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Interdisciplinarity - New Approaches and Perspectives in the Use of Quantitative Methods

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INTERDISCIPLINARITY – A REQUIREMENT OF THE MODERN AND EFFICIENT RESEARCH

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Abstract: *Interdisciplinarity is considered the best way for research. This paper presents the interdisciplinary concept, and defines the necessary and sufficient conditions for developing an efficient interdisciplinary research. There are underlined the needed elements to build correct, concise, and consistent interfaces that assure the continuity, in order to develop a common research language. It is, also, developed an interdisciplinary model, based on a collaborative structure.*

Key words: *interdisciplinarity, modern research, efficient research*

1. The Interdisciplinary Research

Let us consider the disjunctive research domains D_1, D_2, D_n. Each domain has its own vocabulary, respectively, V_1, V_2, V_n.

$$V_i \bigcap V_j = \phi \text{, for any } I \neq j;\ i, j \in \{1, 2, n\}.$$

Each domain, D_i, is characterized by:

- primary axioms and notions;
- theories and models for describing and explaining phenomena, processes, correlations, evolutions and structures;
- outcomes obtained in the course of time, in order to emphasize new characteristics, new interactions, new processes, new effects, and new procedures.

The level of generality concerning the approaching methods has increased in the course of time, reaching a saturation level. Having in view this aspect, the activities for

discovering new materials, new processes, new equipments, new methods, and new models within the respectively domain, is becoming more and more difficult, or, may be, impossible. For solving this problem it is necessary build an interdisciplinary team made up of specialists within the domain D_i, and specialists from others domains. This is the best, and, may be, the only way to develop the necessary premises in order to obtain a significant qualitative leap regarding to the new discoveries.

Nowadays, a solitary researcher, having encyclopedic knowledge is not a realistic approach. In the modern research, the interdisciplinarity is imposed by the following challenges:

- the enhancement of the each research domain complexity;
- biologically limits concerning the assimilation of knowledge from various areas by a single person;
- a problem solution is obtained using knowledge from one domain, experimentally results obtained using tools from other domain, and the applicability is for a target group belonging to the other one;
- the necessary time to solve a problem, for example in the health care domain, requires the simultaneously development of the research process stages; such kind of approaching is possible only whether exist high qualified specialists who simultaneously approach the process stages;
- the existence of a common language, imposed by the research project management, leads both to an evident delimitation of the research stages, and to the increasing of the specialization level; in others words this leads to the increasing of the labor division;
- the necessity to maintain the costs under control
- assisting the research processes, that imposes a collaborative style, within the messages exchanges are developing by direct and efficient flows, flows that are quantifiable by their generated effects.

The interdisciplinarity assumes a new researcher type that has an activity based on procedures, within a team, where his role is well defined.

2. The team research structures and interfaces for communication

There are researches where the activities are sequentially developed, figure 1.

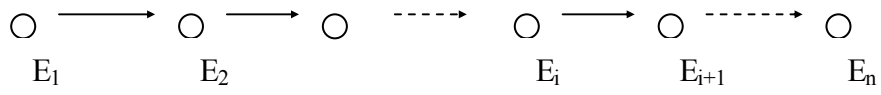

Figure 1. The sequential research structure

Each specialist type has a unique intervention within a well defined time framework. For the specified inputs and for expected outcomes, the specialists apply methods, techniques, algorithms, use tools, assembly objects, and the results from the E_i stage are used by an other specialist team to develop the E_{i+1} research stage.

At the E_n stage end the estimated outcomes of the interdisciplinary research are obtained.

The tree structure assumes a detailed research stages, figure 2, in such way that each researcher has precise tasks, and the outcomes are assembled step by step, in order to accomplish the goal, figure 3.

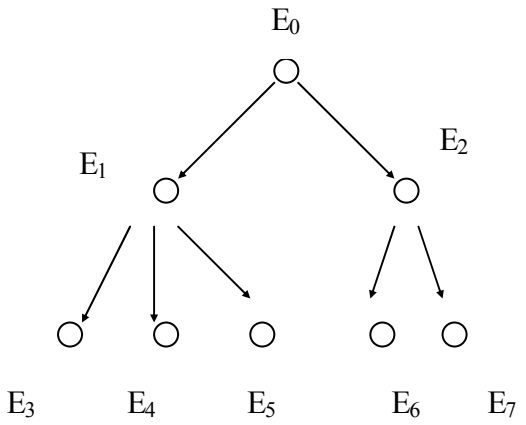

Figure 2. The three research structure

The tree structure associated to the research process assumes the simultaneous development of the E_1 and E_2, E_3, E_4, and E_5, and E_6 and E_7 stages.

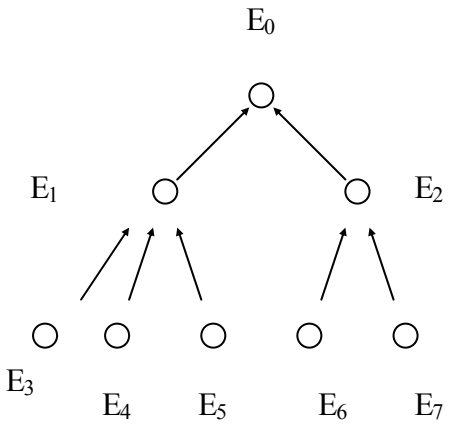

Figure 3. The research outcomes assembly

The graph structure is the most common structure regarding an interdisciplinary research process organization, or regarding interdisciplinary executable projects development, figure 4.

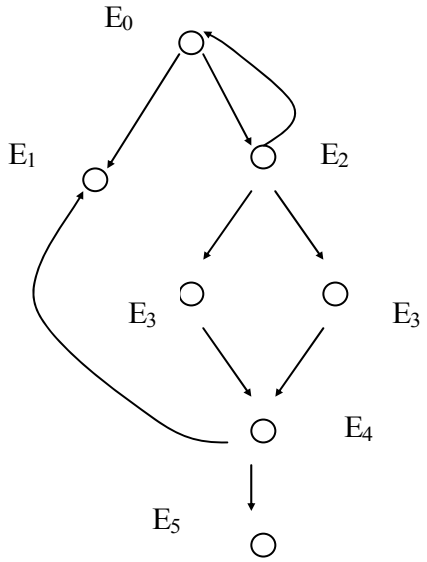

Figure 4. The graph structure

The graph structure gives the possibility to make analyses, and if the obtained outcomes differ from the planned ones, the process is resumed form the certain stage. If the expected outcomes are obtained in advance from the planned stage, some stages are eliminated.

3. The common communication language

The interdisciplinarity assumes that to each structure node is associated a team consisting of high qualified specialists, and the obtained outcomes are taken by an other team having different qualifications.

A node with the complex structure is defined for each level. At the informational level, the specifications offered by the team from previous level K are given together with procedures and the outcomes, figure 5.

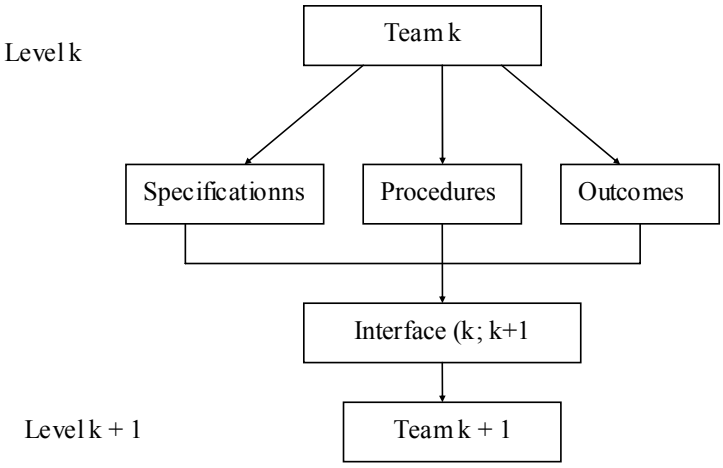

Figure 5. The communication interface among the teams belonging to the D_k, respectively D_{k+1}, domains

The interdisciplinarity assumes the existence of a common vocabulary V_{com}, so that to each word $c_i \in V_{com}$, corresponds a word or a text belonging to the V_i vocabulary, $i = 1, 2, n$, associated to the domain D_i. In other words, the interface have to be built using texts made of the words belonging to the V_{com} vocabulary, and the teams have all the necessary resources in order to develop activities according to their activity domains specificity.

The translation from a text built by the D_i domain team, using V_i vocabulary, to a text built by the D_j domain team, using the V_j vocabulary, is possible only using a language based on V_{com} vocabulary, figure 6.

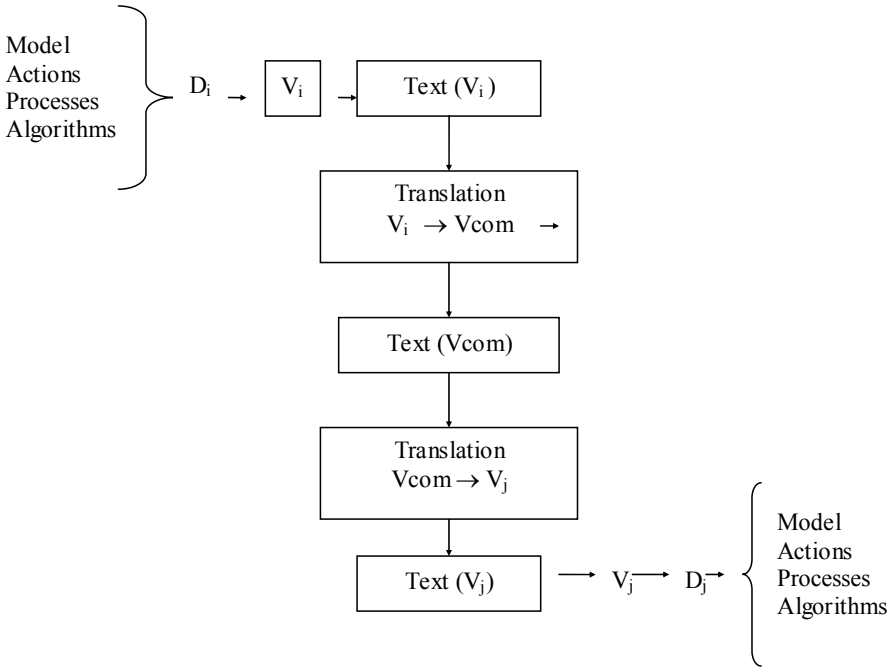

Figure 6. The translation from the specialists within D_i, D_j domains

4. The building a simulation model

The simulation is, by excellence, an interdisciplinary mode. For the domain *DP*, taken into consideration, it is necessary a team consisting of specialists who know:

- the inputs of the real system;
- the processing stages;
- the mechanisms of the transformation which took place within each stage;
- the manufacturing receipts;
- the processes management.

The simulation module assumes data gathering, which is realized by:

- using the measurement and recording devices, and building data time series that are stored in database, giving a clear image concerning the processes that take place within a time period, enough long;
- planning the experiments in order to see the system comportment, using methods with variable levels of completeness, having in view to keep under control both costs, and risks levels.

The data gathering needs specialists who know very well measurement and control devices, and, also, know the basic elements regarding data quality management, *DQ*.

In order to assure the reproducibility, at a certain scale, of the processes for which the simulation model is built, it is necessary a team made up of statisticians, *DT*. Applying some specific test, this team verifies if the data recording frequencies, that reflect the dynamic of the factors which are interacting within the system, are in accordance with certain repartition laws.

The results given by the teams belonging to *DP, DQ*, and *DT* domains, are using by the simulation domain team, *DS*, which builds the simulation model through:

- choosing the significant variables:
- establishing the restrictions;
- defining the objective function;
- defining the variation domains;
- building the selection criteria.

The simulation model is taken by the specialists who use the simulation languages, or develop the specialized software, *DA*, and the model implementation takes place.

Using data set inputs, which are obtained on the work assumptions base, the specialist in the simulation systems comportment studying obtain the results that are used in decision making that are applied to the real system in order to:

- optimize the real system comportment;
- optimize the real system structure in accordance with given optimum criteria.

Such kind of approaching in impossible without interdisciplinary. If the optimization refers to processes that take places within complex chemical installations, or it refers the manufacturing a high speed vehicle, or the optimization refers to the manufacturing receipt, only the collaborative messages exchange among specialists belonging to the domains that contribute to reach the planned goal.

5. Conclusions

The interdisciplinarity is both a reality and a condition in order to successfully develop projects. The interdisciplinary approach requires to define:

- the project size;
- the project goal;
- the typology of the messages which are sent to the target group;
- the schedule.

The domains such are aeronautics, virusology, ecology, construction industry, food processing, agriculture are developing only by interdisciplinary approach concerning both the research activities, and practical activities.

The interdisciplinarity assumes to train both the researchers and the practitioners in order to learn a simple and efficient communication language, to learn to appreciate the work of the specialists belonging to other domains, and to respect them and their work results.

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STYDY ON EARLY WARNING OF BUILDING SAFETY BASED ON SVM

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Abstract: *The building is important strut industry of our national economy. But the safety accidents in building domain occur frequently every year. The safety problem of building directly influences or even restricts the development of building industry. Support Vector Machine (SVM) is a kind of new machine learning method developed on the basis of statistical learning theory. This method based on the principle of structural risk minimization can solve the problem of overfitting effectively and has good generality capability and better classification accuracy. In this paper, the author applied this method in safety management of building and carried on the study of early warning system of building safety based on SVM. At last, we carried on the data experiment to this problem and proved that the method of SVM has good generality capability.*

Key words: *Building safety, Early warning, generality capability, Support Vector Machine*

1. Introduction

At present, the building industry has already become the important strut industry with the development of our national economy. The safety problem of building domain relates to the people life and nation property safety. Its direct aftereffect harms the people's vital interest and influences the situation of social stability. Because the building industry has these characteristics of singleness and complexity and open-air work and upper-air work and labor-intensiveness, the safety accidents in building domain occur frequently. According to the incomplete statistics, the annual number of casualties is about thousands of people and direct economic losses are over ten billion Yuan. So the safety problem in building domain has aroused the universal attention of society. In view of this situation, the government has promulgated a series of laws and regulations to strengthen the safety production of building domain. Some management personnel and technical personnel of building enterprise and

some experts have also carried through various studies and discussions to safety production of building, including having made some achievements in building safety evaluation and early warning. In allusion to the current situation of building safety management of our country, we carried on the study of early warning of building safety based on Support Vector Machine (SVM) in this paper. We hope that to develop this study can reduces casualty and property losses. In addition, it has certain model significance for the building safety management way of our country.

2. Support vector machine

Support Vector Machine is a kind of new machine learning method developed on the basis of statistical learning theory. This method based on the principle of structural risk minimization can solve the problem of overfitting effectively and has good generality capability and better classification accuracy. It is becoming a new research focus of machine learning field after pattern-recognition and neural network.

SVM is used to find the optimal separating hyperplane of linear classification problem first. The so-called optimal separating hyperplane not only can be used to separate the data, but also can maximize the margin. So, the problem of constructing the optimal separating hyperplane can be turned into the following optimization problem:

$$\min \phi(w) = \frac{1}{2}\|w\|^2 \qquad (1)$$

s.t. $y_i(w \cdot x_i + b) \geq 1$, i=1,2,…, l

The above problem can be transformed to the following dual problem by using Lagrange optimization method:

$$\max W(\alpha) = \sum_{j=1}^{l} \alpha_j - \frac{1}{2}\sum_{i=1}^{l}\sum_{j=1}^{l} y_i y_j \alpha_i \alpha_j (x_i, x_j)$$

s.t. $$\sum_{i=1}^{l} y_i \alpha_i = 0$$

$$\alpha_i \geq 0, \; i=1,2,\ldots,l \qquad (2)$$

where α_i are the Lagrange multipliers.

Solving Equation (2) with constraints Equation determines the Lagrange multipliers, and the optimal separating hyperplane is given by,

$$f(x) = \operatorname{sgn}\{(w^* \cdot x_i) + b^*\} = \operatorname{sgn}\{\sum_{i}^{l} y_i \alpha_i (x_i, x) + b\} \quad (3)$$

where sgn ()denotes the sign function.

So far the discussion has been restricted to the case where the training data is linearly separable. However, in general this will not be the case. In the case where it is misclassification, alternatively a more complex function can be used to describe the boundary. To enable the optimal separating hyperplane method to be generalized, Cortes and Vapnik (1995) introduced non-negative variables, $\xi_i \geq 0$. The ξ_i are a measure of the misclassification errors. The optimization problem is now posed so as to minimize the classification error as well as minimizing the bound on the VC dimension of the classifier.

The generalized optimal separating hyperplane is determined by the vector w which that minimizes the functional,

$$\min \phi(w,\xi) = \frac{1}{2}\|w\|^2 + C\sum_{i}^{l}\xi_i \qquad (4)$$

where C is a given viable. The generalized optimal separating hyperplane is nearly the same as to linearly separable problem, just the constraints Equation turns into:

$0 \le \alpha_i \le C$, $i=1,2...l$.

To non-linear problem, we can transform it to the problem of a high dimensional feature space by the use of reproducing kernels. The idea of the kernel function is to enable operations to be performed in the input space rather than the potentially high dimensional feature space. Hence the inner product does not need to be evaluated in the feature space. This provides a way of addressing the curse of dimensionality. So the optimal separating hyperplane is transformed to:

$$f(x) = \operatorname{sgn}\{\sum_{i}^{l} y_i \alpha_i K(x_i, x) + b\} \qquad (5)$$

where $K(x_i, x_j) = \phi(x_i) \cdot \phi(x_j)$

Hence, if we select different kernel function, we can acquire different support vector machines.

3. Early warning of building safety based on SVM

The early warning problem can be regarded as classification problem. Considering the simplest situation, we can classify it into having warning and no having warning. Then we regard the early warning problem as classification problem of two classes by integrating the history data and the present data. Hence, we can solve it by SVM. If we hope to infer different warning degree, we may regard early warning problem as classification problem of multiclasses.

The SVM learning algorithms include SVMlight, SMO, Chunking, Decomposing and so on. We select SVMlight when constructing the early warning system. The systematic design idea is to design the effective algorithm and choose working set of including q non-0 weight and decompose the original optimal problem.

