kind of strategy is based on the exploration of rapid growth taking full potential of the feedback loops. During the discussion he tried to explore those “strategic issues” and kept those in mind.

Start-ups businesses are at the early stages of their life cycle (Kaplan and Norton 1996) and have a number of issues to resolve. The consultant as interviewer used cognitive mapping to elicit beliefs and values (Eden 1994) of the members of the management team. After the initial stage, a round of interviews with the members of the management team, the consultant as facilitator merged the individual maps. The outcome map was as presented below. The strategy map built using the themes of the Balanced Scorecard. To validate the strategy map, the management team along with the facilitator discussed the nature of the new emerged map. The constructs of different colour described the different kind of themes of the Balanced Scorecard.
While useful, cognitive/cause mapping and current performance measurement strategy mapping and performance measurement practices does not describe any indication concerning which the critical few objectives (Akkermans et al. 2005) are. Such a thing could be described by feedback loops (Forrester 1961). The feedback loops describe the reinforcing and balancing loops which can be useful to describe the endogenous elements which can speed up (Warren 2002) or ‘limits to growth’. The consultant along with the members of the management team identified a number of important feedback loops. Such exploration of the feedback loops can take place in the strategy map. Moreover, those were “enhanced” by a through literature review. A number of issues concerning the feedback loop elements of business startup were explored and identified better. Those could enhance the nature of the feedback loop elicitation (Oliva et al. 2003) and elaborate the dynamic effects of strategy making. Nevertheless, the management team was not sure how fast could follow each behaviour (i.e. the growth rate of the behaviour). Therefore the facilitator along with the people elaborated reference modes (Randers 1980) about the behaviour of important key objectives (i.e. number of visitors, perceived web quality). The dynamical reference mode of key objective was particularly useful to explore further the business strategy and under this discussion to enrich the further the initial causal loop.
diagrams conceptualisation. Moreover, in this way, management team was clear upon ‘expectations’ and the ‘time’ to accomplish that.

Figure 2. Elicitation of Reference Modes

Figure 3. The final strategy map presenting the key feedback loops
Reinforcing Feedback Loops

- **R1 (Brand Investment):** The more the brand equity the better site attractiveness and more loyal Visitors the more the cash on hand, the more the marketing spend and the better the brand equity
- **R2 (Server Investment):** The more the loyal visitors, the more the revenues from advertisers and more the money for server Investment
- **R3 (Service Investment):** The more the loyal visitors, the more the revenues from advertisers, the more the service infrastructure but also site attractiveness
- **R4 – R5 in diagram (User Generated Content):** The more the brand equity the better site attractiveness and more loyal customers but also the better user generated content
- **R6 (Employee Royalty):** The more the revenues the more highly ‘paid’ the employees, so the higher retention

Goal Seeking –Balancing Loops

- **B1 (Server Overload):** The more the brand equity the better site attractiveness and more loyal buyers the worse the adequacy of server infrastructure
- **B2 (Service Adjustment):** The better the adequacy of service infrastructure, the better service infrastructure
- **B4 (Server Adjustment):** The server infrastructure eliminates the server infrastructure

Performance Measurement Indicators

The feedback loop elicitation explored the critical few factors which can improve organizational performance. Should performance measures identified, performance measurement system will be developed.

5. Conclusions

The above paper describes how Balanced Scorecard Development could take place in E-Commerce Context by Integrating Cause Mapping and System Dynamics for Strategy Mapping (Kaplan and Norton 2004) with a number of benefits for client’s ownership and validity. The integration of cognitive mapping and system dynamics was particularly useful for Balanced Scorecard Development to inform a much more valid model both in terms of client ownership but also in terms of representing reality. Strategy/Cause Mapping describes a model very close to how human think (Anagnostopoulos 2009). Moreover, system dynamics both qualitative Anagnostopoulos J. & Pollalis Y. and quantitative can be particularly useful to investigate the business model structure and the anticipated time performance. Nevertheless, it should be noted that there was a high demand on time investment by the people but also the facilitator/modeller.
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Tsiouka Y. (2007),
The role of crisis in hiring personnel in tourism industry

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Abstract:  
This article will discuss the scope of hiring personnel in tourism industry during the economic crises. Both tourism and maritime industry are considered to be the heavy industries in Greek economy. During crisis period, tourism industry is fatally affected due to the reduction of income of the potential tourists. In those periods, selection of personnel is one of the most important factors in dealing with this crisis. The main concern of this research is to indicate the main difficulties that tourism industry comes up with, during those periods. One of the main assumptions of this research is that enterprises, which are dealing with tourism industry, have totally changed the way of recruiting personnel. The current research was conducted in Greece, by interviewing in tourism enterprises. The results show that personnel in tourism industry are highly affected during those periods and unemployment in tourism industry is increasingly deteriorated.

Keywords: economy crisis, tourism industry, hiring personnel, human resource management, systemic risk
1. **Introduction**

The tourist industry is the driving force of the Greek economy. Based on the situation, both on a worldwide and a national scale, it is considered intentional that the recruitment of the personnel should rely on qualitative characteristics. The human factor consists the key for the proper operation of a tourist company. Given that the tourist enterprises have an anthropocentric nature, it is crucial for the companies to develop an efficient recruitment system of the personnel.

In order to be clear in which way the recruitment of the staff from the tourist units is working, we have to check the particularities of the Greek tourist market, as well as how the tourist companies are being classified. For that reason, we will attempt to state any differences or similarities that exist in the method of recruiting the personnel, depending on the legal form of the tourist enterprise.

In an environment of uncertainty, where the tourist companies are operating, based on the economic crisis and bankruptcies of the big four tour operators, it is considered intentional to recruit the necessary personnel that it can satisfy all the requirements of the enterprise.

In the modern business environment, the correct selection of personnel is crucial and it consists the most important procedure of human resource management. With the right programming and the proper exploitation of the methods of recruiting personnel, as they are stated in our questionnaires, they would be chosen the persons that they will provide a competitive advantage in the fluctuating labor environment.

2. **Theoretical Background**

The current international situation and the collapse of the USA financial system have vitally influenced the Global economy, creating severe problems in the operation of markets. The American economy is in recession since December 2007 owing to the current real estate crisis. The repercussions of the crisis have started to appear on the horizon and the European economy has already been affected.

The close interdependence between European and Global financial system contribute to the occurrence of this phenomenon. The financial system in several member states of Union is in danger of collapse due to systemic risk. The diversity of this risk is that, unlike other risks, it is not associated with an economic variable or product but it concerns all the financial markets. The close connection among the markets has as a result in transmitting rapidly certain problems from one market to another. One definition that is given according to Kaufman (1995) is as follows:
Systemic risk is “the probability that cumulative losses will accrue from an event that sets in motion a series of successive losses along a chain of institutions or markets comprising a system... That is, systemic risk is the risk of a chain reaction of falling interconnected dominos”.

Given the current financial crisis, the macroeconomic situation in the euro zone has deteriorated since the end of 2008. The economic performance is expected to be sunk in 2009 and a general stagnation is forecasted since 2010. These are reinforced by the fact that there is a change in consuming behavior of European citizens. The increasing danger of unemployment, the income losses and the uncertainty that prevails, regarding the savings will cause a long-term reduction in the consumption and on the investments (Egon Smeral, 2009). These abridgments will disproportionately affect the luxury goods (including the consumption of tourism services).

Furthermore, during this period the tourism industry presents recession in overseas travel bookings and the continuous increase of inflationary pressures affect the demand for long distance travels (Egon Smeral, 2009). Finally, the air companies reduce their tourist destinations as a consequence of low demand. All these lead to the conclusion that in order to come the tourist enterprises out from the impasse which they are confronted, it is crucial to be very careful while selecting and recruiting personnel. The hiring of redundant employees may create additional costs for a company. On the other hand, massive and widespread layoffs are possible to cost enterprises from valuable manpower. Proper exploitation and recruitment of appropriate individuals in the suitable places help companies to operate again smoothly.