The process of early warning of building safety can be regarded as a process of pattern recognition. Comparing the new early warning sample of unknown warning degree with standard sample of known warning degree, we can determine mode category of early warning which new early warning sample should belong to.

According to the above analysis, we constructed the framework of deal with early warning problem by computer as Figure1:

In Figure 1, the man-machine interface is the program interface which users use the early warning system. The original data trained and relevant parameters are inputted through the man-machine interface and the alarm signal is also displayed through the man-machine interface. The knowledge acquisition subsystem formed by SVM classification algorithm is a core of the early warning system. The knowledge base subsystem is a carrier of the early warning knowledge, and is also a guide part of the warning subsystem. Warning subsystem is equivalent to the wrong inspection system in the pattern recognition system.

Under the drive of the new early warning data, it received the warning result by the calculation of decision-making function.

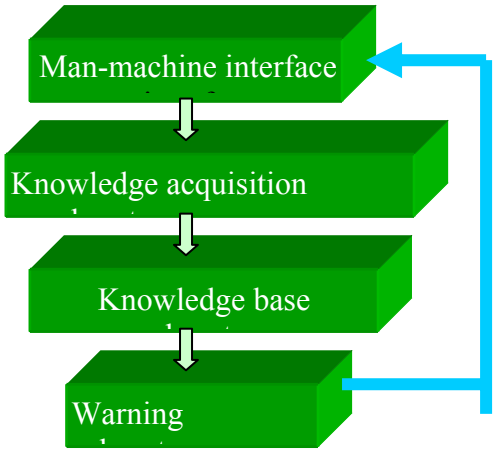

Figure 1. Early warning system framework

In Figure 1, the man-machine interface is the program interface which users use the early warning system. The original data trained and relevant parameters are inputted through the man-machine interface and the alarm signal is also displayed through the man-machine interface. The knowledge acquisition subsystem formed by SVM classification algorithm is a core of the early warning system. The knowledge base subsystem is a carrier of the early warning knowledge, and is also a guide part of the warning subsystem. Warning subsystem is equivalent to the wrong inspection system in the pattern recognition system. Under the drive of the new early warning data, it received the warning result by the calculation of decision-making function.

4. Experiments

We validated the capability of early warning system by the data of some construction group. This data was collected from 1984 year to 2003 year, altogether 20 years.

We regarded the data from 1984 year to 1998 year as training samples. We chose 32 influence features of building safety about each training sample, as in table 1[2].

Thus, each sample vector x_i includes 32 elements. We consider the simplest situation, namely having warning and no having warning. So, $y_i = \pm 1$. +1 denotes having warning. -1 denotes no having warning. Then, we regard the latter 5 years data as test data. The expression method of data is to give 1 or 0 to each element of x_i. 1 denotes positive answer of influence feature. 0 denotes negative answer of influence feature. For example, if the climate is good, $x_{i2} = 1$, and if the climate is bad, $x_{i2} = 0$. The expression method of test samples is the same as training samples. After we chose training sample, we programmed in MATLAB7 to realize SVM knowledge acquisition and constructing SVM decision-making function and testing data. Test result is list in table 2.

Table 2. Test results and original results

Year	Test results	Original results
1999	+1	+1
2000	+1	+1
2001	+1	+1
2002	-1	-1
2003	+1	+1

According to table 2, we can know the test results are completely consistent with original results. This also indicates SVM has good generality capability and better classification accuracy.

5. Conclusions

The final goal of support vector machine is to solve a global quadratic optimization problem and it has generality capability. And the early warning system of building safety constructed on the basis of this theory has excellent ability of prediction and can lower the incidence of the incident of the building to a great extent. In addition, it has certain model significance for the building safety management way of our country.

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[2] **Table 1.** Influence features of building safety

1. Whether the safety equipment is perfect or not.	17. The construction field is good or bad.
2. The climate is bad or good.	18. The machine device runs over load.
3. The worker's physical quality is bad or good.	19. Hoisting equipment and human overlapping work.
4. The special protective measure is bad or good.	20. The machine device is manufactured or fixed perfectly or not.
5. Whether the workers work in dangerous area or not.	21. The construction surroundings is moist or not.
6. The geological data is detailed or not.	22. The timbering system is good or bad.

7. The soil of foundation is liquefied or not.	23. The construction equipment is aging or short of servicing of not.
8. The methane give off from underground or not.	24. The materials body is big and difficult to transport or not.
9. The water on earth's surface or in pipe erode the ground or not.	25. The worker's manipulation is proper or not.
10. Construction disturbs the ground or not.	26. The worker understands the situation of construction field or not.
11. The chemical matter pollutes the soil or not.	27. The workers are short of specialty technique knowledge or not.
12. There is underground barrier or not.	28. The workers are trained or not.
13. The construction result in neighboring pipeline fracture and the dehiscence or not.	29. The inspection persons do their work well or not.
14. The power supply is steady or not.	30. The construction arrangement is good or not.
15. The ray in night is bright or not.	31.There are safety regulations or not.
16. There is dirt, noise, solarization and drench or not.	32. There are technique mistakes or not.

THE ANALYSIS OF THE TELECOMMUNICATIONS SECTOR BY THE MEANS OF DATA MINING TECHNIQUES

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Abstract: *Nowadays, the Internet comprises of huge amount of electronic information concerning different companies' financial performance. This amount greatly exceeds our capacity to analyze it, the problem being that we often lack tools to quickly and accurately process these data. DM techniques are interesting mechanisms that can be applied to rapidly changing industries, in order to get an overview of the situation. One such market is the international telecommunications industry. In this paper we construct a framework using DM techniques that enables us to make class predictions about telecommunication companies' financial performance. Our methodology allows us to analyze the movements of the largest telecommunications companies, to see how companies perform financially compared to their competitors, what they are good at, who are the major competitors in this industry, etc. The dataset contains 88 companies from five different regions: Asia, Canada, Continental Europe, Northern Europe, and USA, and consists of seven financial ratios per company per year. The data used to calculate the ratios were collected from companies' annual reports (between 1995 and 1999), using the Internet as the primary medium. We used data from 2000 and 2001 to test our classification models. We have obtained good maps (SOMs) in terms of ease-of-readability and the average quantization error and clearly identified the six financial performance clusters. The results of our class prediction models also correspond very well with the SOM model.*

Key words: *Telecommunication Sector, Self-Organizing Map, Decision Trees, Performance Benchmarking, Data Mining Techniques*

1. Introduction

The international telecommunications play an important role in today's market dynamic. In the last decade a dramatic change in the ownership structure of telecommunications companies has taken place, from public (state-owned) monopolies to private companies. The rapid development of mobile telephone networks and video and Internet technologies has created enormous competitive pressure on the companies. As new competitors arise, companies need intelligent tools to gain a competitive advantage. Also,

stock market expectations are enormous, and investors and financial analysts need tested tools to gain information about how companies perform financially compared to their competitors, what they are good at, who the major competitors are, etc. (Karlsson et al., 2001). In other words, the telecom companies need to benchmark their performances against competitors in order to remain important players in this market.

There is a huge amount of information about these companies' financial performance that is now publicly available. This amount greatly exceeds our capacity to analyze it, the problem being that we often lack tools to quickly and accurately process these data. The aim of this paper is to analyze comparatively the financial performance of international telecom companies by the means of Data Mining techniques.

2. Data-mining techniques

Data-Mining techniques have different features that make them suitable for analyzing great amount of data. The goal of the DM is to discover new patterns in data, while most analytical tools (query and reporting tools, statistical analysis packages, online analytical processing – OLAP – and visualisation tools) are based on verification where "the system is limited to verifying user's hypotheses" (Fayyad et al., 1996). The problem with the verification-based approach is that it "relies on the intuition of the analyst to pose the original question and refine the analysis based on the results of potentially complex queries against a database" (Moxon, 1996). Among the factors that limit the reliability of verification-based analytical tools are the ability of the analyst to pose appropriate questions and to manage the complexity of the attribute space. DM supports the discovery-based approach since "one defining data-mining characteristic is that research hypotheses and relationships between data variables are obtained as a result of (instead of as a condition for) the analyses activities" (Romeu, 2001). The discovery goal of the DM process can be further divided into prediction, where the system finds patterns or models for the purpose of future predictions and description, where the discovered patterns are presented in a human-understandable way to the user. In this paper we combine the two different goals of the DM process: we are interested in finding both patterns (models) that describe the financial situation of companies as well as models for financial (class) predictions.

In order to fulfil its role DM could perform a number of tasks such as clustering, classification, regression, dependency modelling, summarisation, and change and deviation detection. The link between these tasks and the real-world applications or business problems (the final goal of DM is to address these problems) is not straightforward, because real-world applications rarely have a simple single solution. Many different tasks may match a particular application, depending on how one approaches the problem (Smyth, 2002). For example, in this paper, the real-world application would be to assess telecom companies' financial performance. Treating our problem as a supervised learning task implies that we already have financial performance classes for all the observations used to train the classifier. Actually there are no labelled data available, thus, the class variable has to be created at the beginning, by treating our problem as an unsupervised task. Only after the class variable has been constructed, can a classifier be trained. Smyth (2002) pinpoints various advices worth consideration when linking real-world applications with the data-mining task. The author states that it is advisable to start with only one task to address a real-world application and, only if necessary, add more complex ones. He also suggests

removing the irrelevant details of the original formulation of the problem so that it resembles more closely a standard textbook task description. In order to select the proper task for a given problem, the data miner should have a complete understanding of both the business problem addressed and the task linked to it. Finally, Smyth (2002) states that it is better to approximate the solution to the right problem than it is to solve the wrong problem exactly.

In this paper, we have used Self-Organizing Map (SOM) algorithm to build the class variable and, then, we applied the induction of decision trees (famous Quinlan's See5.0 tree-induction algorithm) in order to extract some rules of how to predict the performance of different telecom companies as data become available. For a detailed technical explanation of the two algorithms (SOM and See5.0) the reader is referred to Kohonen (1997) for SOM and Quinlan (1993) for See5.0.

3. The telecommunication dataset

We characterise companies' financial performance by calculating the following ratios (see Table 1). This ratio classification is the most common financial ratio classification (Lev 1974, p. 12; Lehtinen 1996, p. 44) and has proposed the following categories for financial ratios: profitability, short-term solvency (liquidity), long-term solvency, and efficiency ratios.

Table 1. Formulas of financial ratios

Dim.	Ratio	Formula
Profitability	*Operating Margin*	$OM = \frac{Operating\ Profit}{Net\ Sales} \times 100$
	Return on Equity	$ROE = \frac{Net\ Income}{(Share\ Capital + Retained\ Earnings)\ Average} \times 100$
	Return on Total Assets	$ROTA = \frac{Total\ Income + Interest\ Expense}{(Total\ Assets)\ Average} \times 100$
Liquidity	*Quick Ratio*	$QR = \frac{Current\ Assets - Inventory}{Current\ Liabilities}$
	Current Ratio	$CR = \frac{Current\ Assets}{Current\ Liabilities}$
Solvency	*Equity to Capital*	$EC = \frac{Share\ Capital + Retained\ Earnings}{(Total\ Assets)\ Average} \times 100$
	Interest Coverage	$IC = \frac{Interest\ Expense + Income\ Tax + Net\ Income}{Interest\ Expense}$
Efficiency	*Receivables Turnover*	$RT = \frac{Net\ Sales}{(Accounts\ Receivable)\ Average} \times 100$

The dataset contains 88 companies from five different regions: Asia, Canada, Continental Europe, Northern Europe, and USA, and consists of seven financial ratios (only current ratio was used as a liquidity ratio, quick ratio being left out) per company per year. The data used to calculate the ratios were collected from companies' annual reports (between 1995 and 1999), using the Internet as the primary medium. We used data from 2000 and 2001 to test our classification models. Annual averages were calculated for each of the regions.

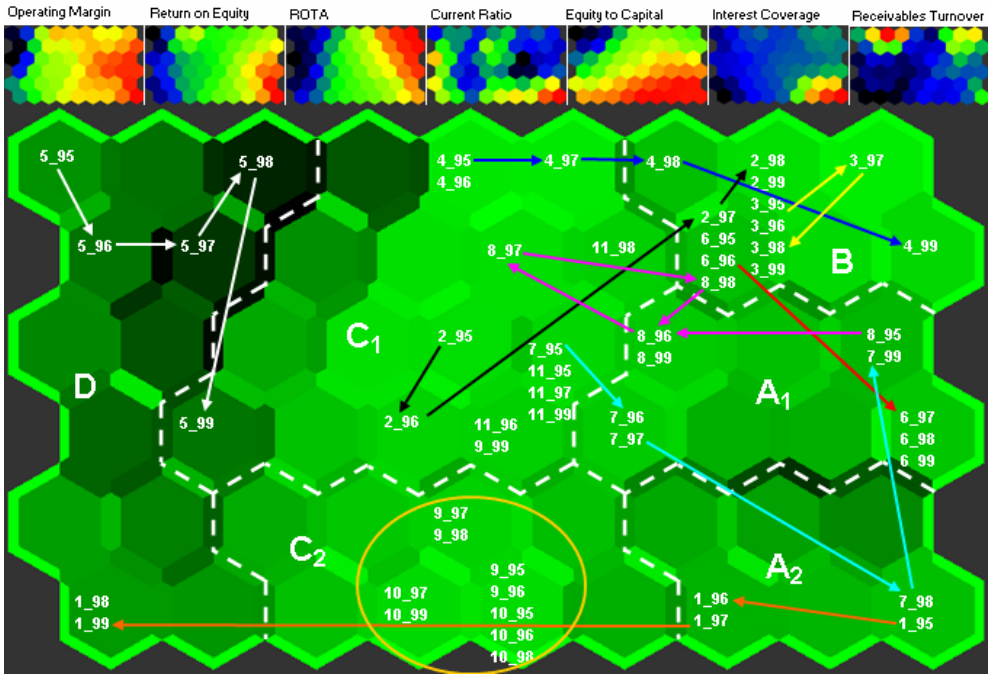
Further details in choosing the companies and how the data were collected can be found in Karlsson (2002).

4. Experiment

In this experiment we assess comparatively the financial performance of international telecommunication companies. Our results are presented in the following publications: Costea et al. (2002a, b), extended in Costea and Eklund (2004), applies SOM and the three classification techniques to assess telecom companies' financial performance, Alcaraz and Costea (2004) introduces Weighting FCM to benchmark the telecom companies, Costea and Nastac (2005) studies three factors that can affect the classification performance of ANNs in the telecom sector data. In this paper we will present how a clustering technique (SOM) and a tree-induction technique (See 5.0) can be combined to assess comparatively financial performance of telecom companies.

Firstly, we applied SOM to the telecom data set. We used data from 1995 to 1999 (462 rows) to build the SOM map (see Figure 1) and train our See 5.0 classification model and the data for 2000 for the Scandinavian companies (11 rows) to test the prediction power of the tree-induction model.

Figure 1. Final 9x6 SOM for the telecom data set with identified "real" clusters and feature planes



Source: Costea, 2005

The borders of the "real" clusters are identified by the dotted lines. Feature planes for each financial ratio are shown at the top of the figure ("warm" colours indicate high values, whereas "cold" colours indicate small values). The financial ratios are presented in Table 1. Trajectories for the Scandinavian companies between 1995 and 1999.

After we attached the classes to each data row, we applied the tree-induction classification technique See5.0 (Quinlan, 1993). The training and testing accuracy rates for See 5.0 are presented in Table 2.

Table 2. Accuracy rate validations for the classification model.

	Main dataset	Part1 (split=0)	Part2 (split=1)
Learning Sample (75%)	95,1%	91,8%	93,5%
Test Sample (25%)	87,9%	89,6%	85,7%
cross-validation	86,4%	no cross-validation	no cross-validation

Source: Costea, 2005

The validation is done according to step 5 of the methodology presented at the beginning of Section 5.2 in Costea (2005).

See 5.0 classification technique achieved high accuracy rates in both training and testing. Also, the See5.0 training accuracy rates are validated against the testing accuracy rates (small differences).

In Table 3, the class predictions based on financial data for the year 2000 are illustrated:

Table 3. Class predictions for Scandinavian telecommunications companies in 2000.

Company	OM	ROTA	ROE	CR	EC	IC	RT	label	Predicted Cluster See 5.0
Benefon	-17,03	-30,02	-74,64	1,22	25,10	-12,05	5,93	1_00	D
Doro	-2,12	-3,90	-63,70	2,24	13,87	-1,27	6,85	2_00	D
Ericsson	11,40	14,63	67,26	1,89	16,81	7,52	3,95	3_00	B
HPY	11,99	7,702	10,87	0,53	15,71	3,84	5,81	4_00	C_1
NetCom	18,77	14,77	66,37	2,75	16,02	4,14	10,10	5_00	B
Nokia	19,02	34,98	52,50	1,57	52,23	50,76	5,10	6_00	A_2
Sonera	84,98	30,11	140,16	0,80	18,47	12,77	1,08	7_00	B
TeleDenmark	29,08	22,27	49,47	1,19	36,96	6,86	2,65	8_00	A_1
TeleNor	9,91	5,58	6,77	1,02	24,53	2,00	4,42	9_00	C_1
Telia	22,21	12,08	22,40	2,38	51,02	41,57	2,52	10_00	A_2
Average	18,82	10,82	27,75	1,56	27,07	11,61	4,84	11_00	C_1

Source: Costea et al., 2002a

The financial ratios are presented in Table 1. The technique used is: Quinlan's See5.0.

These classification models can help the companies involved in the analysis in the following way: if the company predicts the financial ratios for the next time period, based on this model it can have a picture of what its position would be compared with the other companies. In other words the company would know where it would be situated on the financial performance map. Moreover, the beneficiary (the company in question) can build different scenarios regarding what happens in terms of profitability, liquidity, solvency and efficiency if some of the financial ratios are relaxed.

Another beneficiary of these models would be the potential investor that would like to invest in the telecommunications sector and would want to weigh his/her investment opportunities.

4. Conclusion

In this paper we showed how Data Mining techniques can be used to build classification models with which companies from different sectors, e.g. the telecommunications sector, can be compared based on their financial performance. In this attempt we have build a financial performance map (using the SOM clustering algorithm) and identified several financial performance clusters. Then, we have used a tree-induction algorithm, namely Quinlan's See5.0 to model the relationship between the newly-built class variable (which shows the financial position/cluster for each observation) and the financial ratios which depict four performance dimensions: profitability, solvency, liquidity and efficiency.

Our results are good with regard to the validation criteria as well as to their interpretability and practical implications.

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Financial Benchmarking
Economic/Financial Performance Classification Models
Economic/Financial/Process Variable Predictions
Further interests:
Software reliability models

JOURNAL OF APPLIED QUANTITATIVE METHODS

Interdisciplinarity – New Approaches and Perspectives in the Use of Quantitative Methods

SECURITY METRICS FOR ENTERPRISE INFORMATION SYSTEMS

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Abstract: *Managing the security of enterprise information systems has become a critical issue in the era of Internet economy. As any other process, security can not be managed, if it can not be measured. The need for metrics is important for assessing the current security status, to develop operational best practices and also for guiding future security research. The topic is important at a time when companies are coming under increasing compliance pressures that require them to demonstrate due diligence when protecting their data assets. Metrics give companies a way to prioritize threats and vulnerabilities and the risks they pose to enterprise information assets based on a quantitative or qualitative measure. This paper presents a framework for ranking vulnerabilities in a consistent fashion, and some operational metrics used by large enterprises in managing their information systems security process.*

Key words: *system security, security metrics, vulnerabilities, security management*

1 Introduction

The current strategies for evaluating or validating IT systems and network security are focused on examining the results of *security assessments* (including red-teaming exercises, penetration testing, vulnerability scanning, and other means of probing defences for weaknesses in security), and on examining the *building blocks, processes,* and *controls* (for example: auditing business processes and procedures for security policy compliance,

assessing the quality of security in infrastructure components, and reviewing system development and administration processes for security best practices).

These measurement strategies are not good enough considering higher frequency the new vulnerabilities are identified, and the shorter interval the exploit becomes available to the attackers after the vulnerability is publicly announced. As practice showed that any prevention mechanism may fail, a real-time security monitoring strategy and a set of good metrics would help both to determine the status of IT security performance, and to enhance it by minimizing the windows of exposure to the new vulnerabilities.

Metrics—measurable standards—monitor the effectiveness of goals and objectives established for IT security. They measure the implementation of security policy, the results of security services and the impact of security events on an enterprise's mission.

IT security metrics can be obtained at different levels within an organization. Detailed metrics, collected at the system and network level, can be aggregated and rolled up to progressively higher levels, depending on the size and complexity of an organization. If measurements are instantaneous snapshots of a particular measurable parameters, then metrics are more complete pictures, typically comprised of several measurements, baselines, and other supporting information that provide context for interpreting the measurements.

Good metrics are *goal-oriented* and should have the following features: *specific, measurable, comparable, attainable, repeatable,* and *time dependent*.

2. Standardization - Drivers and Results

Security performance measurement by using standardized metrics gained increasingly interest during the last years with the help of guidelines, code of practices and standards accepted widely over the world, and with the efforts of international organizations and companies. Code of practices like BS7799, ISO17799, NIST SP800-33 are useful as a starting point for security measures in organizations. They focus mainly on providing sets of controls, but the measurement of the quality and applicability of these controls is not handled in detail.

In 2004, Security Metrics (SECMET) Consortium was founded to define standardized quantitative security risk metrics for industry, corporate and vendor adoption by top corporate security officers of the sector.

Another standardization effort is led by the Metrics Work Group of International Systems Security Engineering Association (ISSEA). This group is tasked to develop metrics for Systems Security Engineering - Capability Maturity Model (SSE-CMM). SSECMM has adopted the NIST 800-55 methodology of developing security and process metrics. The work group has proposed 22 Process Areas (PA) for metrics development grouped in two sections: security base practices and project and organizational base practices.

Meanwhile, governments around the world already released laws and regulations driving and facilitating IT security measurements. Some example of laws and government regulations are: Gramm-Leach-Bliley Act (GLBA), the Health Insurance Portability and Accountability Act (HIPAA), the Federal Information Security Management Act of 2002 (FISMA) – for the US, and The Data Protection Directive 95/46/EC of the European Parliament – for the EU.

The most important methods used to develop security metrics are: the IT performance assessment methodology, the stakeholder-based model and the capability-based model.

Capability-based model is a product of SSE-CMM international metric project. It addresses the functional capabilities: protect, detect, and respond. SSE-CMM defines required performance of the best practices to generate specific results. *IT performance assessment methodology* (coordinated by US Department of Defence) has three components namely: capabilities, attribute level, and specific metrics. The attribute level addresses the requirement that support that mission and the specific metrics component addresses specific measurable activities that support those mission requirements. The *stakeholder-based model* views metrics from an organizational role perspective: stockholders, stockholders responsibility, stockholders interest and actions.

The challenge of defining security metrics lies on the problem that metrics must be quantifiable information (like percentage, average or absolute numbers) for comparison, applying formulas for analysis and tracking the changes. The result from the manual collection or automated resources should be meaningful performance data and must be based on IT security performance goals of the organization. Metrics should also be easily obtainable and feasible to measure. But research methodology plays an important role here, not to have biased data as a result; and to cover all dimensions of IT security from organizational (people), technical and operational points of view.

3. Metrics to Evaluate the Security Vulnerabilities

CERT reported in 2005 a number of 5,990 vulnerabilities, which represents an increase with 58% from 2004. To determine the urgency and priority of response to vulnerabilities, organizations need models that would convey vulnerability severity.

One such model is the Common Vulnerability Scoring System (CVSS) which was designed to provide the end user with an overall composite score representing the severity and risk of a vulnerability. The score is derived from metrics and formulas. The metrics are in three distinct categories that can be quantitatively or qualitatively measured. *Base metrics* contain qualities that are intrinsic to any given vulnerability that do not change over time or in different environments. *Temporal metrics* contain vulnerability characteristics which evolve over the lifetime of vulnerability. *Environmental metrics* contain those vulnerability characteristics which are tied to an implementation in a specific user's environment. The particular constituent metrics used in CVSS were identified as the best compromise between completeness, ease-of-use and accuracy. They represent the cumulative experience of the model's authors as well as extensive testing of real-world vulnerabilities in end-user environments.

There are seven base metrics which represent the most fundamental features of vulnerability:

- *Access vector* (AV) measures whether the vulnerability is exploitable locally or remotely.
- *Access complexity* (AC) measures the complexity of attack required to exploit the vulnerability once an attacker has access to the target system (high or low).
- *Authentication* (A) measures whether or not an attacker needs to be authenticated to the target system in order to exploit the vulnerability. (required or not required)

- *Confidentiality impact* (CI) measures the impact on confidentiality of a successful exploit of the vulnerability on the target system. (none, partial or complete)
- *Integrity impact* (II) measures the impact on integrity of a successful exploit of the vulnerability on the target system. (none, partial or complete)
- *Availability impact* (AI) measures the impact on availability of a successful exploit of the vulnerability on the target system. (none, partial or complete)
- *Impact bias* (IB) allows a score to convey greater weighting to one of three impact metrics over the other two. The value can be *normal* (CI, II and AI are all assigned the same weight), confidentiality (CI is assigned greater weight than II or AI), integrity (II is assigned greater weight than CI or AI), or availability (AI is assigned greater weight than CI or II)

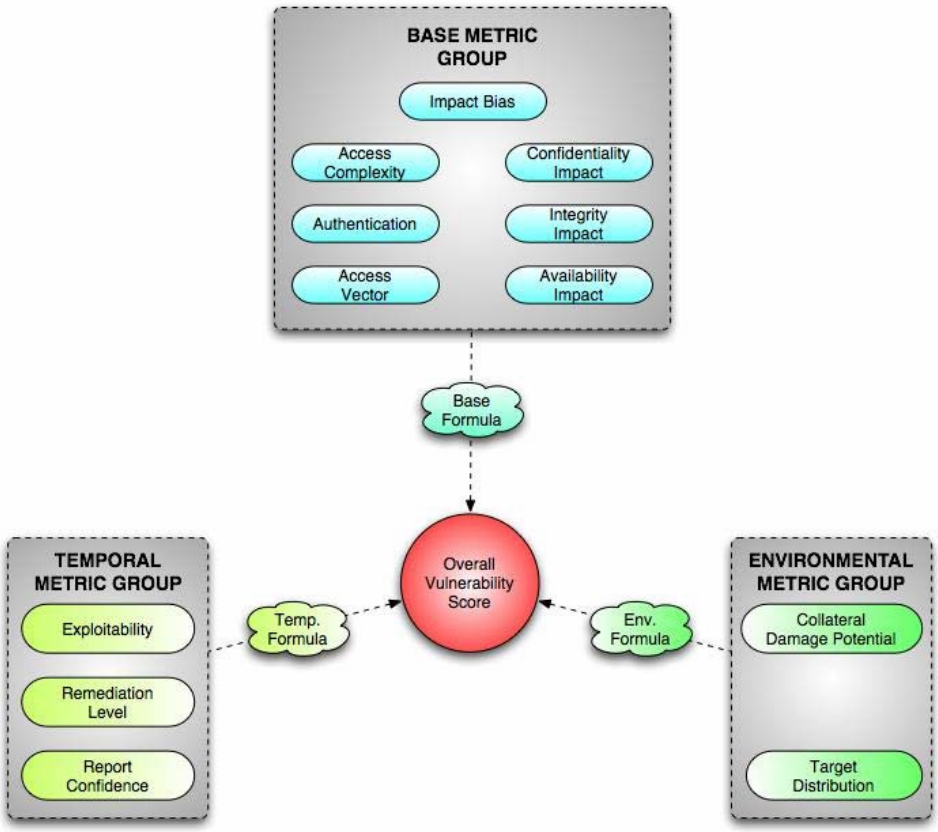

Figure 1. Common Vulnerability Scoring System Framework

The temporal metrics which represent the time dependent features of the vulnerability are:

- *Exploitability* (E) measures how complex the process is to exploit the vulnerability in the target system. The possible values are: unproven, proof of concept, functional, or high.
- *Remediation level* (RL) measures the level of an available solution. (official fix, temporary fix, workaround, or unavailable)

- *Report confidence* (RC) measures the degree of confidence in the existence of the vulnerability and the credibility of its report. (unconfirmed, uncorroborated, or confirmed)

The environmental metrics represent the implementation and environment specific features of the vulnerability.

- *Collateral damage potential* (CDP) measures the potential for a loss of physical equipment, property damage or loss of life or limb. (none, low, medium, or high)
- *Target distribution* (TD) measures the relative size of the field of target systems susceptible to the vulnerability. (none, low, medium, or high)

Scoring is the process of combining all the metric values according to specific formulas. *Base Score* is computed by the vendor or originator using the following formula:

BS= round (10 * AV * AC * A *((CI*CIB) + (II*IIB) + (AI*AIB)),

Once is set and published, the BS score is not expected to change.

It is computed from "the big three" confidentiality, integrity and availability. This is the "foundation" which is modified by the Temporal and Environmental metrics. The base score has the largest bearing on the final score and represents vulnerability severity.

Temporal score is also computed by vendors and coordinators for publication based on the following formula:

TS= round (BS * E * RL * RC),

It allows for the introduction of mitigating factors to reduce the score of the vulnerability and is designed to be re-evaluated at specific intervals as a vulnerability ages. The temporal score represents vulnerability urgency at specific points in time.

Environmental score is optionally computed by end-user organizations and adjusts combined base-temporal score based on the following formula:

ES= round ((TS + ((10 – TS)* CDP))* TD),

This should be considered the final score and represents a snapshot in time, tailored to a specific environment. User organizations should use this to prioritize responses within their own environments

CVSS differs from other scoring systems (e.g. Microsoft Threat Scoring System, Symantec Threat Scoring System, CERT Vulnerability Scoring or SANS Critical Vulnerability Analysis Scale Ratings) by offering an open framework that can be used to rank vulnerabilities in a consistent fashion while at the same time allowing for personalization within each user environment. As CVSS matures, these metrics may expand or adjust making it even more accurate, flexible and representative of modern vulnerabilities and their risks.

4. Metrics to Evaluate the Information Systems Security Controls

In most large organizations, measurements of information systems security are often conducted by separate teams that independently define, collect, and analyze technical metrics. These metrics include the numbers of vulnerabilities found in network scans, known incidents reported, estimated losses from security events, security bug discovery rate in a new software application, intrusion detection system alerts, number of virus infected e-mails intercepted, and others.

The security metrics described in this section focus on network and systems integrity and reliability. The other aspects like information asset value, loss, and opportunity cost are not subject of this presentation.

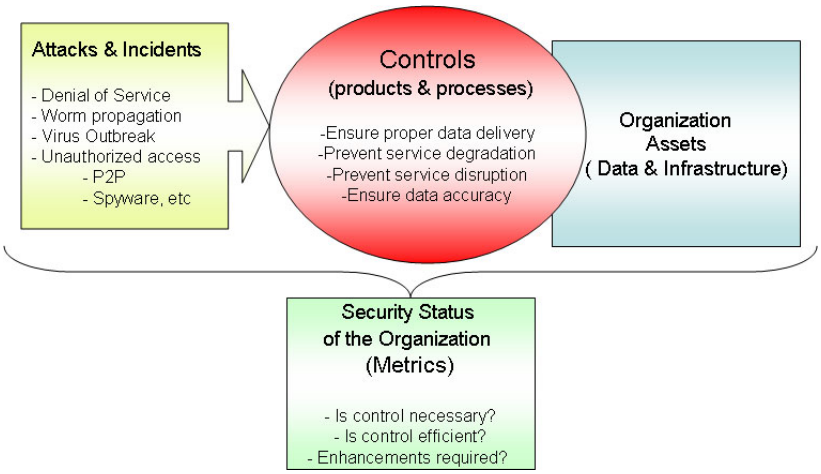

Figure 2. Network and systems security based upon metrics

Depending upon their role in interacting with the information system (stakeholder-based model), various users are concerned about different aspects of information systems security.

Executive officers, being responsible for the overall performance of the enterprise, are concerned with the ability of the information systems to support operations. Because they have the authority to allocate resources, both personnel and financial, to deal with problems of information systems security, they would be interested in answers to the following questions:

- How does the enterprise's information systems security compare to that of similar enterprises?
- How does information systems security this year compare to last year?
- Does the security spending generate the expected return?
- What are the costs and consequences of not acting to improve information systems security?

An example of the information systems security metrics used at the management level is:

- *Systems Service Level* – Percentage of time that information systems services are available for a given period of time as well as part of a time series to give historical context.
- *Network Service Level* – Percentage of time that network services are available for a given period of time as well as part of a time series to give historical context.
- *Business Requirements Met* – Percentage of business needs supported by the infrastructure and which are being met.
- *Number of Compromises* – Number of incidents during a given period in which network or systems security was compromised.
- *Organizational Impact of Compromises* – For each incident, the number of hours, time of day, and people affected by the degradation or disruption of network, systems or application services.
- *Costs and Benefits of Improvements* – The direct and indirect costs and benefits of steps that can be taken to improve information systems security.
- *Peer performances* – Service level benchmarks from similar enterprises.

Network and IT systems operations groups, responsible for infrastructure, and systems production support, are generally interested in a more granular view of the network and systems security. Whereas executives look for support for resource allocation decisions, network and IT operations people seek help to prevent, detect, and respond to network and systems security intrusions. Thus, questions of concern include:

- What computers, applications, or services are compromising enterprise's security?
- Where are they?
- How is the compromise taking place? Is it getting worse? How and where?
- How serious is the impact of the compromise?
- What technical measure can be taken to isolate and remediate the problem machines?

An example of the security metrics used by network and IT operation groups is:

- *Compliant Devices* – Percentage of network devices that are security policy compliant.
- *Managed Devices* – Counts of systems and devices under active management
- *Total Devices and Users* – Total numbers of devices and users on the network.
- *Network Latency* – Mean time for packet delivery in the network.
- *Packet loss* – percentage of packet losses
- *Network Utilization* – Bandwidth utilization at key gateways in the network.
- *Network throughput* – transfer rate for defined end-to-end network services, such as FTP, POP3, HTTP, etc.
- *Viruses detected in e-mail messages* – percentage of emails infected by viruses
- *Unauthorized accesses attempts*– percentage of unauthorized access for various network services (VPN, HTTP, SSH, etc)
- *Impact of Compromise* – Users affected (service degraded, disrupted, or otherwise compromised), number of devices participating in compromise, decrease in network performance, increase in network utilization, and increases in wait times during a network compromise.

The *network and systems security team* is typically responsible for the organization's security policies and programs. Although they may not have direct operational responsibility, they are interested in how security policies, procedures, and programs are ensuring or failing to ensure network and systems security.

- Were the computers responsible for compromising the network policy compliant?
- What changes should be made to security policies and procedures?
- If policies are not working, what behaviour changes should policy modifications be aiming to achieve?
- What technologies could help prevent future compromises?
- What was the impact of the compromise?

A sample of the security metrics used by security operation team is available below:

- *Vulnerability Counts* – Numbers of vulnerabilities found on the network, broken out by those on policy-compliant devices vs. those found on devices that are not.
- *Intrusion attempts* – Number of true/false positive/negative intrusions attempts
- *Unauthorized accesses attempts*– percentage of unauthorized access for various network services (VPN, HTTP, SSH, etc) and networked systems
- *Detailed Compliance Reports* – Numbers of users and devices compliant with each element of the security policy.

- *Incident Forensics* – The numbers of incidents attributable to policy failures vs. policy compliance failures.
- *Impact of Compromise* – Users affected (service degraded, disrupted, or otherwise compromised); data lost, modified, or destroyed; number of devices participating in compromise; decrease in network or systems performance; increase in network utilization; and increases in wait times during a network or systems compromise.
- *Suspect Port Scans* – number of suspect scans on organization's network (e.g. requests sent on port 80 to routers are suspect)
- *Remediation Time* – Time between compromise discovery and completion of system remediation.

The measurement process can be automated by implementing the network and systems security monitoring solutions. In this way, measurement errors and the subjective interpretations are eliminated, making possible for credible measurement comparisons across either time (time-series) or organizations (benchmarks).