For this reason, tourist enterprises should follow certain steps that are reported in recruitment and selection of personnel. These steps are described below:
- Recruitment of new staff
- Analysis of work
- Attracting candidates
- Pre-selection
- Appointment
- Recruitment of employee

At the outset, an analysis of work by the enterprise is essential in order to recognize if it is necessary to hire personnel or not. It can be realized that there is no need of recruiting new employees but it is vital to organize better the existing personnel. If do need arises to hire new personnel it should be done an analysis of work. This analysis will include the competencies that are crucial for work, the main activities that will execute the candidate as well as the education that will be offered to him/her. Job
analysis and prerequisite skills that would be needed for the job will help us to determine if we have the appropriate candidate. Attracting candidates is about whether the company will ask from a foreign agency to find a suitable candidate or it is going to promote an employee from the internal part of the enterprise. In the fourth phase is done the pre-selection of candidates rejecting those that are not appropriate for the job. Then select the candidate after a series of selection procedures that we have mentioned above. Finally he/she is appointed to sign the relevant contract and he/she is educated in the object that is in charge of this aim (Gillian Date, 2005).

3. Problematic

The sub-fields of tourism sector and the dimensions of choice of personnel system as variables of detection of differences or similarities of different enterprises of sector, in periods of crisis. From the above giving, it becomes obvious that in periods of economic recession the tourism sector is affected considerably, because of the limited purchasing force of potential tourists. The above conclusion is also proved by the annual report of the Governor of Bank of Greece, where are recorded the first official negative elements for this year's tourist movement. As a result, the income of the tourism industry of the first two-month year has decreased at 20.2%, in comparison with the last year's period.

In addition, the selection of personnel constitutes the basic factor in the confrontation of economic crisis. A lot of enterprises are seeking ways of curtailment of their unbearable expenses, decreasing the budget of their human resources. Commencing from the above ascertainments is shaped a simple question in relation to the sub-fields of tourism industry and the legal form of these: Is a correlation created between the hotel enterprises, the rent a car offices, the travel offices as it concerns for the criteria of choice of personnel and do they still appear differences or similarities to them as it concerns the legal form of company of tourism sector? In order to lead to the probability to have a clear answer in this question, we will investigate in which way the tourist enterprises select their human resources in situations of crises with a basis on their legal form in anonymous companies, general partnerships, companies of limited responsibility, multinationals and groups of enterprises. The research was conducted with closed questionnaire in 133 enterprises of tourism industry.

In this study we will examine in which way the two basic variables are shaped in the frames of individual dimensions of the choice of personnel system in the tourist enterprises in periods of crisis. Firstly, is the particularity of tourist sub-field in the specification of the perception way of personnel selection and secondly, is the legal form of the tourist
enterprise. The first variable will allow us to realize how it functions as a way of thinking a hotel unit in relation to a travel office and an office of rent a car in the process of personnel selection. We might ascertain if the different object of services that provide these companies, differentiates with them in the criteria of choice of personnel and in the wage policy that they apply. Afterwards, we will seek to export conclusions from whether the legal form of company of particular tourist sub-field plays some role in the choice of human resources. As we mentioned before the above variable has the following forms-dimension: Anonymous Partnership, Limited Partnership, General Partnership, Group of Enterprises, Multinational (or subsidiary company of multinational).

After these clarifications, the affairs of work that can be formed are the following: The differentiations between the various sub-fields of tourism sector will be marginal in the choice of personnel, because their objectives constitute a point of section so that they use the almost same criteria of choice of personnel. Then, as it concerns for the companies of different legal form and taking into consideration the differentiation of initial capital that is required for the establishment of this companies but also the differentiation of processes of operation in their deed of partnership, we suppose that the general partnerships and the limited partnerships will select different ways of choice of human resources concerning the companies of different legal entity.

4. Methodology

In our study, in order to assess the independence of two or more groups, we use the chi-square test of independence. In this research, we want to analyze whether the type of company or the legal type of company affects the questions reported. Furthermore, the test is formalized as:

\[ H_0: \text{the event } '\text{an observation is in row } i' \text{ is independent of the event } '\text{the same observation is in column } j', \text{i.e.} \]

\[ H_1: \text{the events } '\text{an observation is in row } i' \text{ and } '\text{the same observation is in column } j', \text{ are independent, i.e.} \]

According to the above, we analyze the pairs of questions separately and we proceed to the outcomes and to our further analysis.

5. Results

Looking through the questionnaire, subsequent to interviewing 133 companies of the tourism industry, we isolate for further analysis the following questions:

1. In which sector of tourism does your company belong
2. What is the legal type of company
3. How do you manage to attract personnel
4. Who is responsible for the selection of personnel
5. What is your company’s policy according to their work positions
6. Does your company have employee assessment policy
7. What is your company’s pay roll policy

By means of the Spss software:
At first we analyze our data by using the first question:

**Table 1.** Chi-Square Tests Type of company – Attraction of personnel

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>4,608(a)</td>
<td>10</td>
<td>.916</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>6,329</td>
<td>10</td>
<td>.787</td>
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<tr>
<td>Linear-by-Linear</td>
<td>.279</td>
<td>1</td>
<td>.598</td>
</tr>
<tr>
<td>Association</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>131</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11 cells (61, 1%) have expected count less than 5. The minimum expected count is, 32.

**Table 2.** Chi-Square Tests Type of company – personnel selection maker

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>1,648(a)</td>
<td>4</td>
<td>.800</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>2,504</td>
<td>4</td>
<td>.644</td>
</tr>
<tr>
<td>Linear-by-Linear</td>
<td>.804</td>
<td>1</td>
<td>.370</td>
</tr>
<tr>
<td>Association</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>123</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5 cells (55, 6%) have expected count less than 5. The minimum expected count is, 34.

**Table 3.** Chi-Square Tests Type of company – Management for each work position

<table>
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<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
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</thead>
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<td>Pearson Chi-Square</td>
<td>5,948(a)</td>
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<td>.429</td>
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<tr>
<td>Likelihood Ratio</td>
<td>7,040</td>
<td>6</td>
<td>.317</td>
</tr>
<tr>
<td>Linear-by-Linear</td>
<td>2,463</td>
<td>1</td>
<td>.117</td>
</tr>
<tr>
<td>Association</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>118</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8 cells (66, 7%) have expected count less than 5. The minimum expected count is, 12.
According to our analysis, we reach to the conclusion, that all the Chi-square Tests carried out with the first question have no significance. Furthermore, we carry out the Chi-square Tests with the second question and we retrieve the next results:

Table 6. Chi-Square Tests Legal Type – Attraction of personnel

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>17,762(a)</td>
<td>15</td>
<td>,275</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>15,493</td>
<td>15</td>
<td>,417</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>2,497</td>
<td>1</td>
<td>,114</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>125</td>
<td>112</td>
<td></td>
</tr>
</tbody>
</table>

15 cells (62, 5%) have expected count less than 5. The minimum expected count is, 12.

Table 7. Chi-Square Tests Legal Type - personnel selection maker

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>9,351(a)</td>
<td>6</td>
<td>,155</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>8,899</td>
<td>6</td>
<td>,179</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>,980</td>
<td>1</td>
<td>,322</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>119</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7 cells (58.3%) have expected count less than 5. The minimum expected count is, 10.

**Table 8.** Chi-Square Tests Legal Type – Management for each work position

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>15.135(a)</td>
<td>9</td>
<td>.087</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>13.045</td>
<td>9</td>
<td>.161</td>
</tr>
<tr>
<td>Linear-by-Linear</td>
<td>5.427</td>
<td>1</td>
<td>.020</td>
</tr>
<tr>
<td>Association</td>
<td>114</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>114</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11 cells (68.8%) have expected count less than 5. The minimum expected count is, 04.

**Table 9.** Chi-Square Tests Legal Type – employee assessment policy

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>8.553(a)</td>
<td>3</td>
<td>.036</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>12.962</td>
<td>3</td>
<td>.005</td>
</tr>
<tr>
<td>Linear-by-Linear</td>
<td>.173</td>
<td>1</td>
<td>.677</td>
</tr>
<tr>
<td>Association</td>
<td>110</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>110</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 cells (50.0%) have expected count less than 5. The minimum expected count is, 58.