5. Conclusions

Metrics are central for measuring the cost and effectiveness of complex security controls. Security metrics, at least such metrics trying to define a measure for the security of an entire organization, are a quite new area of research. Without widely accepted security metrics, separating promising developments from dead-end approaches would be very difficult.

Security improvement begins by identifying metrics that quantify various aspects of security for the enterprise. Given the increased number of vulnerabilities the enterprises have to handle, we presented an open source framework (CVSS) that can be used to rank vulnerabilities in a consistent fashion while at the same time allowing for personalization within each user environment.

In the last section we covered the metrics for network security from the perspective of stakeholder based model, and presented the major technical-operational metrics used by large enterprises.

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AN APPLICATION OF MINSADBESD REGRESSION

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Abstract: *In this work, an application of the modified minsadbed (minimizing sum of absolute differences between deviations) approach for a fuzzy environment is given. This type of regression was used for a statistical model with two real parameters and experimental observations which implies real numbers (see Arthanary and Dodge[2]). We develop minsadbed to minsadbesd (minimizing sum of absolute differences between squared deviations) which is more suitable for our model on vague sets. The models on fuzzy sets are described by Ming, Friedman and Kandel[3]; these authors estimate the parameters pre-eminently using least squares. We make an attempt for another method, as in the following writing.*

Key words: *mindsadbesd regression, application, fuzzy models*

1. The minsadbesd approach

Consider the model composed by n observations X_i, Y_i which are put in the forms $[\underline{X_i}(r), \overline{X_i}(r)]$, $[\underline{Y_i}(r), \overline{Y_i}(r)]$ where $\underline{X_i}(r)$, $\overline{X_i}(r)$, $\underline{Y_i}(r)$, $\overline{Y_i}(r)$ are real functions defined on closed interval $[0,1]$ (see Goetschel&Voxman[4], Ming, Friedman and Kandel [5]). The model is approximately described by a regression line given by the equation $Y = a + bX$, $(a,b) \in R \times R^*$. We put the additional conditions that the line pass through the point M of form $(M_X(r), M_Y(r))$, where $\underline{M_X}(r) = \overline{M_X}(r) = \text{const.} \in R$, $\underline{M_Y}(r) = \overline{M_Y}(r) = \text{const.} \in R$. Thus we have the initial relation $\underline{M_Y} = a + b\underline{M_X}$. For the inputs $X_i, i = 1...,n$ the distance between an observed value Y_i and the corresponding theoretical value $Y_i = a + bX_i$ is[6]:

$$D_i = \sqrt{\left[\int_0^1 \left(a + b\underline{X_i}(r) - \underline{Y_i}(r)\right)^2 dr + \int_0^1 \left(a + b\overline{X_i}(r) - \overline{Y_i}(r)\right)^2 dr\right]} \text{ if } b > 0$$

and

$$d_i = \sqrt{\left[\int_0^1 \left(a + b\overline{X_i}(r) - \underline{Y_i}(r)\right)^2 dr + \int_0^1 \left(a + b\underline{X_i}(r) - \overline{Y_i}(r)\right)^2 dr\right]} \text{ if } b < 0 .$$

Case 1: $b > 0$.

In this case we solve the problem under the assumption that $b > 0$.

The minsadbesd algorithm lead us to solve the problem

$$\min_{(a,b)\in R\times R_+^*} \sum_{i<j} \left| D_i^2 - D_j^2 \right| \quad (1.1)$$

or

$$\min_{(a,b)\in R\times R_+^*} \sum_{i<j} \left| \int_0^1 \left(a + b\underline{X_i}(r) - \underline{Y_i}(r)\right)^2 dr + \int_0^1 \left(a + b\overline{X_i}(r) - \overline{Y_i}(r)\right)^2 dr - \right.$$

$$\left. - \int_0^1 \left(a + b\underline{X_j}(r) - \underline{Y_j}(r)\right)^2 dr - \int_0^1 \left(a + b\overline{X_j} - \overline{Y_j}(r)\right)^2 dr \right| \quad (1.2)$$

For all $i < j$, $i, j = 1,\ldots,n$, we make the substitutions:

$$\begin{cases} p_i(r) = \underline{X_i}(r) - \underline{M_X}(r) \\ q_i(r) = \underline{Y_i}(r) - \underline{M_Y}(r) \end{cases}, \quad \begin{cases} P_i(r) = \overline{X_i}(r) - \overline{M_X}(r) \\ Q_i(r) = \overline{Y_i}(r) - \overline{M_Y}(r) \end{cases},$$

$$\begin{cases} p_j(r) = \underline{X_j}(r) - \underline{M_X}(r) \\ q_j(r) = \underline{Y_j}(r) - \underline{M_Y}(r) \end{cases}, \quad \begin{cases} P_j(r) = \overline{X_j}(r) - \overline{M_X}(r) \\ Q_j(r) = \overline{Y_j}(r) - \overline{M_Y}(r) \end{cases}.$$

Thus (1.2) is equivalent to

$$\min_{b\in R_+^*} \sum_{i<j} \left| b^2 \int_0^1 \left(p_i^2(r) + P_i^2(r) - p_j^2(r) - P_j^2(r)\right)dr - \right.$$

$$- 2b \int_0^1 \left(p_i(r)q_i(r) + P_i(r)Q_i(r) - p_j(r)q_j(r) - P_j(r)Q_j(r)\right)dr +$$

$$\left. + \int_0^1 \left(q_i^2(r) + Q_i^2(r) - q_j^2(r) - Q_j^2(r)\right)dr \right| \quad (1.3)$$

or

$$\min_{b\in R_+^*} \sum_{i<j} \left| a_{ij}b^2 + b_{ij}b + c_{ij} \right| \quad (1.4)$$

where

$$a_{ij} = \int_0^1 \left(p_i^2(r) + P_i^2(r) - p_j^2(r) - P_j^2(r)\right)dr, \quad c_{ij} = \int_0^1 \left(q_i^2(r) + Q_i^2(r) - q_j^2(r) - Q_j^2(r)\right)dr,$$

$$b_{ij} = -2\int_0^1 \left(p_i(r)q_i(r) + P_i(r)Q_i(r) - p_j(r)q_j(r) - P_j(r)Q_j(r)\right)dr .$$

Let $f_{ij}(b) = \left|a_{ij}b^2 + b_{ij}b + c_{ij}\right|$. For function $a_{ij}b^2 + b_{ij}b + c_{ij}$, we have $\Delta_{ij} = b_{ij}^2 - 4a_{ij}c_{ij}$.

The sign of the discriminant is unknown. We have four cases which depends on signs of a_{ij}, Δ_{ij}; consequently, the graph of $f_{ij}(b)$ has one of the forms shown in Fig. 1-4.

Case 1.1.

The "easy" case appears when all the discriminants are negative, namely $\Delta_{ij} \le 0, \forall i = 1,...,n$. In this situation the functions have the forms shown in Fig. 3 or Fig. 4.

The problem (1.4) is equivalent to

$$\min_{b\in R_+^*}\left[Ab^2 + Bb + C\right] = \min_{b\in R_+^*}\left[\left(\sum_{i<j}\left|a_{ij}\right|\right)b^2 + Bb + C\right] \quad (1.5)$$

where $B = \sum_{i<j} \pm \left|b_{ij}\right|$ (this writing means that some of the terms are positively and the others are negatively, depending on the concrete signs of a_{ij}) and $C = \sum_{i<j} \pm \left|c_{ij}\right|$.

The unique minimizing point for the function $u(b) = Ab^2 + Bb + C$ (see also Fig. 5) is

$$b^* = -\frac{B}{2\sum_{i<j}\left|a_{ij}\right|}.$$

Case 1.2.

Δ_{ij} have random signs.

The graph of the continuous function $\sum_{\substack{i,j=1,n\\ i<j}} f_{ij}(b)$ is composed from small pieces which are parts from the functions given by the equations $Db^2 + Eb + F$ where D, E, F are real numbers with general form $D = \sum_{i<j} \pm \left|a_{ij}\right|$, $E = \sum_{i<j} \pm \left|b_{ij}\right|$, $F = \sum_{i<j} \pm \left|c_{ij}\right|$ (see Fig. 6).

We consider the following sets: $S_1 = \left\{-\frac{c_{ij}}{b_{ij}} / \; for\ all\ i<j\ which\ gives\ a_{ij} = 0, b_{ij} \neq 0\right\}$,

$$S_2 = \left\{\frac{-b_{ij} \pm \sqrt{b_{ij}^2 - 4a_{ij}c_{ij}}}{2a_{ij}} / \; for\ all\ i<j\ which\ gives\ a_{ij} \neq 0, b_{ij}^2 - 4a_{ij}c_{ij} > 0\right\},$$

$$S_3 = \left\{-\frac{E}{2D} / \; for\ all\ D \neq 0, D > 0\right\}.$$

Thus the feasible set is $S = \bigcup_{i=1}^{3} S_i$ and the problem (1.4) becomes $\min_{b\in S} \sum_{i<j} f_{ij}(b)$ which is relatively easy to settle, as in Section 2.

Case 2: $b < 0$.

$$\min_{(a,b)\in R\times R_-^*} \sum_{i<j} \left| d_i^2 - d_j^2 \right| \quad (1.6)$$

gives

$$\min_{(a,b)\in R\times R_-^*} \sum_{i<j} \left| \int_0^1 \left(a + b\overline{X_i}(r) - \underline{Y_i}(r)\right)^2 dr + \int_0^1 \left(a + b\underline{X_i}(r) - \overline{Y_i}(r)\right)^2 dr - \right.$$

$$\left. - \int_0^1 \left(a + b\overline{X_j}(r) - \underline{Y_j}(r)\right)^2 dr - \int_0^1 \left(a + b\underline{X_j} - \overline{Y_j}(r)\right)^2 dr \right| \quad (1.7)$$

The problem (1.7) is equivalent with

$$\min_{b\in R_-^*} \sum_{i<j} \left| b^2 \int_0^1 \left(p_i^2(r) + P_i^2(r) - p_j^2(r) - P_j^2(r)\right)dr - \right.$$

$$- 2b \int_0^1 \left(p_i(r)Q_i(r) + P_i(r)q_i(r) - p_j(r)Q_j(r) - P_j(r)q_j(r)\right)dr +$$

$$\left. + \int_0^1 \left(q_i^2(r) + Q_i^2(r) - q_j^2(r) - Q_j^2(r)\right)dr \right| \quad (1.8)$$

which becomes

$$\min_{b\in R_-^*} \sum_{i<j} \left| a_{ij}b^2 + b'_{ij}b + c_{ij} \right| \quad (1.9)$$

if

$$b'_{ij} = -2 \int_0^1 \left(p_i(r)Q_i(r) + P_i(r)q_i(r) - p_j(r)Q_j(r) - P_j(r)q_j(r)\right)dr .$$

We denote $g_{ij}(b) = \left| a_{ij}b^2 + b'_{ij}b + c_{ij} \right|$. For function $a_{ij}b^2 + b'_{ij}b + c_{ij}$, we have $\Delta'_{ij} = b'^2_{ij} - 4a'_{ij}c'_{ij}$.

Case 2.1.

First, we consider the case $\Delta'_{ij} \le 0, \forall i = 1,...,n$.

Thus the graph of $g_{ij}(b)$ has one of the two forms shown in Fig. 3 and Fig. 4.

Then the problem (1.9) is equivalent with

$$\min_{b\in R_-^*} \left[Ab^2 + B'b + C' \right] = \min_{b\in R_-^*} \left[\left(\sum_{i<j} \left| a_{ij} \right| \right) b^2 + B'b + C' \right] \quad (1.10)$$

where $B' = \sum_{i<j} \pm \left| b'_{ij} \right|$, $C' = \sum_{i<j} \pm \left| c_{ij} \right|$.

The unique minimizing point for function $\left[Ab^2 + B'b + C' \right]$ is $b^{**} = -\dfrac{B'}{2\sum_{i<j} \left| a_{ij} \right|}$.

The approach is the same as in first case but with other coefficients.

In both situation, a is obtained from the condition that the line pass through the initial fixed point.

Case 2.2.

All the comments stored in case 1.2 keeps their validity.

For $D' = \sum_{i<j} \pm |a_{ij}|$, $E' = \sum_{i<j} \pm |b'_{ij}|$, $F' = \sum_{i<j} \pm |c_{ij}|$ we have

$$S'_1 = \left\{ -\frac{c_{ij}}{b'_{ij}} / \; for \;\; all \;\; i < j \;\; which \;\; gives \;\; a_{ij} = 0, b'_{ij} \neq 0 \right\},$$

$$S'_2 = \left\{ \frac{-b'_{ij} \pm \sqrt{b'^2_{ij} - 4a_{ij}c_{ij}}}{2a_{ij}} / \; for \;\; all \;\; i < j \;\; which \;\; gives \;\; a_{ij} \neq 0, b'^2_{ij} - 4a_{ij}c_{ij} > 0 \right\},$$

$$S'_3 = \left\{ -\frac{E'}{2D'} / \; for \;\; all \;\; D' \neq 0, D' > 0 \right\}$$ and (1.4) is equivalent with

$$\min_{b \in S'_1 \cup S'_2 \cup S'_3} \sum_{i<j} g_{ij}(b) = \min_{b \in S'} \sum_{i<j} g_{ij}(b) \quad (1.11)$$

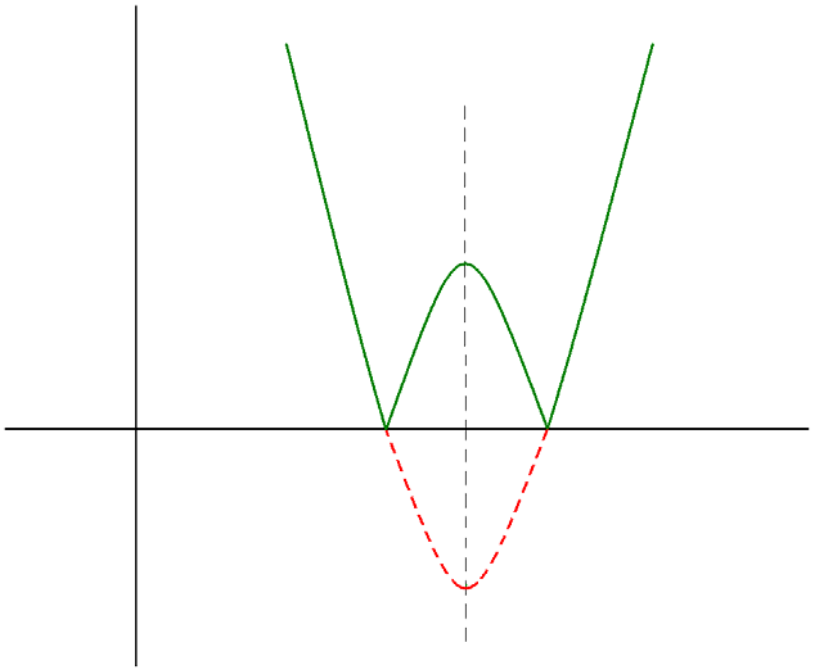

Figure 1. The graph of $f_{ij}(b)$ (green) if $\Delta_{ij} > 0$ and $a_{ij} > 0$

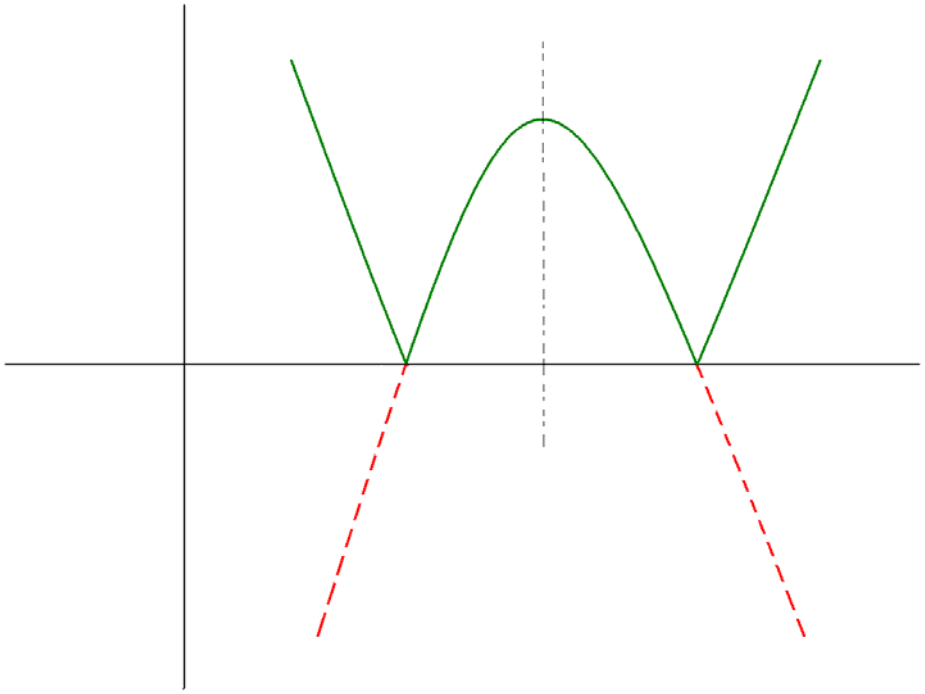

Figure 2. *The graph of* $f_{ij}(b)$ *(green) if* $\Delta_{ij} > 0$ *and* $a_{ij} < 0$

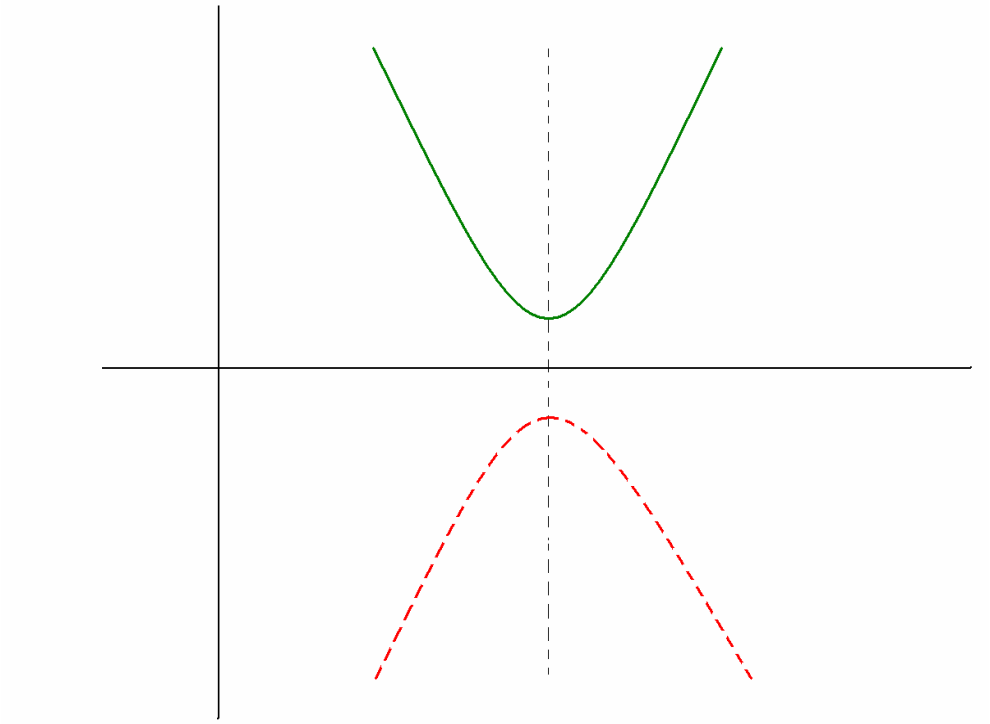

Figure 3. The graph of $f_{ij}(b)$ if $\Delta_{ij} < 0$ and $a_{ij} < 0$

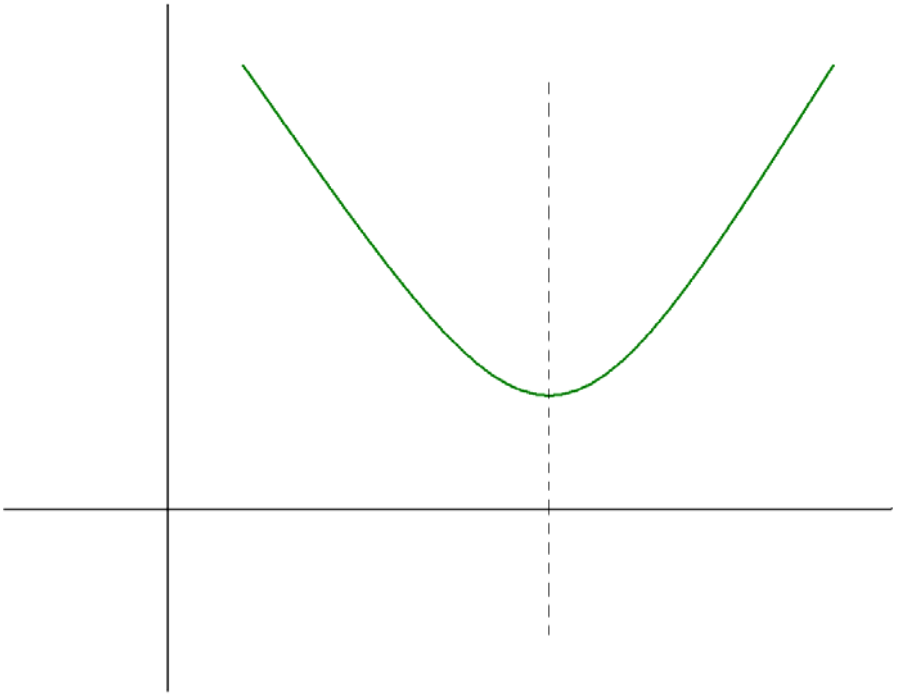

Figure 4. The graph of $f_{ij}(b)$ if $\Delta_{ij} < 0$ and $a_{ij} > 0$

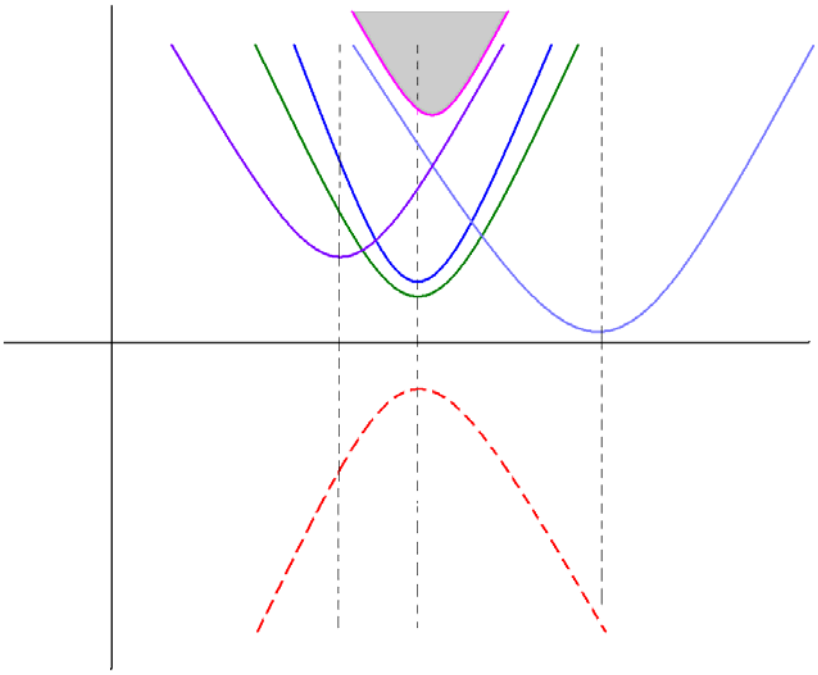

Figure 5. The graphs of the functions $f_{ij}(b)$, $\sum_{i<j} f_{ij}(b)$ when $\Delta_{ij} \leq 0, \Delta'_{ij} \leq 0, \forall i, j = \overline{1,n}, i < j$; the surface bounded by the graph of $\sum_{i<j} f_{ij}(b)$ is colored in gray

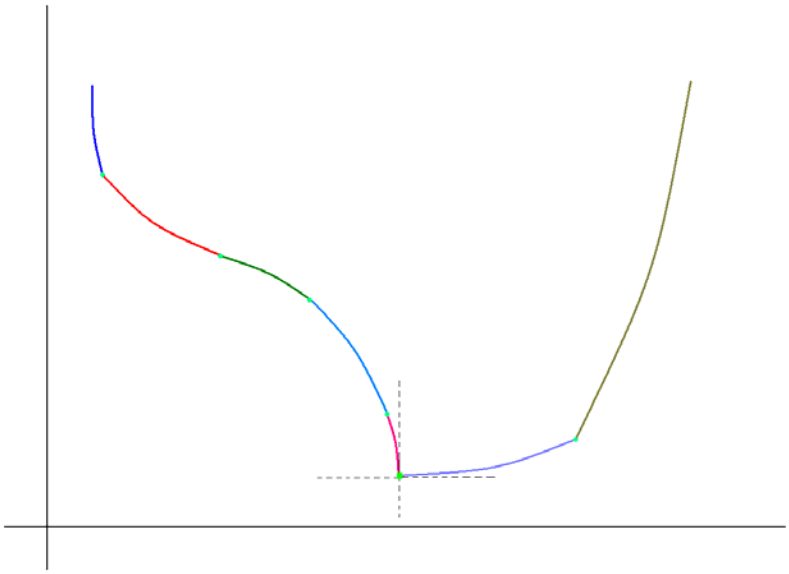

Figure 6. The graph of the function $\sum_{i<j} f_{ij}(b)$ when $\Delta_{ij}, \Delta'_{ij}\ (i, j = 1,...,n; i < j)$ have random signs

2. Example

We test the method for fixed point $M = (1,2)$ and the fuzzy data:

$X_1 = [3 - r, 3 + r]$; $Y_1 = [5 + r, 6 + r]$

$X_2 = [4r, 5r]$; $Y_2 = [4 + 7r, 10 + r]$

$X_3 = [3 + r, 7 - r]$; $Y_3 = [9r, 8 + r]$

Then

i	p_i	P_i	q_i	Q_i
1	$2 - r$	$2 + r$	$3 + r$	$4 + r$
2	$-1 + 4r$	$-1 + 5r$	$2 + 7r$	$8 + r$
3	$2 + 3r$	$6 - r$	$-2 + 9r$	$6 + r$

i	$\int_0^1 (p_i^2 + P_i^2)dr$	$\int_0^1 (q_i^2 + Q_i^2)dr$	$\int_0^1 (p_i q_i + P_i Q_i)dr$	$\int_0^1 (p_i Q_i + P_i q_i)dr$
1	9.66	32.66	16.50	15.5
2	0.58	108.66	21.00	20.00
3	43.33	55.33	46.66	36.00

and

$f_{12}(b) = |-3b^2 - 9b + 76|$, $g_{12}(b) = |-3b^2 - 9b + 76|$

$f_{13}(b) = |33.66b - 60.33b + 22.66|$, $g_{13}(b) = |33.66b^2 - 41b + 22.66|$

$f_{23}(b) = |36.66b^2 - 51.33b - 53.33|$, $g_{23}(b) = |36.66b^2 - 32b - 53.33|$.

Case 1: We search the minimizing points for the function $\sum_{\substack{i,j=\overline{1,3}\\ i<j}} f_{ij}(b)$.

Accordingly to the facts proved in the preceding chapters, namely Section 1, case 1.2, the set of feasible points is $S = S_2 = \{-6.75;-0.69;0.53;1.25;2.09;3.75\}$ (notice: for this example we obtain $S_1 = S_3 = \phi$) and the minimum is attained for $b = b^* = 2.09 > 0$. The complete solution is $(a,b) = (a^*,b^*) = (-0.9;2.09)$.

Case 2: We search the minimizing point for $\sum_{\substack{i,j=\overline{1,3}\\ i<j}} g_{ij}(b)$. Using the theoretical results obtained in Section 1, case 2.2, the set of feasible points is $S' = \{-6.75;-0.84;1.71;3.75\}$ and the minimum is attained in $b^{**} = 1.71 > 0$. This point don't fulfill the restriction concerning the sign of parameter b. From the appearance of the decreasing function $\sum_{\substack{i,j=\overline{1,3}\\ i<j}} g_{ij}(b)$ on $(-\infty,1.71)$ we conclude that the estimators for $b < 0$ are the real numbers $\beta \in V_\varepsilon(0) \cap (-\infty,0)$ where $V_\varepsilon(0) = (-\varepsilon,\varepsilon)$ and ε depends by the desired threshold of error. If $\beta_1, \beta_2 \in V_\varepsilon(0) \cap (-\infty,0)$, $|\beta_1| < |\beta_2|$ then β_1 is a better estimator.

At last, we have $\sum_{\substack{i,j=\overline{1,3}\\ i<j}} f_{ij}(2.09) = 87.44$ and $151.99 = \sum_{\substack{i,j=\overline{1,3}\\ i<j}} g_{ij}(0) < \sum_{\substack{i,j=\overline{1,3}\\ i<j}} g_{ij}(\beta)$ for all $\beta \in V_\varepsilon(0) \cap (-\infty,0)$. Thus $\sum_{\substack{i,j=\overline{1,3}\\ i<j}} f_{ij}(2.09) < \sum_{\substack{i,j=\overline{1,3}\\ i<j}} g_{ij}(\beta)$ and the final solution for this problem is $(a,b) = (-0.9;2.09)$.

3. Conclusions

From the preceding theoretical facts and numerical example we obtain the following conclusions:

1) For $b^* > 0$, $b^{**} < 0$, we evaluate $\sum_{i<j} |D_i^2 - D_j^2|$ and $\sum_{i<j} |d_i^2 - d_j^2|$.

If $\sum_{i<j} |D_i^2 - D_j^2| < \sum_{i<j} |d_i^2 - d_j^2|$ thus the solution is b^*.

If $\sum_{i<j} |D_i^2 - D_j^2| > \sum_{i<j} |d_i^2 - d_j^2|$ thus the solution is b^{**}.

2) For $b^* > 0$, $b^{**} > 0$ or $b^* < 0$, $b^{**} < 0$ it is necessary to make small supplementary calculations which implies the special properties of the functions $\sum_{\substack{i,j=1,3 \\ i<j}} f_{ij}(b)$, $\sum_{\substack{i,j=1,3 \\ i<j}} g_{ij}(b)$, as we shown in Section 2.

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THE ROLE OF MEDIA IN EMERGENCY MANAGEMENT

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Abstract: *It's very important for the government to let the public correctly understand the current conditions and guide them to create a favorable atmosphere for solution to the incident through media. Therefore, media are indispensable in the process of emergency management. But media is widely viewed as biased. We investigate the news release when an emergency incident happened based on game mode with assumptions that audiences prefer information consistent with their beliefs, and that media often slant stories toward these beliefs. We show that, competition cannot reduce bias but the price, and reader heterogeneity is more important for accuracy in media than competition. It is shown that the government should loosen the media constrain but not let go completely. Then some suggestions were given to improve the quality of media information to let the public correctly understand the current conditions and guide them to create a favorable atmosphere for solution to the incident through media.*

Key words: *Emergency Management, Media Bias, Game Model*

1. Preface

Various kinds of incidents occurred more frequently in recent years. The 911 incident happened in 2001 was one of the social security incidents while "SARS" appeared in 2003 was attributed to the public health incident triggered by bacteria. There were other kinds of emergency that had made great tragedy on human beings such as the power blackouts in August 2003 in North America and tsunami natural disasters on Indian Ocean in 2005(Ji Lei, etc. 2006). Although the probability of all these incidents is very small, the influence is tremendous. For example on 26 December 2004 the Indian Ocean tsunami killed in excess of 225,000 people and dislocated millions more in countries spread around the Oceans rim from Kenya to Indonesia. The 2001 bombing of the World Trade Center in New York generated direct and indirect losses that most probably will exceed 50 billion US Dollars. Emergency incidents have become an important restricting factor for economic and social development.

There is increasing recognition of the need for study of emergency management. Some of the EM research relates to social sciences (Hughes, 1991). This type of research focuses on disaster results, sociological impacts on communities, psychological effects on survivors and rescue teams, and organizational design and communication problems (Li Jie,2005; C. S. ReVelle, H,2005;Swersey 1994, Sherali,1997). van Wassenhove wrote six cases on Humanitarian Logistics in Disaster Situations, commenting that "the subject of disaster management is an absolutely fascinating one that is growing in importance" (Van Wassenhove,2003). Green and McGinnis (2002) provide a discussion of the broad classification of these events by causation that helped frame our investigation. Others experts also gave details on classification of emergency in incidents management (Jean Luc Wybo, Harriet Lonka, 2002; Yang Jing, 2005; Eleftherios Iakovou, Christos Douligeris, 2001).

In reality, many countries and cities have established emergency response mechanism. USA established its Federal Emergency Management Agency (FEMA) in April 1979 which should be one of the earliest in the world. Many other countries also established related organizations and systems on emergency management, including Russia, Japan, South Korea, China, etc.

The Chinese government devotes great attention to disaster reduction and has achieved significant results. The Ministry of Civil Affairs of China assumes the work of organizing and coordinating emergency relief, supervising and promulgating information on disasters, managing and distributing disaster relief funds and central government materials and monitoring their use. The Ministry divides the work of responding to unexpected natural disasters into three grades based on the scene of disaster losses, and enacted the "Work rules for response to unexpected natural disasters of the Ministry of Civil Affairs of China" in June2003. China has promulgated laws such as the "Law on Flood Control of P. R. China" and "Law on Earthquake Control and Disaster Reduction of P. R. China"

Media has also played an important role as a social force except the government. Confronted with emergency, it's very important for the government to let the public correctly understand the current conditions and guide them to create a conductive atmosphere for solution to the incident through media. Therefore, media are indispensable in the process of emergency management. For example, during the early stage of SARS crisis, the medias of our country just try to deal with crises by attempting to prevent disclosure of uncomfortable facts. And this accelerates the spread of the diseases to some extent. In the critical time that the SARS crisis transformed from incubation to outbreak, however, all the medias changed their strategies and rush on the diseases information afterwards. Unfortunately the role of medias in the crises was very limited with lack of relative independence and failed to take the initiative to cooperate with the crisis management of government. In contrast, when the 9.11 incident broke, the medias delivers all kinds of news to audiences and guide them to act rationally, avoiding rumors spread effectively. Apart from discuss such problems about who was the terrorists and what actions the government would take, American media put their emphases on appealing the public to resume normal life as much as possible. Some newspapers even call on the public to refuel, shopping and spending. On the other hand, the over exposed scene of terrorists or slaughter about the 9.11 incident may result in panic. In one word, the news media plays an essential role in emergency management, but surveys indicate that the media is widely viewed as biased (Baron, David ,1845).

In our country the media always focus on positive publicity propaganda because of media constrain, and try to avoid to disclosure bad incidents because of strict control of the press. Is that effective to put medias in competitive market? In this paper we will discuss the factor of reducing media bias.

2. Assumption

We assume that readers hold biased beliefs, which might come from their experience, knowledge education, and previous news, or maybe just from prejudices. We assume that audiences prefer to hear or read news that is consistent with their beliefs. The idea that people appreciate, find credible, enjoy, and remember stories consistent with their beliefs is standard in the communications literature (Graber, Doris,1984; Severin, Werner and Tankard,1992). Research on information processing shows that people seek information that confirms their beliefs and to be less credible when confronted with data inconsistent with their beliefs (Klayman, Josh,1995, Rabin, Matthew and Schrag, Joel,1999).

Our second assumption is that medias have bias (Hayakawa, Samuel,1990). Bias could take a variety of forms. It could be ideological, where owners, editors, or journalists present stories that support particular world views. Bias could also result from information hidden or distorted by sources or because of personal preferences of journalists. Bias could also be measured in a variety of ways. For example, bias could be measured in terms of outcomes that differ from the average. Bias can be depicted in the following example. Suppose that another 4 suspect severe acute respiratory syndrome (SARS) case was identified. What are the different ways a paper can report this number? Consider just two different ways to presents the above fact.