**Table 10.** Chi-Square Tests Legal Type – pay-roll policy

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>22.823(a)</td>
<td>21</td>
<td>.353</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>25.398</td>
<td>21</td>
<td>.230</td>
</tr>
<tr>
<td>Linear-by-Linear</td>
<td>.029</td>
<td>1</td>
<td>.866</td>
</tr>
<tr>
<td>Association</td>
<td>118</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>118</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

26 cells (81.3%) have expected count less than 5. The minimum expected count is, 03.

Concluding our analysis, we find out that the only relevance exists between the legal Type of Company and the employee assessment policy. The \( \chi^2 \) equals with 8.553 by 3 degrees of freedom and statistic significance equals to 0.0036.
6. Conclusion

The current financial crisis has severely influenced the world economy. During this period the inflationary pressures that markets are confronted have as a main result the reduction of people’s consuming power. Therefore, consumers are trying to satisfy their basic needs by reducing their demand for tourist and maritime services.

In such difficult period, the tourist enterprises in order to deal with the crisis they should reorganize the human resources. Furthermore, the hiring of appropriate employees could create competitive advantage and boost the demand for the consumption of tourist services.

From the statistical analysis it is observed that the legal form of enterprises is related to assessment system of employees. For example, the anonymous companies have a particular policy as it concerns the hiring of human factor within companies. The recruitment of employee is not based on arbitrary criteria but it is contacted after the analysis of the internal needs in tourist enterprises.

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Tourism clusters: management and technology challenges

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Abstract:  
Tourism clusters have rapidly become the premier instrument of regional government policy in the service industry. Despite considerable arguments regarding their definition, their membership and their contribution to the wealth of their geographical regions, tourism clusters do remain popular with policy makers. Tourism clusters includes a diverse set of interrelated industries including retail establishments, hotels, restaurants, transportation services, and arts & entertainment venues. With the number of real (or perceived) tourism clusters increasing in the world, there is a need to identify the specific management and technology challenges that tourism clusters present to policy makers.

Keywords:  
cluster policy, tourism clusters, regional development

1. Introduction

Over the last fifty years, tourism has been one of the economic activities with the highest growth potential in the world. Since the 1980s, globalization and the resultant relaxation of travel barriers have elevated tourism to the upper echelon of growth, second only to the financial sector. The opening of national economies and improved transport and communications systems has reduced traveling time and costs and accelerated the growth of tourism globally (Asheim, 2002).

The major characteristic of tourism activity is that it is strongly linked to a geographical territory and that its product can only be consumed in loco. Tourism is thus a sector that favours local development in that it generates jobs, provides new income and stimulates capital investments in
a region (Bodun et al. 2001). Naturally, development agencies have sought out policies that will foster growth based on tourism (Oxford Research, 2008). These policies attempt to address needs for:

- long-term, strategic planning for the tourism sector
- creating an open, inclusive industry in tourism and in related sectors
- developing capacities within the sector itself
- encouraging and facilitating linkages between tourism-related enterprises
- monitoring and tracking the social and economic contributions of the sector.

It seems that the organizational initiative of choice for governments is the concept of clusters, i.e. linking entrepreneurs into value chains on a local and regional level. Cluster theory emphasizes the role of networks and relationships between the various parts of a cluster, in sharp contrast to that of individual firms, along with models of innovation and competitiveness. The cluster concept is particularly suited to specific characteristics of tourism activities. The tourism product is by its very nature dependent upon a complex network of complementary and interdependent activities linking local and regional enterprises (Crouch and Ritchie, 1999). Often, however, the concept of clusters is employed by policy makers without any real understanding of its nature and of the factors that help or impede its success. There is a growing set of international examples and a wealth of data that can allow for meta-studies. While the data available is to a large extend reliable and objective, a coherent framework for their analysis and interpretation is still lacking. In this paper, we attempt to identify the major tenets of such a framework as well as the research questions that should be posed within its context from a service management and engineering perspective.

2. The Tourism Cluster Concept

Porter’s much cited definition of a cluster as a geographically proximate group of inter-connected firms in a particular sector, along with related suppliers and service industries and, crucially, a range of institutions including universities, industrial associations and standards agencies has been taken up by governments as something of a development ‘mantra’. Porter’s approach is based upon the premises that (Porter, 1998):

- local factors of production remain relevant in an era of globalization and can be enhanced in order to build competitiveness, and that
• the simultaneous organization of competition and cooperation
  confers collective competitive advantages upon the companies
  involved.

The concept of cluster is ideally suited to tourism activity, whose
product is linked to geography and requires the joint action of an
agglomerate of enterprises involved in the region’s tourism product.
Tourism clusters vary in their deepness and sophistication, but generally
include companies up and down the supply chain, producers of common
and complementary products, suppliers of specialized infrastructure,
governmental institutions (devoted to specialized training, education,
information, research and technical support) and often commercial and
other private associations (Hjalager, 1997).

The tourism cluster concept has been further defined to include other
relevant characteristics, such as the information exchange between the
cluster members, the infrastructure needed to support tourism activities and
the implementation of strategic actions among agents. It has been
suggested, for instance, that a complete tourism cluster must include some
other technology-related characteristics related to attractiveness,
competitiveness, economic, environmental and cultural sustainability,
quality of life and synergy to distinguish it from others in its geographical
area (Hjalager, 2002).

Another approach is to define a tourism cluster through its
characteristics and components such as the primary and complementary
activities carried out by the member companies, the communication and
transportation infrastructure available, the spectrum of interrelated
companies responsible for the tourism product as well as the level of
supporting services, the available natural resources and the institutional
policies in place.

According to Markussen (1994), there are four types of tourism clusters:

• «Marshallian clusters» as conglomerations of geographically
  related enterprises,
• «Hub-and-Spoke clusters» with a well-defined leader enterprise,
• «Satellite platforms» where the leader is a multinational, and
• «State-Anchored clusters» where there exist specific ties with the
  public sector.

In other typologies (European Commission, 2003), tourism clusters are
classified according to their maturity as (DTI, 2004):
• Embryonic clusters,
• Established clusters,
• Mature clusters, and
• Declining clusters.

Thus the impact of specific policies directed towards clusters is different at distinct age brackets of the pertinent clusters (Machiavelli, 2001).

Tourism clusters thus allow for the effective exploitation of collective efficiencies (entrepreneurial cooperation, work productive specialization, collective infrastructure, service specialization, joint marketing campaigns, collective negotiation with suppliers and wholesale customers etc.). In addition to these advantages, tourism clusters facilitate the development of new models, production processes and organization through the exchange of technical and market information and promote innovation faster than the isolated actions of individual companies. On the negative side, the members of a well-defined cluster are effectively dependent on each other and a sub-par performance of one member may compromise the success of the others (weak-link concept). An illustrative representation of the tourism cluster concept appears below.

**Source:** Oxford Research AS, January 2008.
Even when tourism clusters are viewed as a loosely connected group of companies and institutions bound up to a tourism product they do confer distinct competitive advantages in a country, region or zone of tourism activity. Consequently, government programs consider them as an appropriate local strategy for combating regional disparities and social inequality (Metcalfe and Miles, 2000).

Unfortunately, the concept of clusters is being utilized without any real understanding of its nature, its characteristics or its linkages with other development factors. With the aim of producing highly visible policies in the context of rapid economic restructuring, local and regional governments often forcibly encourage entrepreneurs to participate in value chains on a local and regional level through financial and other incentives. This is in sharp contrast to the well-established view that the ultimate success of a cluster depends upon the self-interest of its members and that government interventions often lead to negative results (SRI, 2000).

The ultimate question is of course to define cluster productivity and to assess its territorial, entrepreneurial and institutional effects. Tourism cluster productivity can be defined in tangible and intangible ways. The tourism enterprise differs from more conventional industry in that its outcomes are measured largely by the scale of its imported customers’ expenditures, rather than the scale of exported products or services. Often studies of tourism clusters have focused more heavily on the support industries providing many of the jobs, rather than on the core enterprises that attract visitors. Either way, the ability to reach targets above the average of the sector in a sustained and sustainable way is a direct quantifier of a tourism cluster’s success. The ability to enhance tourist satisfaction is a less-easily measurable, yet very important index. Thus, the ultimate measure of cluster competitiveness is its ability to fulfill the expectations of all the agents participating in the activity of tourism.