Headline: SARS fears grow. New data suggest the SARS is growing severe. The Bureau of Health reports that the death number of SARA case increased by 4 again in the last week, and there are another 20 persons were diagnosed as suspect SARS case. This was an ominous sign of severity of SARS. It is only the beginning of more to come.

Headline: Turnaround in sight. Is the SARS poised for an imminent turnaround? Data from the Bureau of Health suggest that it might be. Newly released figures show death number of SARS case inching up just 4 in the last week compared with 8 persons died in the week before. That's because of the effective quarantine policy.

Neither story says anything false, yet they give radically different impressions. Each sounds reasonable, but each omits some aspects of the data: the first by neglecting to mention the death number of the week before, the second by ignoring the increased number of suspect SARS case. Each slants the news by not telling the whole truth, but they slant them in opposite directions. Our model of the market for news combines the assumption of readers preferring stories consistent with their beliefs, with the assumption that newspapers may slant stories toward beliefs. We examine two crucial aspects of this environment. First, we consider two alternative assumptions about the nature of competition: monopoly versus duopoly. Our model of media competition is analogous to a Hotelling model of product placement (Drew Fudenberg,1991; Jean Tirole1998). Newspapers locate themselves in the product space resembles to their reporting strategies. Audiences' beliefs determine their "transportation" costs since they spend psychic costs of reading papers whose reporting does not cater to their beliefs. In this context, our utility function implies quadratic transportation

costs and our distribution of reader beliefs in the heterogeneous case corresponds to a uniform distribution of consumers.

3. Model Description and Analyses

Players: The players in our model are "media" and "audiences". The "media" may be the single organization in monopoly, or two corporations in competitive market, and "audience" is the potential reader of media.

Actions: "media" responses for emergency and announces its bias strategy s(d) and the price P it charges. Potential readers decide whether to buy the paper with the price P according to his belief.

Information: The media get some information about emergency incident. Because of the incomplete information and the constant variety, the media need to make some judgment by maximizing his expected utility.

3.1. Reader's Utility Function

Readers are interested in some underlying variable t which might come from their experience, knowledge education or previous news which is distributed $N(0, v_t)$. Let $p = 1/v_t$ denote the precision. Readers hold a belief about t that may be biased; beliefs are distributed $N(b, v_t)$. We assume that a rational reader's utility is decreasing with the amount of slanting. So, if he reads a newspaper, his utility is:

$$Ur = u_i^*(d) - Xs^2 - P$$

where P is the paper's price. If he does not read the newspaper, he gets utility 0.

Biased readers on the other hand get disutility from reading news inconsistent with their beliefs.

The distance between the news and the reader's beliefs, b, was measured as $(n - b)^2$. The overall utility of a biased reader is:

(1) $$U = u_i^*(d) - Xs^2 - \delta(n - b)^2 - P.$$

where $\delta > 0$ denote his preference for hearing confirming news, $u_i^*(d)$is the average function of i.

We consider two different distributions of reader beliefs, homogeneous and heterogeneous. Homogeneity means that all readers hold the same beliefs b. For example, all or nearly all Chinese believe that Taiwan is an indiscerptible part of China. Heterogeneity means that there is a distribution of reader beliefs. We assume that heterogeneous beliefs are distributed uniformly between b1 and
b2 where $b1 < b2$, and $b_2 > 0$. We denote by b* the average of b1 and b2.

In the homogeneous case, there is only one kind of reader. Bias is defined as the average amount by which the news read deviates from the data for the average reader, so we define $B_{hom} = E_d[(n - d)^2]$ to measures the average bias that readers encounter, where n is the news read by these readers. In the heterogeneous case, let n_i be the news read by reader $i \in [1, 2]$. Bias is then denoted as:

$B_{het} = \int_i E_d[(n_i - d)^2]$.

3.2. Media's Strategy

Medias are in the business of reporting news about t. They receive some data $d = t + \varepsilon$. In the above example, these data might be the death number and the suspect SARE case. We assume that the medias then report these data with a slant s, so the reported news is $n = d+s(d)$. Before seeing the data d, media announces its slanting strategy s(d) and the price P it charges. The media's utility function is (P-C)D, where D is the demand of readers. Potential readers decide whether to buy the paper with the price P. Once readers decide whether to buy the paper, the medias observes its signal d and reports $n = d+s(d)$. Readers read the news and receive their utility.

3.3. Equilibrium in Monopoly market

Here we consider the equilibrium in two conditions. One is in monopolized market and the other is in competitive market. In the first condition we suppose there is a single media, and there are two medias in the second condition.

3.3.1. Confronted with homogeneous readers

Confronted with homogeneous readers, the media's can extract all surpluses in monopolized market. He maximizes expected utility:

$\max [u_i^*(d) - Xs^2 - \delta(n - b)^2 - C] = \max u^* - X \int_d (s^*(d)^2) - \delta \int_d (d + s^*(d) - b)^2 - C$

For a given d, differentiating with respect to s, then we can get:

$Xs+\delta(d+s-b-C)=0.$

That is:

(2) $$S^*_{hom}(d) = \delta(b + C - d)/(X+\delta)$$

Input the value of s to the expected utility, we get price P:

(3) $$P^*_{hom} = u^* - X\delta[b_2 + v_d] /(X+\delta)$$

Then we can compute news he reports is:

$n = \delta b/(X+\delta)+Xd/(X+\delta)$

The reported news is a convex combination of bias and data, with weights given by utility parameters.

In this case we say the monopolist "slants towards b".

3.3.2 Confronted with heterogeneous readers

When confronted with heterogeneous audiences, the media's must first decide which one of the heterogeneous groups is its target audience when it comes to monopoly market.

Suppose medias faces a completely heterogeneous audience with $b^* = 0$. For $b^* = 0$, the monopolists profits equal to

(4) $$\pi = (P-C) * 2\sqrt{\delta}\left(u^* - \frac{\delta X v_d}{\delta + X} - P \right)$$

Let P_m be the global maximum of this function. At this maximum we get the boundary condition

(5) $$Y = \delta /\left(u^* - \frac{\delta X v_d}{\delta + X} - P - C\right).$$

So if $b2 - b1 < 2Y$, the media will monopoly the whole market. He can then get maximum profits by setting a price equal to the utility of the boundary reader. His price and strategy is:

(6) $$s^*_{het} = \delta(b - d)/(X+\delta) = -\delta d /(X+\delta)$$

(7) $$P^*_{het} = u^* - X\delta v_d /(X+\delta) - \delta^2 b2$$

If b2 −b1 > 2Y the monopolist chooses not to cover the market.

The media in monopoly market covers the market if the dispersion of reader beliefs is small enough. If beliefs are distributed too far apart, readers on either extreme will not read the paper.

3.4 Equilibrium in competitive market

We suppose there is two medias in competitive market and there are two different distributions of reader beliefs, homogeneous and heterogeneous.

3.4.1 Confronted with homogeneous readers

Case 1 In the competitive market, there are two medias confronted with homogeneous audiences. First we consider the price-setting stage with audiences is homogeneous. Let V_i be the reader's utility associated with reading news of media j. suppose $V_1 > V_2$, the price equilibrium is for media 1 to charge $V_1 - V_2$ and capture the full market, and media 2 get zero. If $V_1 = V_2$, then both medias charge C. C can be the fee for journalist or the opportunity cost for a reader to available to the media.

In the competitive market, the strategy of each media is holding constant the rival's strategy.

Any media's strategy is maximizing his expected utility:

$\max [u_i^*(d) - Xs^2 - \delta(n - b)^2 - C]$

For both media, optimal strategy is:

(8) $$S^*_{hom}(d) = \delta((b + C - d)/(X+\delta).$$

This shows that equilibrium is both medias provide equal utility, prices equal to C.

They show that, when audiences have homogeneous biases, competition does not eliminate them, it only leads to price reductions. Medias always cater to reader prejudices no matter in monopoly market or in competitive market. This means that we cannot get accuracy - even in the competitive media on information where the readers have similar beliefs.

3.4.2 Confronted with heterogeneous readers

When confronted with heterogeneous readers, the media's must first decide which one of the heterogeneous groups is its target audience in competitive market.

Firstly we calculate e the bias of the reader who is indifferent between reading the two media if media j charges P_j and has bias zj . This allows us to get the market share and the equilibrium price.

Secondly, we then calculate the best response functions for firms 1 and 2 respectively.

Suppose medias faces a completely heterogeneous audience with b* = 0 and we are in a symmetric situation where $z_2 = - z_1$, $b_2 = -b_1$. An audience with bias x receives utility:

$u^* - X\delta((v_d+e^2)/(X+\delta) - \delta^2(z_i - e)^2/(X+\delta) - P_j$

from reading paper j. If the reader with bias x is indifferent between these two papers then their utilities are equal:

$u^* - X\delta(v_d+e^2)/(X+\delta) - \delta^2(z_2 - e)^2/(X+\delta) - P_2 = u^* - X\delta((v_d+e^2)/(X+\delta) - \delta^2(z_1 - e)^2/(X+\delta) - P_1$

This equality can be simplified to:

(9) $$e = (z_1 + z_2)/2 + (P_2 - P_1)X + \delta/2\,(z_2 - z_1)\delta^2$$

Now we calculation best response price functions. Since the indifferent reader is located at x firm profits are given by:

$\pi 1 = (P_1 - C)(e - b_1)/(b_2 - b_1)$

$\pi 2 = (P_2\text{-}C)(b_2 - e)/(b_2\text{-}b_1)$

Differentiate profits with respect to each price; we can get medias' best price response. For firm 1,

$P1 = P_2/2 + (b_2+z^*)((z_2 - z_1)\delta^2/(X+\delta) + C$

$P2 = (P_1\text{-}C)/2 + (b_2\text{-}z^*)(z_2 - z_1)\delta^2/(X+\delta)$

We get:

(10) $P1 = 2(b_2+z^*)((z_2 - z_1)\delta^2/(X+\delta) + 3C/4$

(11) $P2 = (2b_2 - 2z^*/3)((z_2 - z_1)\delta^2/(X+\delta)$

The Nash equilibrium of market share can be calculated from the response functions:

$$e = z^*/3\text{-}3C(X+\delta)/8(b_2+z^*)(z_2 - z_1)\delta^2.$$

Then we can calculate each medias' bias chosen by differentiating the profit function:

$\pi 1 = P_1(e\text{-}b_1)$

$\pi 2 = P_1(b_2 - e)$

Differentiation with respect to z_1 gives:

$$\frac{\partial \pi_1}{\partial z_1} = (b2 + \frac{z^*}{3})(-z_1 - b_2) - \frac{3C}{4}$$

So $Z_1^* = 3C/8\text{-}b_2$ is bias equilibrium of media 1.Similarly bias equilibrium of media 2 is $Z_2^* = b_2 \square 3C/8$

Therefore $Z_1^* = 3C/8\text{-}b_2$ and $Z_2^* = b_2\text{-}3C/8$ is a Nash equilibrium.

Substitution the figure to profit function, prices must be equal to $4\delta^2 b_2^2/(X+\delta)$.

Finally we verify that in equilibrium, the boundary conditions of the consumer are satisfied. That is we must show that:

$u^* - X\delta v_d/(X+\delta) - \delta^2(b_2+3C/8)^2/(X+\delta) - 6\delta^2 b_2^2/(X+\delta) \geq 0$

which equivalence to:

$$b_2 \leq \frac{3C}{8} + \sqrt{\frac{1}{9}(\frac{X+\delta}{\delta}u - \frac{Xv_d}{\delta})}.$$

Now we get the medias choice in competitive market confronted with heterogeneous readers:

If $b_2 \leq \frac{3C}{8} + \sqrt{\frac{1}{9}(\frac{X+\delta}{\delta}u - \frac{Xv_d}{\delta})}$,

(12) $$S_{1\,het}^*(d) = \frac{\delta}{X+\delta}(b_1 - d_1 - \frac{3C}{8})$$

(13) $$S_{2het}^*(d) = \frac{\delta}{X+\delta}(b_2 - d_2 - \frac{3C}{8})$$

where without loss of generality we assume that firm 1 slants toward the left and firm 2 slants toward the right. They share the whole market. The opportunity cost C may affect the strategy of the media.

As in the standard Hotelling model, the media in monopoly market caters to both audiences unless they are too far apart, while medias in competitive market positions as differentiate from the other as possible and medias in monopoly market report more diverse news than in competitive market when readers are heterogeneous.

4. Conclusions

It was concluded that there are of no use to reduce bias in reporting to the median audience. Competition by itself is not a powerful force toward information accuracy. It forces newspapers to cater to the prejudices of their readers, and greater competition typically results in more aggressive catering to such prejudices as competitors strives to divide the market. By contrast, we found that audience diversity is a useful force toward accuracy. It is shown that the government should loosen the media constrain but not let go completely.

Firstly, our government should transit his mind and offer enough space to the media. Indeed, the media are an important force for the crisis management, which should not just be a speaker. Secondly the government should respect the "right to know" of the public and spurn the wrong opinion that open the disaster information to the public will lead to severe panic. Thirdly, establish information open constitution system to guarantee the information interaction smoothly and the right of media. The Government Spokesman institution offers an authoritative and credible source of information and proves to be effective in reducing media bias. Last but not the least, the media itself should also strengthen their sense of responsibility and raise the information quality to minimize the negative impact on emergency management.

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THE LARGE HOUSING ESTATES REHABILITATION POLICY IN ROMANIA. EVALUATION FROM AN INSTITUTIONAL PERSPECTIVE[1]

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Abstract: *This paper represents a part of the author's contribution to the project "The Rehabilitation of Large Housing Estates in Romania" developed under the auspices of the National Council for Higher Education Scientific Research. It addresses the relationship between housing policy and local development policy mainly from an institutional and legislative perspective, focusing on the actors involved in supporting housing and urban renewal actions in Romania. The role of local public administration is particularly envisaged, considering the authority of city councils with regard to rehabilitation of apartment block areas and, in a wider context, to urban regeneration. Case studies on two Romanian cities will be presented in order to reveal not only current opportunities but also a series of drawbacks in this process.*

Key words: *rehabilitation, large housing estates, urban renewal, local administration*

1. Introduction

At present Central and East European Countries (CEECs) display a large proportion of the housing stock as large housing estates. They were built mainly in the second half of the twentieth century in order to cover the extensive destruction provoked by the World War II on the one hand and as a response to the fast increase in the population number, industrialization, social integration and equity objectives of regional policy on the other hand. Thus the emphasis was put on building new dwellings, well equipped, offering better living conditions compared to traditional housing whereas the historic inner city areas lost a lot of their attraction (Knorr-Siedow, 1996). The good standard of social and cultural infrastructure (schools, cultural centres and clubs, medical centres, etc.) as well as the good connections created by public transportation networks with workplaces and city centres represented other strengths of these large housing estates.

Statistics shows that in 1990 approx. 170 million people from CEECs (former Soviet Union countries apart) were living in 53 million new flats located in large housing estates (LHE) As Table 1 indicates, the proportion of dwellings built between 1960 and 1990 in total

dwellings located in large housing estates varied in 1990 from 48% in former GDR to 64% in former Czechoslovakia, respectively from 18% to 56% in total existing dwellings in the same two countries.

After 1990, in the new context created by the radical political changes, economic decline, industrial restructuring, privatization, large social disparities, etc. the situation of the LHE has worsened to a great extent, displaying negative aspects in many respects such as: dwellings decay in neglected urban areas accompanied by significant cases of economic, social and ethnic segregation, the absence of energy-efficient technologies, wasteful water management systems, etc.

These problems have been addressed in a larger framework created by the new housing policies of the CEECs. They focus on the allocation of land for private housing construction, the provision of urban infrastructure, the establishment of adequate financial instruments.

Table 1. The proportion of dwellings in CEECs located in large housing estates

Country	Built between 1960-1990 (%)	% of all existing dwellings in 1990
Bulgaria	55	27
GDR	48	18
Poland	61	35
Romania	49	26
CSSR	64	56
Hungary	52	29

Source: Knorr-Siedow, 1996

In general governments aim to reduce their participation in housing financing at the same time with maintaining their influence on the market through appropriate regulations. They also support the development of housing market by ensuring the availability of construction materials, technology and credit and encouraging household savings for mortgages, etc. (Hegedus et al., 1996).

Some countries support the involvement of private sector in urban infrastructure rehabilitation whereas others consider the provision of infrastructure and basic services as a responsibility of local authorities. In both cases the improvement of urban infrastructure envisages the maintenance and improvement of water supply and water treatment, the use of sustainable energy and modern energy-saving technologies, the increase in the efficiency of heat supply systems, the setting up or improvement of the legal framework for disaster mitigation, etc.

As regards the housing stock, both its increase through new construction and the rehabilitation of the old stock (including the restoration of historical buildings) are taken into consideration.

The new framework for urban planning emphasizes the increasing responsibility of local authorities with regard to land use, finance, investment planning, urban management and housing. The improvement of tax collection in order to enhance financial resources, staff training and capacity-building programmes are considered as ways to improve the cost-efficiency of administration of human settlements (Habitat II Conference, 1996).

These overall considerations are confirmed by Romania's experience after 1989 with regard to local development policy, urban planning and housing policy.

According to the official statistics, at the end of 2004 the total number of dwellings in Romania was 8,176 thousands, of which 199 thousands of state majority ownership and 7977 of private majority ownership[3] (Statistical Yearbook of Romania, 2006). The total number of rooms was 21,054 thousands and the living floor 309,939 thousand m^2, for a population of approx. 21.7 million inhabitants.

In 2004 30,127 new dwellings were completed, of which 25,160 were financed from private funds and 4,967 from budgetary funds. The latter category had as the main beneficiary the young and low income families.

The rehabilitation of the LHE (of which almost 50% were built in the socialist period, counting for approx. one third of the existing dwellings) represents an issue of a major concern for the Romanian Government, which has included the complex, integrated urban rehabilitation of the LHE among the basic objectives of its strategy for 2005-2008, within the physical planning chapter, having the central and local public administration nominated as responsible institutions. The rehabilitation of the LHE requires a systemic approach, considering that more than half of the total Romania's housing stock has exceeded the estimated span life and the whole housing stock built before 1990 will have the life cycle completed in the next 20 years. Moreover, many drawbacks can be noticed in terms of population's comfort and functionality expectations.