<table>
<thead>
<tr>
<th>VERTICAL INTEGRATION</th>
<th>Producers</th>
<th>Distributors</th>
<th>Facilitators</th>
<th>Consumers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td></td>
<td>Incoming Agents</td>
<td>Tourism Information</td>
<td></td>
</tr>
<tr>
<td>Attractions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accommodation</td>
<td></td>
<td>Tour Operators</td>
<td>Travel Agents</td>
<td></td>
</tr>
<tr>
<td>Catering</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HORIZONTAL INTEGRATION</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1.
3. Challenges and Conclusions
In this general framework, the following distinct challenges appear for tourism clusters (Nordin, 2003).

1. There is a need for the education of policy makers and key industry players about the importance of tourism to the overall economy.

2. The development of strategies that will maximize the return on investment for policy makers is integral to the support of tourism clusters.

3. The need for improved connection between higher education & tourism industry in order to provide a trained workforce is crucial.

Above all, of course, is the need to inspire a vast and diverse industry, largely made up of small, fiercely independent entrepreneurs to see themselves as part of the “whole.”

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Topic: Public Sector

Innovation culture building – contemporary dimensions and challenges upon the public sector in Bulgaria

*Diana Antonova, Miglena Pencheva*

Transportation infrastructure, economic growth and population density in Turkey

*Mehmet Aldonat Beyzatlar, Yeşim Kuştepeli*

Are trolley buses in Athens and Piraeus efficient?

*Panayotis Michaelides, Athena Belegri-Roboli, Theoharis Marinos, Kostas Kavouridis*

The image of a region: a tool for its sustainable development

*Vasilis Angelis*
Innovation Culture – Contemporary Dimensions and Challenges upon the Public Sector in Bulgaria

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Abstract:
Since the innovations are topical subjects in the recent years, they are examined in the paper from the cultural point of view. More precisely, there are comparisons made between the cultural dimension of innovative world leaders and Bulgaria from one hand. From another hand, the cultural dimensions of public sector are examined, in order to see if it is a precondition or obstacle for innovation development.

Keywords:
National cultural models, Hofstede, Bulgarian cultural model

1. Introduction
The dimensions of innovation culture obtain growing popularity at least for the following reasons:

- Different countries register different achievements in the field of innovation. The attainments have been determined and measured based on multinational comparative analysis, but their origin stays out of an explanation. Thus, it is not clear how to overcome the national differences, more specifically their negative implications.

- The globalization processes along with the growing dynamic of changes enforce the public sector to take part in competitive direct
interaction with representatives of other cultures (thus envisioned as an aggressive) market environment.

- The pressure for anticipative growth rates comes with a drift to copy foreign models of behavior in no conformity with the host country as an outcome, the differences turns into barriers (even thought it is not embedded in their nature) for adoption of good practices in public sector management.

- The aspiration for entrepreneurship development and the initiatives for spreading the cluster approach are not consistent with the characteristics of the national culture. It brings to failure the putted efforts or makes the least of their potential. (Александрова, 2004)

- We witness that increasing number of organizational culture merges because of different occasions - enterprise absorption, expansion of foreign branches in Bulgaria, Bulgarian firms connecting in multinational chains of foreign companies (e.g. franchising chains, which function as a channel for technology transfer), joint ventures and strategic alliances.

The innovation culture puts into words a specific part of the dimensions of the national cultural model in one particular field – the innovations. That is why the cultural awareness and the understanding of the dimensions are examined in the paper. Secondly, the individual and the organizational behavior in the public sector based on the cultural dimensions are taken into consideration in the article. This gives a light over the reasons why some countries are so successful while others – so resistant to changes. The objective is to promote their match. The presented conclusions summaries results of survey on Bulgarian cultural model along with analysis of innovational potential of Bulgarian public sector conducted in the last two years.

2. Innovation culture

According Matsumoto, the innovation culture is dynamic system of clearly defined and at the same time self-explanatory rules, which are determined by individuals and groups aiming to ensure their surviving. They comprise values, attitudes, notions, norms, and behavioral models, which are common for a group, but differently applied from the specific, in-group fragments, passed from one generation to another, relatively sustainable, but capable to change in a long run. (Матсумото, 2002)

The innovation culture is a multilayer concept. Despite that, different authors do different compilations of its elements. There is a common idea
that the majority of them are external, accepted by default, not always clear enough to picture the real cultural identity of the individuals and groups who voice them. Only tiny portion of those elements - usually hidden and difficult to explain, express the real reasons for one or another behavior. Geert Hofstede unites the visual cultural applications – heroes, symbols and rituals under one common term – practices. The latter express groups’ believes and attitudes towards context factors and representatives of other cultures, however they do not explain them. Such explanation should be searched in the inner, thus difficult to research part of the innovation culture – the values system.

It is believed that the differences between values systems, which are the fundament of the national cultures, are resistant to change. It is easier to adapt practices. Thus, when it comes to fulfillment of an innovative project or activity, which suppose a clash between different cultures (e.g. technology transfer, know-how implementation, adoption of a good practice, system or model) the objective should be agreement on capable mechanisms to accomplish the change instead of enforcement of “approved” decisions, inconsistent with the local culture. The variety of applications of the different cultures could be explained and predicted via main cultural dimensions: power distance, individualism/collectivism, masculinity/feminity, uncertainty avoidance and long term orientation. (Hofstede, 2001) There is a variety of cultural concepts to relate, but Hofstede’s methodology and the accumulation of empirical studies based on it gives ground for further application, thus comparison between different areas and organizations. The subject matter in this paper are the innovations, more precisely – the attitudes of the people in public sector towards innovations. The aim is to add another perspective of the organizational culture in the public sector.

The contemporary understanding of an innovation course comprises both the process approach and the system approach. The innovation progression is not a uniform; it is composed of relatively self depended and at the same time mutual connected phases, which are put up into practice in consecutive or parallel order. The outcome of this progression is the materialization of new technological knowledge into ultimate product or service. Due to the specific features of that process, it is usually an effort of different subjects/teams, which set their interaction as a key factor for successful result of the innovational project.

The categories culture and innovation contradict to one another due to their core characteristics. The culture is conservative, since it is a carrier of traditions, perceives, and attitudes lay down for generations. From another hand, the innovations express themselves via change. The concept of innovation culture is based on a kind of balance between traditional values and achievements, and the ability to change and adapt upon the context.
The unity of that dual nature is a necessity for sustainable development of the systems.

The innovation culture could be determined as a real ability of an individual, a group or a society to adopt novelties, the willingness and the readiness to turn them into new products, processes or services. (Coffman, 2008) The presence of innovation culture is not a certificate for successful innovations; however it is a prerequisite for development of innovation potential and competitive edge. The innovation culture corresponds to creativity, entrepreneurship attitudes toward calculated risks, commitment to long life learning and labor mobility tolerance (Иновации). That kind of culture is an overlapping area between national, corporate and professional culture. It applies in a specific complex of innovative practices via human behavior. Ones behavior is influenced not only by national, corporate or professional culture layers; it is also determined by individual and group characteristics. The attitudes toward innovations and entrepreneurship are that kind of the human behavior, which we believe are to big extend dependent on the values set on the individual level. However, differences between cultures on national level could explain variations in innovational behavior on nationally represented companies. What is more, they could frame future expectations about the success/failure of their innovational strategies and projects.

Based on he Geert Hofstede four dimensional methodology and the country scores of three of the most innovative countries in world - USA, Japan and Sweden, there are images presented on the figure 1. Conclusions could be made based on comparison of these images. The purpose of this comparison is to look for common or significantly different elements of these innovative cultures and to try to “project” the case of Bulgaria on this map. What is more, we would try to fit the culture of the public sector in the same map and to examine whether or not it provides fundamentals or obstacles for overall innovative activeness, thus competitiveness of the country.
When one takes a look at the images on fig.1, there is a conclusion that inevitably pops up. All of the presented countries have at least one dimension scoring to the utmost level. The USA case, they are very high on Individualism (IC) dimension and moderate to high on masculinity (MF). The case of Japan, they score extremely high both in masculinity and uncertainty avoidance (UA) index, and moderate to high on power distance (PD). Sweden is high on individualism, utmost low on masculinity and relatively low in uncertainty avoidance. Based on these scores, we could assume that the three countries have tailored their own recipes for successful innovation activities. One could guess that the success of USA innovations is grounded on the individual efforts combined with moderate to high orientation toward results, thus creating an environment in which people who possess know-how, knowledge, talent or other innovative asset could relatively easy transfer it into product or service (due to the “friendly” environment – regulations, intellectual property protection, and etc.). Japan shows an extremely result/goal orientated society along with the huge discomfort in unknown situations. It could presumably lead to very precise system of rules and regulation, which is organized in kind of a structure, where a collective body makes decisions about innovation in a very calculated and precise manner. The scores of Sweden lead to the idea that their successful innovations are grounded on individual efforts and premises (like in USA) but due to the extremely low MF, they would interact among themselves instead of competing for results. This
interaction would be driven on voluntary bases with less formal structure - informal contacts (referring to both MF and PD scores).