This paper proposes an insight into Romania's policy regarding the rehabilitation of LHE from an institutional perspective, stressing the role of local authorities in this process. Two examples are provided in order to illustrate the problems that the rehabilitation actions have to face as well as the responses provided by local authorities as a part of their local development policy. The selected cities are Bucharest, Romania's capital city and Galati, a traditionally industrial city in the South-East region that recorded a high population growth in the '60s – '70s and beyond as a result of setting up and development of a huge metallurgic works.

2. Actors involved in the rehabilitation of LHE. The role of central and local administration

In general, the actors involved in the rehabilitation of LHE in Romania fall under the following categories:

- Central public administration ;
- Municipal and sector local public administration;
- NGOs;
- Project management teams and the multi-disciplinary work teams providing technical expertise;
- investors;
- commercial companies and public utilities providers;
- representatives of the local community:
  - owners/owners' associations;
  - tenants/tenants' associations;
  - owners of buildings and construction sites in the area;
  - users, natural and legal entities, carrying out activities in the area.

Central public administration (a major component being the Ministry of Transports, Constructions and Tourism) has the following accountabilities:

- devises the national strategy for urban rehabilitation as part of the housing strategy;
- draws up the specific legislation to facilitate restoration/rehabilitation actions;
- promotes best practice programmes in the field;
- develops fiscal policies and programmes;
- provides assistance-subsidies, fiscal deductions.

Local public administration – authorisation for the rehabilitation of LHE lies with city and town councils and in the City of Bucharest it is divided between the local sector Councils and the General Council of the City of Bucharest (CGMB).

CGMB and the Mayor of Bucharest formulate the rehabilitation of LHE policy for housing ensembles and promote specific programmes.

Local councils – according to art 95 section (2) letter c) of the Law on local public administration no. 215/2001 - approve studies, forecasts, programmes of social-economic development, land organisation and development, including regional development programmes, under the law, which are subsequently submitted for the approval of CGMB. Further on, letter i) specifies: check and approve, according to the law, zone and detail urban physical plans for the sectors and submit them to CGMB; approve, within the limits of their authorization, technical economic documentations for local investment works and ensure the conditions required to carry them out in accordance with the general urban physical plan of the city of Bucharest and related regulations.

According to the legislation in force, CGMB is authorized to check and approve city planning documentations of strategic importance. So far, the legal framework has undergone numerous modifications in terms of competence of authorization and approval of city planning documentations at zone level. Currently, local sector Councils play the leading role in the process of housing ensembles restoration.

The role of local public administration involves:

- initiation of urban restoration/rehabilitation programmes;
- adapting own strategy based on the national strategy;
- commissioning the city planning plans underpinning any restoration interventions;
- sustaining through local taxes the restoration/rehabilitation of certain zones;
- regulating the use of construction sites ;
- correlating district level with city level restoration;
- mediating dialogue between the actors involved in the restoration process;
- facilitating dialogue between the actors involved in the restoration process;
- facilitating and guaranteeing access to public funds.

Project management and the multi-disciplinary work teams design the restoration programme, coordinate, monitor implementation activities and provide technical support. Depending on the importance of the housing estate they may establish the project management team. For instance, in the case of Bucharest, the design for the restoration/rehabilitation of central city areas may be entrusted to institutions expressly set up for this particular purpose – e.g. Bucharest 2000 area.

Professional / non-governmental organisations ensure dialogue between the public administration and civil society representatives, exercise pressure, support opinion

trends or community needs in an organised form; manage community development programmes complementary to restoration programmes.

Individual apartment owners – express their needs; report dysfunctions; negotiate with programme designers; take part in restoration programmes by various legal forms of financing, have the rights and obligations stipulated by Law 114/1996 (Housing Law, amended and completed by Law 145/1999).

Owners' associations – express the joint opinions of certain groups of citizens, such as the residents of a block of flats; report dysfunctional services in the area; may exercise control over services and restoration works in the area, have the rights and responsibilities stipulated by Law 114/1996.

Tenants/tenants' associations - express individual and group requirements; negotiate programme solutions, have the rights and responsibilities stipulated by Law 114/1996.

Owners of buildings in the area – express their requirements, report dysfunctions, negotiate solutions, and have rights and obligations according to the law.

Users in the area – express their point of view on restoration programmes through representatives or associations.

Commercial companies and public utilities providers – develop rehabilitation programmes and set the parameters to be reached; provide the link between the LHE and the city; provide the financial support for the infrastructure rehabilitation in own exploitation, have rights and obligations under the law.

The extent of participation of local actors depends on the strategic importance of the area. Obviously, a central or semi-central residential area requires a greater involvement of municipal or even central administration. For example, marking the limits of central intervention areas in view of restoration in Bucharest was effected by Government Decision – the Historical Centre, Bucharest 2000.

According to the methodology for the restoration of housing ensembles, the Guide for drawing up frame programmes for complex urban rehabilitation developed by INCD-URBANPROIECT in cooperation with UAUIM and UTCB, mentioned above, proposes *four groups of actors* (URBANPROIECT, 2002):

- **community** – representatives mentioned above under the last six items ;
- **restoration forum** – a body created especially for expressing the opinions of those involved in choosing the most adequate and widely accepted solutions, made up of representatives of all the entities that are part of the local community, including representatives of the local public administration;
- **administration and multi-disciplinary team** – programme management – third item;
- **local council** – representatives elected by vote.

The same study developed by URBANPROIECT included *pilot studies* of complex city planning according to the methodology of the Guide for Drumul Taberei and Colentina-Lacul Tei districts in the City of Bucharest. The studies have been submitted for approval.

The studies reported the main dysfunctions at the level of LHE and individual housing units – block of flats, apartments. The criteria used in diagnosis analysis were:
- physical and spatial: safety, comfort, efficiency;
- management-related

The multi-criteria analysis was completed with the findings of sociological surveys by categories of subjects: block of flats administrators, resident population, business companies, non-governmental organisations, representatives of public utilities companies.

Particularities of the City of Bucharest

The restoration/rehabilitation operations are the outcome of the restoration/rehabilitation strategies developed at national or local level. In the case of the City of Bucharest, its position as the capital of the country and its aspiration to become a member of the European capitals network led to particularities in urban restoration/rehabilitation actions. The priorities of rehabilitation in the case of inhabited areas depend on their strategic importance within the urban ensemble, as well as on the requirements expressed by residents, especially in their relationship with sector administrations.

Local sector councils, through their legal competencies are closer to the interests expressed by citizens and can more easily become involved in various restoration activities. On the other hand, financial resources make them depend on national and municipal policies.

For these reasons and due to the fact that restoration/rehabilitation activities are highly complex, it was deemed necessary to set up restoration/rehabilitation forums, bringing together all the actors involved. Their purpose is to represent the interests of the local community, organise debates on the programme proposed and improve it by involving the population in all the stages of the programme, providing advisory services and mediating conflicts of interests.

The forums, as proposed in the *Guide for developing frame programmes for the complex restoration of the great ensembles of blocks of flats* mentioned above, are set up by programmes and include all the entities engaged in the restoration process.

As we have already stressed, the strategic importance of the area is decisive in determining the percentage of local actors involved. It goes without saying that a central or semi central residential area requires a greater involvement of the municipal and even central administration. For example, marking the limits of central intervention areas in view of restoration in Bucharest was effected by Government Decision – the Historic Centre, Bucharest 2000.

The housing ensembles in city districts are currently under the authority of **sector administrations**. Democratically speaking, this is extremely correct but observing technical standards requires support from higher authorities. Thus, restoration/rehabilitation interventions may be selective or questionable in terms of city planning, both technically and aesthetically. The more dynamic sector administrations, as is the case currently of sector 5, may carry out questionable actions aimed at restoring housing ensembles – whitewashing the facades of blocks of flats, without any prior repairs or analyses of sub-assemblies.

Other actions partially included in restoration measures are those related to restoration of *the central heating systems of buildings* Although this action is currently receiving national and local support, technical coordination is a must as chaotic interventions could have negative effects on the exterior of buildings. In this sense, aspects related to the proximity of residents and divergence of interests should be given careful consideration. It is a well-known fact that the introduction of individual central heating systems has generated numerous and strong disagreements between the residents of blocks of flats.

Depending on the *importance of the areas* planned for restoration a legal framework for coordination of restoration actions can be put in place. For instance, in the case of the restructured *central area* Bucharest 2000, the general opinion is to set up a specific *institutional structure*.

District residential areas require a legal and normative framework to regulate and facilitate the development of programmes area by area. In this sense, the Guide designed for this particular purpose, stresses the importance of the *technical component* of the project team as well as the significance of the forum *harmonising the interests* of the actors involved.

To get a clear picture of the requirements of the population, various methods of consultation have been proposed, depending on the level of interventions – apartment, block of flats, housing estate. *Population can be consulted* by means of:

- Questionnaire-based surveys ;
- Discussions on topics of general interest within the respective programme;
- Organising discussion-groups to include community leaders)delegates of associations) and public administration authorities, investors;
- Setting up NGOs based on community-public administration-investors partnerships to manage certain projects.

So far, actions meant to contribute to the restoration of housing estates have been carried out by involving central and local public administration with the occasional involvement of investors. *The role of civil society remains minimal for the time being*, citizens being insufficiently consulted and involved in actions related to the restoration of housing ensembles or individual collective living quarters.

Local administration plays a major role in initiating programmes and providing technical expertise. Mention should be made of the fact that any intervention at housing estate level requires the drawing up of city planning documentations which are checked and approved by local councils according to the law. These documentations provide the mainstay for restoration/rehabilitation programmes and represent a mandatory stage. They also ensure a legal framework for regional development programmes with external financing.

Within the Bucharest City Hall (PMB) city planning documentations are subject to the approval of:

- The Technical Commission for city planning, comprising specialists in the field and PMB civil servants – Directorate for city planning and land development, Chief architect;
- Technical Commission of the city local council - CULPAT- Commission for city planning, public works, land development.

According to the legislation in force, CGMB is responsible for approving only PUZ-type documentations, for buildings situated in areas of municipal interest, the remaining areas falling under the authority of sector local councils.

In recent years, the absence of coordination between the municipal and sector levels has generated uncoordinated land developments on city territory. In this sense, PMB technical departments and commissions need to increase technical control of local development as this is the optimum level of coordinating city development overall. This type of control which ensures the coordination of interventions can be applied in the stage of checking city planning documentations.

PMB can provide support for restoration actions through its own institutional structure as well as subordinated departments. One of the public services responsible for substantiating the technical-city planning decision is ensured by the **Bucharest Urban and Metropolitan Planning Centre,** which operates as public institution of public interest, being a legal entity subordinated to CGMB. The activity of the centre focuses on:

- Substantiating and devising the territorial strategy for balanced development of the city and metropolitan space on short, medium and long term;
- Developing, through specific studies and projects, the regulations and norms of city planning and land development in order to substantiate the decision of local municipal administration on development management;
- Protecting public interest and ensuring consistency in reaching public utility objectives.

The object of activity consists in drawing up/coordinating specific studies, research projects and documentation applied in the Bucharest zone, in the areas of strategic city project and planning, of structuring and managing the urban data base.

The activity of the Centre is subordinated to CGMB and is carried out in cooperation with PMB specialised directorates, with the Directorate for city planning and land development and with the Bucharest Chief Architect institution.

3. Examples of the involvement of local public administration in supporting city planning and rehabilitation of LHE

3.1. The building restoration/rehabilitation in the City of Bucharest

The development programme for 2000-2008 developed by the Bucharest City Hall includes a series of objectives such as « Urban Rehabilitation, reconstruction and regeneration in Bucharest » refers to the rehabilitation of LHE.

Actions of **urban rehabilitation** in the City of Bucharest are currently focused on three types of areas:

- Historical areas;
- Deconstructed urban areas;
- Collective housing areas.

The areas of crucial importance for the city-capital are considered to be including patrimony and local identity values and the poles of strategic development. In this sense restoration programmes with international financing for the Historic Centre area have already been initiated.

The Historic Centre Area – extending over approx. 50 ha - currently includes housing, services and culture facilities. Its main characteristic is the identity value conferred by the high density of historical monuments and environmental buildings.

Restoration programmes are maintained in accordance with European trends in the field, which promote: conservation of the buildings patrimony, traditional activities, cultural and trade activities, utilization for tourism purposes, efficient management of specific resources.

In the period 2000-2002, PMB developed in cooperation with UNDP the project *Beautiful Bucharest* with the following objectives:

- revitalisation of the historic centre – restoring facades, pavements;

- training young adults coming from children's homes to facilitate their finding jobs.

Studies carried out by PMB on this occasion revealed the complexity of issues related to urban restoration in this particular area. As a result there are now several actions focused on the historic centre of the capital city.

It should be noted that any intervention at urban area level may be carried out according to the law, only after city planning documentations have been drawn up and then approved by the local administration. In this sense, the PUZ-type city planning documentation for the historic centre has already been drawn up and approved and the intervention strategy for the revitalisation of the area is due to be completed soon.

The complex character of the intervention requires coordination of the following sector-based development policies:

- utilities and services policy;
- investment policy ;
- traffic policy;
- rent policy;
- environment protection policy;
- institutional development policy.

The possible variants of the institutional frameworks from which GMB will have to choose in the future include:

- the City Hall ensures the management of operations and the private sector operates on the basis of trade contracts in the area;
- the City Hall establishes partnerships with the private sector for the management of operations;
- a City Hall directorate becomes a commercial company with CGMB as sole shareholder for the management of operations.

There is currently an on-going project for the restoration of the historic centre with a BERD contribution totalling 9.5 million EURO. The major component of the project is the rehabilitation and extension of water, sewage, gas, electricity, telephony, pedestrian passages, and street lights systems. The completion date is set for 2006.

Restoration of destructured zones. Destructured zones are the consequence of urban interventions dating from socialist years left unfinished. The main dysfunctions are related to the deficient street network and insufficiently connected to the urban system, unused land with an uncertain legal status which impedes investments, unclear spatial and functional structure from the point of view of the Urban Planning Regulations. Interventions in areas of this kind can only be carried out following approval of zone and detail Urban Plans by CGMB and local councils, from case to case and according to the law.

Such destructured zones are to be found on the outskirts of the city, which have only recently been included in the built environment area, and in the central areas previously affected by demolition. Typical for the capital is the zone of the new civic centre known as such after the launch of the Bucharest 2000 Zone city planning competition.

The zone covers approx. 485 ha, of which 2,000 ha are free of buildings.

The basic functions are: higher standard housing conditions, services for the population and economic agents, the national-level administrative function.

City planning objectives include:

- setting up an urban pole with services of cross-municipal, national and international importance;
- reshaping the existing political-administrative centre;
- rehabilitation of destructured zones.

The rehabilitation strategy consists of:

- utilising the land potential by erecting representative housing estates;
- promoting development of profitable mixed functions (offices, trade, hotel, entertainment, culture, housing);
- increasing the attractiveness and technical-urban endowment;
- promoting competitive urban management and marketing in order to utilize the extremely high potential of the area.

Rehabilitation of LHE districts Collective, LHE areas which take the form of large ensembles of blocks of flats are to be found on the outskirts of the city or in semi central zones. They were built in the course of 3 decades, especially between 1960 and 1985, housing around 1,300,000 residents. The height of blocks of flats ranges from ground floor + 4 stories and ground floor + 10 stories. The structure is brick in the case of low buildings and reinforced concrete for high buildings.

The main dysfunctions are noticeable in the case of housing facilities, construction equipment, and city planning. They emerged as a result of the wear and tear of constructions and installations, the degradation of spaces used in common, the changing needs of the resident population:

- absence of adequate social equipment at local level;
- arid micro-climate caused by the destruction of vegetation;
- shortage of parking lots and garages;
- technical and spatial solutions which no longer meet current requirements, monotonous, unattractive aspect, disorganised facades.

City planning objectives include:

- improving the technical, functional and aesthetic quality of individual or ensemble housing units;
- improving the living, health and safety conditions of residents.

The rehabilitation strategy is focused on:

- renovation, restoration and re-configuration of the public utilities infrastructure, public transport system, personalization and differentiation of individual or ensemble housing units, creating community contact venues;
- completing the system of social-cultural facilities and equipment, correcting and adapting architectural and urban planning solutions;
- involving residents in managing collective issues – promoting modern forms of partnership between the local administration, inhabitants and residents of the housing areas.

The anticipated *effects* of restoration measures include: improved comfort for residents, adapting living quarters to meet the requirements of residents, increasing community cohesion.

The City Administration is currently focusing on strategic interventions, so the rehabilitation component has specific features Consequently, the main priorities are directed towards providing quality public services and public utilities equipment with positive impact

on housing facilities, as part of the general city planning system and as part of the structure of housing ensembles.

The programmes currently supported by PMB with own funds and co-financing include:

- improvement of the roads and motorways system;
- improvement of the water supply and sewage system;
- upgrading the heating distribution system;
- fitting blocks of flats with water and gas consumption meters.

The projects refer to:

- projects included in the Programme for the rehabilitation and modernization of the heating system in Bucharest - Programme START 1998-1999 – under implementation.
- Project for the modernization and rehabilitation of the thermal energy production and distribution system -1999 - finalized.
- Project for the modernization of the water-supply system 2000- finalized.

Other projects specific to the capital are related to the *reinforcement of housing constructions*. According to GEO 20/1994, the central administration, local city administration and residents' administration are responsible for the commissioning of expert evaluations, design and reinforcement of blocks of flats exposed to seismic risk. So far, 122 housing constructions are in different stages of intervention, and PMB foresees around 10-15 buildings per year will undergo expert evaluations. All these measures although selective interventions, are part of a programme developed at government level and are components of each and every restoration action and intervention priority respectively.

3.2. Aspects of the rehabilitation of LHE in the City of Galați

Issues related to the construction of blocks of flats in Galați. LHE in Galați can be grouped under three generations, each with its specific issues: constructions built before 1950, constructions in the period 1950-1977 and constructions built after the earthquake of 1977. All constructions are affected by the type of soil on which the city is built, clay on top with ground-water layer underneath, which has led to the flooding of basements in buildings situated in the city valley and centre – Bădălan, Port, Centru districts. The unproven explanation given by constructors is that the new blocks of flats built after 1997 have created an additional pressure in the uppermost area of the city leading to a rise in the water level in the lower part of the city, based on the principle of communication vessels.