3. Bulgarian culture scores

There are several surveys on the national scores of Bulgaria based on the Hofstede model. Despite the fact that they are not meticulously match from statistical point of view, they are sufficient enough to provide an overall notion on the Bulgaria cultural model. (Александрова 2004, Дуранков 2000, Витоша рисъч) According to “Innovations – European National and Regional Practices” Bulgaria is high on PD – 75, moderate to high on UA – 68, moderate on both IC – 51, and PD – 50 (referring also to Сотирова, Давидков 2005). Regarding the scores of the last two dimensions, there are arguments in favor of high masculine traits and high collectivism.

The consequences of the high PD could be observed in the high hierarchical structures and the centralization of the decision making, which we envision as an obstacle for innovation behavior. On the societal level it implies in the polarization of the society ‘with almost no middle class’, huge disparity of the levels of compensation of the different, hierarchical levels. There is willingness to expand the administrative staff both in public and private sector.

The UA express itself in stress and job frustrations on the workplace, even in health and family issues in private life. If there is an issue in hand, which solving requires creative thinking, and variety of decision scenarios, it could end with inadequacy, rejection and embarrassment. It could be interpret also as an obstacle to the successful innovational behavior. However, due to the rapid changes in the environment, this is about to change.

The moderate score on MF imply in ambition, preciseness and goal achievement orientation either with men, or with the women. Even thought the social roles of gender matter, the women possess enough inner motivation to cope with it.

Regarding the level of IC, Bulgaria is more collectivistic. Referring to this dimension, there is a contradiction between the desire /ideal/ situation and the researched outcomes. Bulgarians prefer to work on their own, to be appraised based on their results, but very often they are not willing to take the responsibility. They often rely on family support, personal ties, friends, and etc. the lack of confidence toward other social groups is a barer for entrepreneurship approach either in the company, or upon international cooperation.

There is another dimension in the referred model. It is long term orientation (LTO), it is added later on, and thus it is not depicted on fig.1. Bulgaria ranks low in LTO either on individual level, or on the
organizational one. It applies in a lack of investments in long run, either in financial portfolio, or in reengineering of the process and innovation installments. There is survey (in 2006) measuring the innovativeness of the Bulgarian enterprises - 10 (Иновации.бг). It shows that over 65% of the companies have not renovated their operations during the last years. The short term orientation applies in underestimation of the efficiency of investment in human capital building.

Comparing the scores of Bulgaria with those shown on fig.1 it is easy to see that our society do not rank anywhere at the utmost limit. We tend to be higher in PD, which is not the case of the innovatively flourishing leaders. However, each of them had designed unique recipe for innovation development consistent with the cultural model, thus we are not going to “copy and paste”, but to try to examine the situation in Bulgaria /based on the Rousse region/.

4. Innovation Culture as Challenge upon the Public Sector in Bulgaria

The process of innovation is a complex of mutually integrated activities orientated to creation of a new knowledge and it practical implication in new or improved technological products and processes or non technological novelty. The key characteristics which determines prerequisites of the innovative culture (according to the process of innovation) are: simple and flexible organizational structure (in favor of creative cooperation), initiation and participation in networks for exchange of ideas, information and technology, development of mechanisms for ongoing improvement on individual and organizational level, proactive strategic thinking towards existing environment.

Based on the above description, one could make “projection” of a consistent profile of the “proper” innovation culture. Since we refer to a simple and adaptive structure it is suppose that the ideal profile should consists low PD dimension. The need for creative thinking and interaction presume that there would be moderate to low UA. The idea of interaction and common support is consistent with moderate to low MF along with moderate collectivism. The ongoing improvement and to some extent the need for strategic thinking require moderate to high LTO.

The awareness and the examination of the national culture are good enough to give a bread perspective of the attitudes toward innovation. Keeping in mind the characteristic of our national scores - high PD, moderate to high UA, moderate IC, and short term orientation, we consider the public sector as a player with a real potential of influence over innovation activities. As a starting point we think as important to observe the innovative culture in public sector it self. We aim to examine if it is
consistent with the innovative idea, to be able to predict whether public sector would promote investment or administrative comfort or anything else to boost the innovations.

Objects of the survey presented in the paper are local administrative units, which are empowered to make decision of local impact (Rousse in our case). They can apply national policy, at the same time they could promote proposition in the national agenda. They could also make some decisions about the taxation, administrative services, and etc (Pencheva, Antonova 2008). Each public organization could be logically divided into operative and administrative function. The operative part comprises people who do the job and supply public goods. The administrative function is about the executive body that manages monitors and controls the performance of organization. Both part of public organization are examined in the survey, either employees, or people in the decision making. More precisely, the respondents are employee and employers of the Rousse District Administration and Rousse Municipality Administration.

Objects of study are the characteristic of the organizational culture in district and municipality administrations in Rousse. The survey follows the five dimensional methodology of Hefstede – UA, PD, IC, MF, LTO (Hofstede, 2001). More specifically, the form is questionnaire, with Likert scale. The survey is conducted during September – December 2007. The sample size consists of 108 in total: 33 – district administration respondents and 75 – municipality respondents. The outcomes are presented in the table 1 and illustrated at the fig. 2.

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>District Administration</th>
<th>Municipality Administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>UA</td>
<td>39.07</td>
<td>52.94</td>
</tr>
<tr>
<td>PD</td>
<td>21.03</td>
<td>71.65</td>
</tr>
<tr>
<td>IC</td>
<td>41.99</td>
<td>43.61</td>
</tr>
<tr>
<td>MF</td>
<td>55.23</td>
<td>48.45</td>
</tr>
<tr>
<td>ITO</td>
<td>30.06</td>
<td>37.47</td>
</tr>
</tbody>
</table>
The first conclusion that pops up is the administrative culture is more alike than less to the national one. It is boldly emphasized in PD overlapping between the municipality at the national scores. It means that the initiative for any novelty development is expected from the upper level of management. It is also seen in the district and municipality images above. The municipality administration ranks higher on PD, which is also embedded in its role to be a body who implements the national priorities, policies, and etc.

Referring to IC, both organizations rank moderate. It is most contradiction dimensions in Bulgaria. However, there are arguments in favor of being collectivistic. It is supposed that some connection should be made before going into the real matter. These ties should not necessary be relatives, friends, and etc. they could be based on professional ground, but that kind of network is envision as needed. The issue with investment in human capital is also topical here. The expectations on who should invest in people: a) they by their own should act as entrepreneurs, to invest in acquiring new knowledge and skills and to gain afterwards, or 2) the company/state needs to invest in them according to the priorities in hand.

There is moderate to high MF index, which applies in the willingness for fast and significant results. The moderate UA leads to readiness to take calculated risk. However in the near past our society has tended to be less risky orientated.
Regarding to LTO, the respondents tend to short term orientated, both on individual and organizational level. Again, Bulgarian administrative officers prefer short term investments, expecting fast revenue; the funds for human resource development are envisioned more like a chance for money waste instead of investment for competitive advantage in a long run. Both, the employees and employers envision the change of a workplace as an appropriate and acceptable way for career development, instead of promotion or succession planning. Thus, it could end up with a brain drain. What is more, LTO results in funds restrictions for research and development.

6. Basic conclusions

Regarding to the innovation behavior in the public sector it could be concluded as follows:

- There are problems with the development of innovation friendly environment, in which the novelty is an object of dissemination via variety of diffusion channels, thus not to be restricted to the group of the innovation users.

- There is no support for innovative climate in terms of complex intervention measures by the state – e.g. regulations and legislation, tax reduction, support for prioritized sectors and activities.

- There is a lack of harmoniously cooperation between the national innovation framework system with the superior systems – e.g. access and dissemination of information, technological transfer, human resource mobility, and etc.

- There is need for development of a framework for management of change – e.g. development of schemes, norms and rules to provoke and accelerate the creativeness. One could find contradiction here, but keeping in mind high PD it is a way to promote attempt for innovations.

- Special attention and measures are required from the state for human resources development, since they are both carrier and subject of innovation culture, along with assessment and optimization in the usage of intellectual assets.

- There is a need for proactive behavior in public sector upon the environmental changes.
Summary
The survey of the dimensions is a kind of attempt to add to the Bulgarian cultural model compost of ground of local characteristics, values system (believes, norms, etc.), and practices (symbols, heroes and rituals).

The main task in the paper is to examine the gap between the current dimensional scores/positions and the requirements for the desired innovational behavior - overlapping areas, possible controversies, the scope of the required change.

Development or proper adoption of consistent practices for innovation transmitting and enhancement is required to achieve innovation culture building.

The choice and the implementation of proper managerial techniques would approve explications of the innovative culture in everyday behavior, thus to create an environment for innovative tolerance and development.

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Transportation infrastructure, economic growth and population density in Turkey

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Abstract:
Transportation infrastructure is an exciting topic for public policy, private sector and the connection between them. This study deals with the impact of railways as hard type of transportation infrastructure on economic growth and population density. The purpose of this study is to search for historical relationships between railway infrastructure and economic growth; and between railway infrastructure and population density in Turkey. By using annual data for 1950-2004, both tangible and intangible effects of railway infrastructure are aimed to be estimated. The results form cointegration and causality tests imply that there is a positive long run relationship between railway length and population density and between railway length and GDP. Railway length causes GDP to increase only in the long run but it causes population density to increase both in the long and the short run. These results confirm the theoretical framework that improvements in transportation infrastructure lead to higher income and higher population in the investigated area.

Keywords: Hard types of infrastructure, Public Policy, Transportation systems, Railways, Causality

1. Introduction
Public and private sector complementarities have many important linkages for stabilized continuity in terms of infrastructure in wide range (such as transportation, communication). Firm clusters, national and international companies establish their production facilities near transportation sources to benefit from the services they provide. Firms are in need of more opportunities and maintenance from public authorities for various
transportation systems. In addition, when new plants are built, public service expenditures such as water, sewer, electricity, telephone lines and internet lines are provided by public sector. Public authorities’ support is crucial for private sector settlements for different kinds of reasons; for example, more plants offer new job opportunities thus reduce unemployment around those areas.

This perspective argues that public policies create important incentives for private sector as they affect private sector output, labor market, manufacturing industry and many other economic measures. Therefore, public policy should contain feasible and beneficial elements of infrastructure investment to sustain development. Thus, transportation infrastructure is an exciting topic for public policy, private sector and the connection between them. Transportation systems improve rapidly and these improvements go parallel to economical issues such as manufacturing industry production and exports. This is a strong basis for public sector to make innovations, purchase new equipments and provide better maintenance for transport infrastructure.

There are two types of infrastructures; hard type of infrastructure and soft type of infrastructure. Transportation systems or in other words transportation infrastructure is considered to be a part of both types. Hard type of infrastructure deals with roads, highways, railways, harbors, airports, water and sewer, etc. Soft type of infrastructure; telephone lines, internet, other communication infrastructures and institutional infrastructure types; act as complements to hard types of infrastructure. In this study, hard types of transportation infrastructure, specifically railways are taken into consideration, due to their positive role in the historical economic development of Turkey.

The purpose of this study is to search for historical causality relationships between railway infrastructure and economic growth and between railway infrastructure and population density. By these, we aim to measure not only the tangible but intangible effects of railways.

The next section of the study provides the literature review about the proposed hypothesis. The third part contains data and methodology. The results, which are obtained by relevant econometric tests, are presented in the empirical analysis part. Conclusion and policy implications are in the fifth section.

2. Literature Review

2.1 Transportation Infrastructure and Economic Measures

The effects of infrastructure on economic measures have been investigated for more than three decades. These effects became more visible with the increase of trade in the world which resulted in the requirement of faster
and multi dimensional trade routes. Firms began to form clusters near airports and harbors. More firms meant more plants which increased the demand for infrastructure. So, infrastructure investment became one of the most susceptible connections between the private sector and public authorities.

The pioneer study which considers the relationship between economic and infrastructure measures from public and private sector complementarity perspective, is Aschauer (1989) where he investigates the impact of public capital on private sector productivity. His results indicate that the elasticity of private sector productivity with respect to public capital is positive, meaning that infrastructure has positive impact on private sector productivity.

In a later study, Aschauer (1990) defines an exact transportation infrastructure rather than a basket of infrastructure measures and selects highways to analyze the impact on per capita income. He finds a positive relationship.


The researchers that use cost function approach also come up with positive impact of transportation infrastructure. Berndt and Hansson (1992), Lynde and Richmond (1993), Seitz (1993), Nadiri and Mamuneas (1994), Conrad and Seitz (1994) and Boarnet (1996; 1998) analyze Sweden, United Kingdom, West Germany and USA, respectively, and their common outcome is that transportation infrastructure is a cost reducing element in different geographies and industries.

The marginal contribution of public infrastructure relies on the structure of economy and previous conditions of the country (Crihfield and Panggabean, 1995). There is not a consensus on its effect on growth rate of output when transportation is considered as public capital. The payoff of the investment is related to the size and configuration of the network, being
usually smaller in the case of larger networks. If public capital is considered as a public good, increases in the public capital shift the production function upward, raising the steady state level of output and the growth rate of the economy in the transition to the steady state. On the contrary, many services provided by the public capital stock may be subject to congestion, and therefore the marginal increments of the public capital stock may not have an impact on output. Sanchez-Robles (1998) show that infrastructure expenditures as a share of GDP yield inconclusive results but the indexes of infrastructure physical units are significantly and positively related to per capita growth.

2.2 Transportation Infrastructure and Demographic Measures

In addition to the effects of transportation infrastructure on tangible measures such as output, there are also intangible effects on demographic variables such as living standards, population and migration. People may desire to live in a city, where their children can take better education and they can find jobs with higher wages. This kind of behavior tends to be seen more in developing countries rather than developed countries. That is why; investing in transportation infrastructure has often been appraised as an effective strategy for policy-makers in underdeveloped areas rather than developed ones.

Although scholars define the role of transportation infrastructure differently on the basis of regional economic theories, all recognize that it plays an important role in regional economic growth and development (Mikelbank, 1996). Demographers’ view transportation infrastructure as a necessary but not sufficient requirement for local economic growth and development (Halstead and Deller, 1997), as transportation infrastructure is one of many factors affecting population change (Boarnet and Haughwout, 2000; Bohm and Patterson, 1971, 1972; Briggs, 1981; Hobbs and Campbell, 1967; Taylor, Broder, and McNamara, 1987; William, 1958).

Chi, Voss and Deller (2006) provide an extensive summary of the existing literature for transportation and population change. They argue that there are two ways to understand the relationship between transportation and population: the possible paths by which investments in transportation influence population change in addition to the stages (preconstruction, con-struction, and post construction) and spatial areas (urban, suburban, and rural) that population change is related to transportation. At the county and municipal levels, they address transportation as indirect causes of population change via economic growth, employment change, socio-demographic structures, and environmental change.

Growth theories (neoclassical growth theory, growth pole theory, and location theories) are the principal regional economic theories that relate
transportation infrastructure investment to economic growth and population change. Neoclassical growth theory is insightful in explaining and predicting metropolitan development after the transportation network has been built. Neoclassical growth theory considers transportation infrastructure as an input into the production process (Boarnet, 1997; Eberts, 1990), an enhancer to increase the productivity of other inputs such as labor (Eberts, 1994), or a household amenity factor to attract workers (Eberts, 1994).

Growth pole theory is useful for forecasting population change from the standpoint of decision makers because it specifically outlines how resources should be invested in a region given limited resources to devote to economic growth and development (Thiel, 1962). Growth pole theory understands transportation investment as a catalyst of change to influence population growth in its surrounding areas where population decline is also a possible outcome. Location theory is strong in interpreting geographic distributions of human settlements. This theory understands transportation infrastructure as a facilitator for the flows of raw materials, capital, finished goods, consumers, and ideas among central places and their neighborhoods and a limitation on these flows, as a means of importing inputs into and exporting outputs out of a location (Vickerman, 1991); or as necessary but not sufficient for local economic growth and development (Halstead and Deller, 1997).

Allen and MaClennan (1970) use growth pole theory to identify centers of economic activity that are believed to attract investment because of their agglomerative powers. They observe regional problems which are caused directly and/or indirectly by public policies in Italy and France. The study identifies growth poles as urban areas having population interval between 30,000 and 200,000 residents. The research concludes that rural areas close to these cities may benefit from spread effects and public policies are effective among those benefit relations. Hansen (1971) uses regional development theory to determine the best use of infrastructure investment at a minimum population threshold of 250,000 for areas deemed worthy of infrastructure investment. He argues that investment in public infrastructure should be concentrated in urban areas that have some level of prior dynamism or development.

Gaegler, March and Weiner (1979) and Lichter and Fuguitt (1980) investigate the relationship between interstate highways and demographic measures such as employment population characteristics for various service industries in non-metropolitan counties during the period 1950-75. They find that counties with interstate highways consistently maintained an advantage over other counties in net migration and employment growth. Population growth was also found to be greatest in interstate highway
counties, with positive effects of highways on net migration strongest in less remote areas.

Hilewick, Deak and Heinze (1980), is another empirical study, which looks at rural growth effects of investing in transportation networks compared with the effects of investing in communications systems; thus providing a comparison among soft type and hard type of infrastructure systems. They conclude that investing in communication results in stronger short-term and long-term effects rather than transportation investments on demographic and economic measures such as population, jobs, income, gross regional product, and overall economic structure.

Carlino and Mills (1987) and McHugh and Wilkinson (1988) investigate the factors affecting US county population and employment growth during the 1970s. Total employment, manufacturing employment, and population density are positively affected by the presence of limited-access highways.

Just as population change can have many causal factors; transportation can influence population change by several paths: economic growth or decline, employment and socio-demographic structure. Forkenbrock and Foster (1996) examine the degree to which highways as transportation measures are likely to influence business location decisions. They argue that access to highways generally has become a less important factor in location decisions than it was earlier. State-level highway investment policies that emphasize proper maintenance and relatively minor improvements are likely to be more cost-effective strategies for economic development than expensive highway construction projects.

3 Data & Methodology

3.1 Data

The variables used in this study are railway length for railway infrastructure, population density and gross domestic product for economic growth. These variables are represented by RW, PD and GDP respectively throughout the analysis. Data for railway length is acquired from Turkish State Railways (TCDD) in kilometers. Population density is calculated by dividing the population of the observed place by the area of the same place in square kilometers. Population and GDP data are acquired from Penn World Tables and the areas in square kilometers are obtained from Turkish Statistical Institute (TUIK). All data are annual for the period from 1950 to 2004.

3.2 Methodology

The aim of this study is to investigate the historical relationships between railway infrastructure and economic growth; and between railway
infrastructure and population density for Turkey by using time series analysis (cointegration and causality analysis). The literature reveals that production-function and cost-function approaches in addition to causality analysis are widely used to test the relationship between transportation infrastructure and economic growth. Causality analysis is also used to investigate the effect of transportation infrastructure on demographic measures.

Time-series analysis requires that the variables should be tested in order to find their stationarity by applying unit-root tests. The stationarity of the variables are determined by the use of three different tests to check the robustness of the results: ADF (Augmented Dickey-Fuller), PP (Phillips-Perron) and KPSS (Kwiatkowski-Phillips-Schmidt-Shin) unit-root tests.

After unit-root tests, cointegration tests are performed as the second step. A cointegration analysis is used to determine whether a group of non-stationary variables are cointegrated or not. Engle-Granger cointegration test is conducted at first. Engle-Granger cointegration test has two steps, which is also named Engle-Granger two-step cointegration test. First step gives the long-run relationship with respect to the coefficients and t-statistics of variables, integrated in the same order. The error term, which is taken from first step, is saved and ADF unit-root test is applied to error term (ut) to find that if it is stationary or not. Error Correction Mechanism (ECM) is the aim of the second step and is the first lagged value of the error term (ut-1) obtained from the first step. If that value is between 0 and -1, ECM is said to work.

Johansen cointegration test is also performed to compare the results of Engle-Granger cointegration test as the second test. Johansen cointegration test implements Vector auto-regression (VAR) based cointegration analysis developed by Johansen in the early 1990s.

Causality relationship analysis is the third step after unit root testing and cointegration analysis. Granger-Causality test is modeled as follows:

$$X_1(t) = \sum_{j=1}^{p} A_{11} X_1(t-j) + \sum_{j=1}^{p} A_{12} X_2(t-j) + E_1(t)$$

$$X_2(t) = \sum_{j=1}^{p} A_{21} X_2(t-j) + \sum_{j=1}^{p} A_{22} X_1(t-j) + E_2(t)$$

This model tests the causality relationship between two variables in both directions such as from railways to population and from population to railways. The direction of the effect is important as well as the magnitude of the relation. A time-series $X_1$ is said to Granger cause of time series $X_2$, if variable $X_1$ provides statistically significant information about the future.
values of variable $X_2$. The test uses F-test on lagged values of both variables during the estimation process of the regression model. The general model (1) above is transformed to model (2) in order to test the relationship between GDP and RW; and to model (3) to test the relationship between PD and RW.

\[
\begin{align*}
(2) & \quad GDP(t) = \sum_{j=1}^{p} A_{11j} GDP(t-j) + \sum_{j=1}^{p} A_{12j} RW(t-j) + E_1(t) \\
& \quad RW(t) = \sum_{j=1}^{p} A_{21j} RW(t-j) + \sum_{j=1}^{p} A_{22j} GDP(t-j) + E_2(t) \\
(3) & \quad PD(t) = \sum_{j=1}^{p} A_{11j} PD(t-j) + \sum_{j=1}^{p} A_{12j} RW(t-j) + E_1(t) \\
& \quad RW(t) = \sum_{j=1}^{p} A_{21j} RW(t-j) + \sum_{j=1}^{p} A_{22j} PD(t-j) + E_2(t)
\end{align*}
\]

4 Empirical Analysis

Cointegration analysis is feasible only if the variables under consideration are integrated of the same order, i.e. if they have the same number of unit roots. Table 1 shows the results of the Augmented Dickey Fuller (ADF), Phillips-Perron and KPSS unit root tests for RW, PD and GDP. The results indicate that all variables have one unit root or in other words, they are integrated of order (1). This implies that cointegration analysis can be pursued.

Table 1. Unit-Root Tests

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>RW</th>
<th>PD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Trend</td>
<td>Level</td>
<td>-1,849** (1)</td>
<td>0,972** (1)</td>
</tr>
<tr>
<td></td>
<td>1st Dif.</td>
<td>-9,113 (0)</td>
<td>-9,135 (0)</td>
</tr>
<tr>
<td>Trend</td>
<td>Level</td>
<td>-1,804** (3)</td>
<td>-3,36** (1)</td>
</tr>
<tr>
<td></td>
<td>1st Dif.</td>
<td>-5,72 (0)</td>
<td>-9,082 (0)</td>
</tr>
<tr>
<td>PP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Trend</td>
<td>Level</td>
<td>-2,762** (0)</td>
<td>-0,866** (2)</td>
</tr>
<tr>
<td></td>
<td>1st Dif.</td>
<td>-14,857 (3)</td>
<td>-9,463 (3)</td>
</tr>
<tr>
<td>Trend</td>
<td>Level</td>
<td>-4,913 (0)</td>
<td>-3,37** (3)</td>
</tr>
</tbody>
</table>
In the next step Engle-Granger two-step cointegration test is performed and Table 2 and Table 3 show the results of this test on the two hypotheses of the paper. In both cases, there is evidence of positive long run cointegration relationship. Railway length affects gross domestic product and population density positively with very close coefficients (11.29 and 11.84 respectively). ECM is obtained from the second step of Engle-Granger test as -0.17 and -0.02 for both hypotheses, which can be monitored at tables 2 and 3 respectively. ECM is working in both hypotheses because the values are between 0 and -1.

Table 2. Engle-Granger Cointegration Test for railway length and GDP

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>Standard Dev.</th>
<th>T-stat (Prob.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-96.2828</td>
<td>3.5321</td>
<td>-27.2594 [.000]</td>
</tr>
<tr>
<td>RW</td>
<td>11.2855</td>
<td>0.3816</td>
<td>29.5701 [.000]</td>
</tr>
<tr>
<td>ADF</td>
<td>-3.5245**</td>
<td>(1)</td>
<td></td>
</tr>
</tbody>
</table>

\[ \Delta \text{lgdpt} = \alpha_0 + \alpha_1 \Delta \text{lrw} + \alpha_2 u_{t(-1)} + \epsilon_t \]

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>Standard Dev.</th>
<th>T-stat (Prob.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( u_{t-1} ) (ECM)</td>
<td>-0.1709</td>
<td>0.0847</td>
<td>-2.017 [.049]</td>
</tr>
</tbody>
</table>

Note: * denote the rejection of the null hypothesis and ** denote the non-rejection of the null hypothesis at 5% level respectively. Critical value are based on MacKinnon (1991) and at 5% significance level are -2.9179; models include constant and no trend; \( k \) is the lag length used in the test for each series and number of lags are determined according to the AIC and given in parenthesis.
Table 3. Engle-Granger Cointegration Test for railway length and population density

\[
lpd_t = \beta_0 + \beta_1 lrw_t + u_t
\]

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>Standard Dev.</th>
<th>T-stat (Prob.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-45.8564</td>
<td>1.1087</td>
<td>-41.3595 [.000]</td>
</tr>
<tr>
<td>RW</td>
<td>11.8422</td>
<td>0.2758</td>
<td>42.9251 [.000]</td>
</tr>
</tbody>
</table>

ADF : -3.6124** (1)

\[
\Delta lpd_t = \alpha_0 + \alpha_1 \Delta lrw_t + \alpha_2 u_{t-1} + \epsilon_t
\]

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Coefficient</th>
<th>Standard Dev.</th>
<th>T-stat (Prob.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ut(-1) (ECM)</td>
<td>-0.0176</td>
<td>0.0105</td>
<td>-1.6777 [.100]</td>
</tr>
</tbody>
</table>

Note: * denote the rejection of the null hypothesis and ** denote the non-rejection of the null hypothesis at 5% level respectively. Critical value are based on MacKinnon (1991) and at 5% significance level are -2.9179; models include constant and no trend; \( k \) is the lag length used in the test for each series and number of lags are determined according to the AIC and given in parenthesis.

Although Engle-Granger test is suitable for an analysis with two variables, Johansen cointegration test is also applied in order to test the robustness of the results. The results of this test provided in Tables 4 and 5, confirm the results of the Engle-Granger test of a cointegration relationship for both of the relationships. The coefficients are 13.09 and 10.64 respectively and statistically significant.

Table 4. Johansen Cointegration Tests for railway length and GDP

<table>
<thead>
<tr>
<th>Null</th>
<th>Alternative</th>
<th>Regression Statistics</th>
<th>1%</th>
<th>5%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0</td>
<td>r &gt;= 1</td>
<td>35.6366</td>
<td>25.0781*</td>
<td>20.2618*</td>
<td>17.9803*</td>
</tr>
<tr>
<td>r &lt;= 1</td>
<td>r &gt;= 2</td>
<td>8.6456</td>
<td>12.7607</td>
<td>9.1645</td>
<td>7.5567</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Null</th>
<th>Alternative</th>
<th>Regression Statistics</th>
<th>1%</th>
<th>5%</th>
<th>10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>r = 0</td>
<td>r &gt;= 1</td>
<td>26.9910</td>
<td>25.0781*</td>
<td>15.8921*</td>
<td>13.9059*</td>
</tr>
<tr>
<td>r &lt;= 1</td>
<td>r &gt;= 2</td>
<td>8.6456</td>
<td>12.7607</td>
<td>9.1645</td>
<td>7.5567</td>
</tr>
</tbody>
</table>

\[
lgdp_t = -49.17^* + 13.095^* lrw_t
\]

* denote statistical significance at 1 and 10% respectively.
Table 5. Johansen Cointegration Tests for railway length and population density

<table>
<thead>
<tr>
<th></th>
<th>TRACE TEST</th>
<th>MAXIMUM EIGENVALUE TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null Alternative</td>
<td>Statistics</td>
<td>Statistics</td>
</tr>
<tr>
<td>$r = 0$</td>
<td>$r &gt;= 1$</td>
<td>$r &gt;= 1$</td>
</tr>
<tr>
<td>$r &lt;= 1$</td>
<td>$r &gt;= 2$</td>
<td></td>
</tr>
<tr>
<td>7.4890</td>
<td>16.5538 12.5179 10.6663</td>
<td></td>
</tr>
</tbody>
</table>

\[ \text{lpd}_{i} = -40.97 + 10.641 \text{lr}_{i} \]

*, *** denote statistical significance at 1 and 10 % respectively.

Granger causality test takes into account the cointegration relationships between the variables and tests the causality of this long run in addition to the short run causality by determined lag lengths. The causality test is carried through a vector auto regression where the short run causality is tested with F-test and the long run cointegration relationship is tested with t-test.

According to the results posted in Table 6, the long run relationship for railway length and GDP is significant for both directions; meaning that they cause each other in the long run. However, in the short run, GDP causes railway length to decrease (-0.036, -0.008).

Railway length causes population density to increase both in the short and the long run. The size of the F-statistics is interestingly very large (12943.36). Population density affects railway length only in the long run as the coefficient of the cointegration relationship is found to be significant.
Table 6. Granger Causality Test

<table>
<thead>
<tr>
<th>null hypotheses</th>
<th>dependent variable</th>
<th># of lags</th>
<th>t-test for short run</th>
<th>coefficients</th>
<th>t-test for long run</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railway length doesn’t cause GDP</td>
<td>$\Delta$ (GDP)</td>
<td>(2)</td>
<td>2.226</td>
<td>-0.388</td>
<td>-3.067</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.100**</td>
</tr>
<tr>
<td>GDP doesn’t cause railway length</td>
<td>$\Delta$ (railway length)</td>
<td>(2)</td>
<td>3.744***</td>
<td>-0.036</td>
<td>-0.008</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.183*</td>
</tr>
<tr>
<td>Railway length doesn’t cause population density</td>
<td>$\Delta$ (population density)</td>
<td>(3)</td>
<td>12943.36*</td>
<td>0.011</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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*, ** and *** indicate the rejection of the null hypothesis at 1, 5 and 10% significance levels respectively. $\Delta$ denotes change.

5 Conclusions

From the perspective of public sector and private sector complementarities, transportation infrastructure constitutes an important and interesting topic. National and international companies establish their production facilities near transportation sources to benefit from the services they provide. Firms are in need of more opportunities and maintenance from public authorities for various transportation systems. In addition, when new plants are built, public service expenditures such as water, sewer, electricity, telephone lines and internet lines are provided by public sector.

This study investigates the historical causality relationships between railway transport infrastructure and economic growth; and between railway infrastructure and population density in Turkey for 1950-2004. The long run estimation results indicate that both of the relationships are positive in the long run. Railway length causes GDP to increase only in the long run but it causes population density to increase both in the long and the short run. These results confirm the theoretical framework that transportation infrastructure leads to higher income and higher population in the investigated area.

There is also evidence that although increase in GDP leads to an increase in railway length in long run, in the short run it leads to a decrease. This implies that when income of the country increases,
resources are devoted out of railway infrastructure to other areas, but in the long run investment in railways continues. In addition, as railways cause population density to increase in the long run, population density makes the same effect on railway length

References


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Moon, H. E. (1988), “Interstate highway interchanges as instigators of nonmetropolitan development” Transportation Research Record, 1125, 8-14


### APPENDIX

#### Table A1. Literature Review part 1

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*Proceedings of the 5th ISSS Conference, Xanthi, Greece, 2009*
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