Restoration works required for buildings erected before 1950. The main works required for these buildings include:

- Reinforcement of the resistance structure
- Changing the interior of flats to meet the current requirements of residents;
- Upgrading and supplementing interior installations based on the new land development structure;
- Restoring the vertical systematization.

The main problem with these buildings, however, is the resistance structure which is of a mixed type, as a rule, with full-brick walls and frames of reinforced concrete pillars and beams, reinforced concrete floors covered with wooden framework. Most of these buildings

will have to be demolished as they have long exceeded the life expectancy of this type of constructions. 15,000 buildings are currently in this situation.

Restoration works required for buildings erected in the period 1950-1977. Blocks of flats built especially in the first decade of the period, followed the Russian model: blocks of reinforced concrete with brick walls and large, high rooms. These blocks now require a reinforcement of the resistance structure and especially the upgrading of electric and water supply installations, and replacement of wooden window frames.

Blocks of flats built in the period 1960-1977, mainly of reinforced concrete frames with cell concrete filling, require complicated works to modify the resistance structure and upgrade water supply installations and electric systems. All of these buildings have an exterior design problem, namely ugly, scaly facades with balconies of all kinds, open, glassed-in, of various colours giving the impression of post-war debris.

Restoration works required for buildings after the earthquake of 1977. In general, these blocks of flats require only upgrading of installations in the flats, block basements and exterior renovation.

A major issue in LHE is the rehabilitation of green spaces, access lanes and main access roads.

Institutional framework for house repairs. The main institution responsible for repairs of blocks of flats (cleaning basements, insulation fitting) is the Local Council within Galați City Hall in cooperation with the administrators of residents' associations and apartment owners.

Difficulties encountered in programme development. The main difficulty in carrying out LHE rehabilitation is the chronic shortage of financial resources of the Local Council and city citizens who have been severely affected by mass restructuring in major local companies: Galati Shipyard and SIDEX Galați Steel Works.

Owing to the lack of financial resources, around 85% of citizens in Galati are struggling to earn money for food and the bare necessities for their children. Of the 85% inhabitants with limited resources, 33% are residents barely above the poverty line, failing to cover the maintenance expense in blocks of flats where they live, so APATERM Galați, the main cold and hot water supplier is due to receive from the citizens an outstanding amount of 150 billion lei of which 100 billion have been outstanding for over a year.

Since 90% of flats are private property, the owners are responsible for rehabilitation works. Lacking financial resources, the owners cannot afford to pay the expenses for such works. If the owner had been a company profiled on building administration, then it would have been responsible for all rehabilitation and maintenance works.

Proposals for the LHE rehabilitation. The measures required for the rehabilitation of LHE fall under the following categories:

a) to ensure financial resources:
- Development of financing projects by specialised companies;
- Modification of local taxes by setting taxes on the real value of the buildings (the value to be determined by ANEVAR expert evaluators), not on the historic value.

b) to harmonize the LHE:
- Setting up an authority financed by the Local Council, to draw up the plans for building façade restoration;

- Accrediting construction companies to repair LHE - accreditation includes verification of the capacity and financial reliability of such construction companies;

c) for the education of the population:

- Television programmes explaining the responsibilities of citizens living in blocks of flats (programmes for cleaning, garbage depositing, maintenance of plumbing systems, restrictions to throwing parties, etc.)
- Fines for citizens who do not observe the rules set by the community ;
- Freeing prisoners with sentences of less than three years and involving them in community service – city restoration works.

4. Concluding remarks

The rehabilitation of the LHE in Romania requires the correlated action of a large range of actors, of which central and local administration play a major role. The involvement of local communities, NGOs as representatives of civil society as well as business companies, representatives of public utilities companies, etc. is also of a great importance.

Up to present, the actions meant to contribute to the restoration of housing estates have been carried out by involving central and local public administration with the occasional involvement of investors. The role of civil society remains minimal so far, citizens being insufficiently consulted and involved in actions related to the restoration of housing ensembles or individual collective living quarters.

Therefore it is highly necessary to set up rehabilitation forums, bringing together all the actors involved. Their purpose is to represent the interests of the local community, organise debates on the programme proposed and improve it by involving the population in all the stages of the programme, providing advisory services and mediating conflicts of interests.

An effective rehabilitation should be based on integrated actions, able to take into consideration the needs of residents as well as the social and economic conditions of the surrounding community (Knorr-Siedow, 1996). Thus will be possible to restore a positive image, to support social and cultural integration and to ensure a permanent and sustainable improvement in the housing provision situation.

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[3] Romania's housing policy has aimed to diversify the housing market, state's withdrawal from ownership of housing and reduction of housing subsidies.

TENDENCIES OF INTERNATIONAL CAREER OF ROMANIAN RESEARCHERS: BRAIN DRAIN?

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Abstract: *Recent economic and technological developments have led to a growing international demand for highly skilled human resources. The increased competition for human capital has determined numerous OECD countries to take special measures for attracting and retaining human capital in such fields as: information technology, biotechnology, nanotechnology, health care, etc. These measures have stimulated the emigration of highly skilled professionals, especially from less developed to more developed economies. In this international context, in the last decade, Romanian and other Eastern European people with an academic background have had a significant propensity towards emigration. This phenomenon is not surprising if one considers the limited (although increasing) number of attractive career opportunities in this region. Consequently, numerous scientists and other highly skilled individuals from Eastern Europe have been attracted by the United States, Canada and other Western countries, which have facilitated the access of certain categories of qualified foreigners.*

Key words: *researcher, brain drain, Romania, career*

Motto: "*Forget terrorism and weapons of mass destruction. The next global war will be fought over human capital.*"
David Heenan, **Flight Capital**

1. Introduction: Study Background and Motivation

After the accession to the European Union in 2007, the number of Romanian and other Eastern European workers abroad is likely to increase (Constantin & al., 2004, p. 78+). This can have negative consequences on the quantity, quality and structure of the workforce available in their home country. For instance, Romania's internal production could diminish by more than 3%, due to emigration (Van der Putten, 2002). In addition, since most people who choose to live and work abroad are young, this phenomenon may also enhance the social problems associated with the demographic ageing in the country of origin. This threat is particularly serious for Eastern Europe, which is experiencing low fertility and high emigration rates.

Without underestimating the importance of international migration management for other occupational categories, in our opinion, a special attention should be paid to the highly skilled people, who have numerous career opportunities abroad (researchers, doctors, professors and so on). Their international experience could be a major resource for socio-economic development in their home country, to the extent their productive and creative potential is retained. Otherwise, the country of origin loses the investment made in the scientists who emigrate, while the destination countries benefit from their expertise.

In today's globalizing economy, the international migration management is a common concern worldwide. Therefore, Romania (as well as other states facing similar challenges) can learn from the experience of those countries, which have already conceived and implemented measures to attract and retain human capital, in general, and scientific talent, in particular. According to the OECD experts, these measures can be classified in several categories such as:

- *developing the infrastructure for innovation and high-tech entrepreneurship*, by setting-up (or stimulating the entrepreneurs to set up) companies in high-tech industries;
- *improving the attractiveness of public research sector*, by increasing scientists' compensation and offering more and better career opportunities in public universities and research institute;
- *repatriation schemes for post-docs and scientists*, including adequate financial incentives;
- *leveraging immigrant and Diaspora networks*, that is ensuring collaboration between the highly skilled migrants and their peers in the country of origin etc. (Auriol & al., 2002; Cervantes & Guellec, 2002).

However, the application of certain methods, which have proven to be appropriate in a specific context or country, does not guarantee similar outcomes in another context or country. Therefore, in order to design and implement efficient policies, projects and programs for a specific country, (at least) the following questions should be asked regarding the international career of scientists (and other highly skilled migrants):

- *To what extent the action plans adopted by other countries are also indicated for "country X" (in this case, Romania), in order to attract and retain scientists? Which*

are the priorities, according to the people concerned, i.e. the national scientists residing abroad (including PhD students, post-docs, professors, etc.)?

- *To what extent do scientists residing abroad collaborate with their peers in the country of origin? To what extent do they intend to return to the country of origin, on a permanent or on a temporary basis, to work there?*

However, to date, the literature on this topic consists of several articles, which reflect the personal opinions and experiences of one (the author) or a small number of Romanian researchers. For these reasons, we have launched a quantitative-qualitative study regarding the international career of Romanian researchers.

2. Research Hypotheses and the Relative Importance of Various Factors Influencing Romanian Researchers' Professional Emigration

Several Romanian researchers have pointed out various challenges faced by the research activity in their country. According to them, Romania's attractiveness for scientists depends on finding suitable solutions to the identified problems. A central concern refers to the insufficiency (doubled by the inadequate allocation) of financial resources for research. In certain specializations, such as genetics or chemistry, the equipment, as well as other technical and material resources are particularly important for successful research. These remarks form the basis of our first hypothesis, that is:

Hypothesis 1: *A major determinant of Romanian researchers' emigration, especially in certain domains of activity, is represented by the insufficient funding, technical and material resources allocated to research in their home country.*

Nevertheless, the lack of adequate resources is not the only problem faced by the research sector in Romania. Therefore, other factors may have a considerable impact on Romanian researchers' decision to pursue career opportunities abroad. Indeed, an international career involves certain risks and sacrifices, which are usually accepted by ambitious individuals, highly motivated to further their development, to get an intercultural experience and/or a better salary and benefits. Hence, our second hypothesis is the following:

Hypothesis 2: *The type of work, getting better opportunities for professional development and advancement, a better compensation package and/ or gaining international experience represent, for the majority of the researchers, factors with a considerable impact ("high", "very high" or "crucial" importance) in their decision to work abroad.*

Prior to this research, we have conducted several exploratory interviews, involving Romanian PhD students and post-docs at Leiden University and Technical University Delft (The Netherlands). These interviews revealed that, after leaving their country, Romanian PhD students and post-docs in The Netherlands had a limited relation or no relation with their former university and colleagues in Romania. On the other hand, the experts in expatriate management recommend keeping in touch with the migrant workers, in order to stimulate their return in the home country / organization. Hence, the third hypothesis states:

Hypothesis 3: *The relations between the Romanian researches working abroad, on the one hand, and universities, research institutes and scientific community in Romania, on the other hand, are, in general, limited. This is correlated with a low interest of Romanian researchers residing abroad to return and work in their home country.*

Remark: Since most people invited to answer our questionnaire are members or collaborators of "Ad Astra Association", we have also expected our study to reveal that "Ad Astra" is an important way to keep in touch with the Romanian scientific environment, while residing abroad.

Based on the international studies in this field, the "migrant workers" integrate gradually in the host country's socio-professional environment; at the same time, their "links" to the country of origin diminish. This process is accompanied by increased legal rights in the host country (usually, after 5 or more years of continuous residence). Consequently, we assume the following:

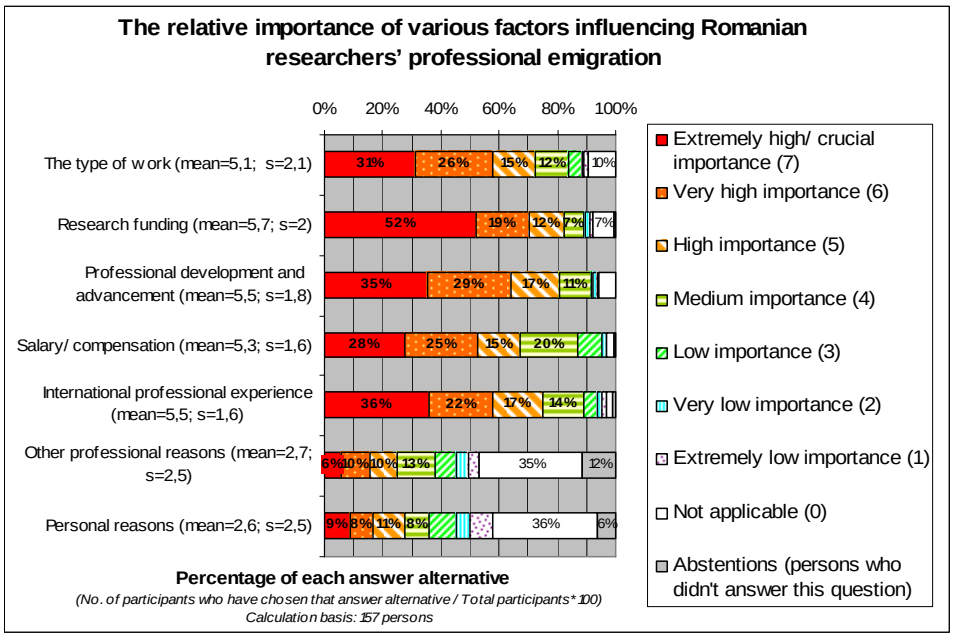
Hypothesis 4: *The majority of Romanian researchers, particularly after a few years of work outside their home country, prefer to extend their stay abroad, usually in the same host country.*

Nevertheless, the scientists' emigration is not necessarily a (total) loss for the home country. The international experience proves that highly skilled migrants could contribute, in a way or another, to the socio-economic development of their country of origin. Usually this involves their return in the home country, for professional reasons, either on a permanent or a temporary basis.

Figure 1 below summarizes the respondents' reasons for working abroad.

As anticipated (see Hypothesis 1), *the insufficient resources allocated to research in Romania ("research funding") represents the most important reason for researchers' emigration* (71% stating is was "crucial" or "very important" in their decision to work abroad).

Figure 1.



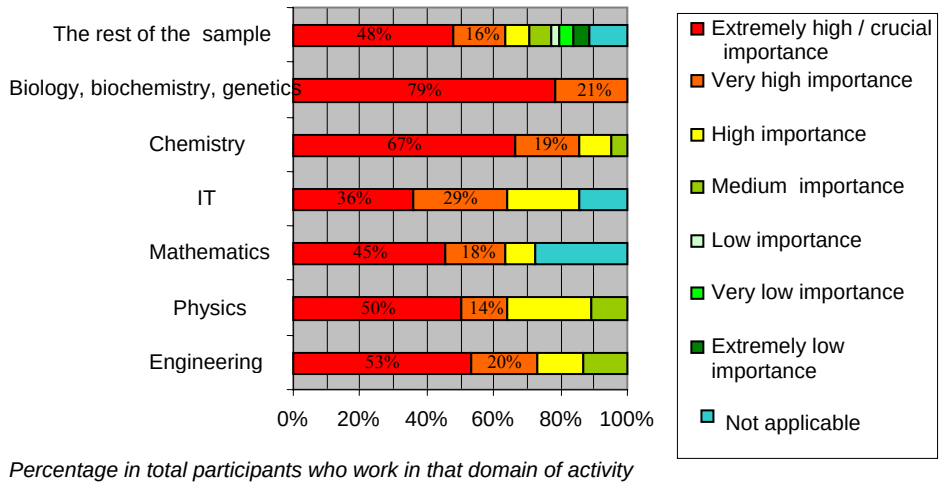
Remark: "s" represents "the standard deviation"

The relevance of "research funding" differs from one scientific domain to another. Thus, all respondents specialized in biology, bio-chemistry or genetics appreciated this factor as having an "extremely" or a "very" important role in their decision. This factor had a similar role for 86% of chemists (see *Figure 2*). Furthermore, the overwhelming majority of participants working in chemistry or biology (including bio-chemistry and genetics)

considered "extremely" or "very" important to enhance "technical and material resources for research" and to increase "research project funding", in order to motivate scientists from abroad to return to Romania.

On the other hand, a considerable percentage of mathematicians (27%) and IT specialists (15%) were **not** influenced in their decision to emigrate by the limited research funds in Romania (see *Figure 2*). Since excellence in mathematics and IT does not require as many resources as research in chemistry, bio-chemistry, genetics and biology, in general, this finding is not surprising. Nevertheless, almost two thirds of the IT and mathematics specialists considered the "insufficient research funding" in Romania as playing a "very high" or even a "critical" role in their decision to work abroad. Moreover, virtually all of them think this factor needs to be ameliorated in order to stimulate Romanian scientists' repatriation.

Figure 2. The importance of "research funding" in the participants' decision to work abroad - differentiation on domains of activity



According to our expectations (see Hypothesis 2), besides the insufficient funding of researches in Romania, there are other reasons why Romanian researchers choose an international career, instead of working in their home country. For instance, getting "an international professional experience" seem to be "very" or "extremely" important for a considerable number of Romanian highly skilled migrants (58% of our sample).

Sixty four percent declared that getting better "opportunities for professional development and advancement" had a "crucial" or a "very important" role in their decision to emigrate. Interestingly, our study reveals a statistically significant correlation between this factor and "promoting clear and objective assessment criteria in the Romanian research system", as a way to attract Romanian scientists towards their home country (χ^2 = 111,9574; p = 0; 42 degrees of freedom; critical value for p=.01 (1%): 0.0) – see *Table 1*. Hence, the following conclusion: the ambitious researchers, which are keen to learn and grow professionally, are highly interested in the objectivity and transparency of the research evaluation. Therefore, improving this dimension of the Romanian research system (i.e. the

quality of assessments) is an essential prerequisite for stimulating the repatriation of talented scientists from Diaspora.

Table 1.

Number participants who indicated the corresponding answer alternatives		The importance of "promoting clear and objective assessment criteria in Romania's research system" for stimulating scientists' repatriation						
		Extremely low/ Not significant	Very low	Low	Medium	High	Very high	Extremely high/ crucial
The importance of "opportunities for professional development and advancement" in respondent decision to work abroad	Not applicable	1	0	0	0	2	1	4
	Extremely low	0	0	0	0	0	1	0
	Very low	0	0	0	0	1	1	0
	Low	0	0	1	0	0	0	0
	Medium	1	1	0	3	3	4	5
	High	0	1	0	1	1	8	15
	Very high	1	0	0	1	4	9	**29**
	Extremely high/ crucial	2	0	1	2	4	9	**36**

As indicated in *Figure 1*, almost three quarters of participants gave a considerable importance ("high", "very high" or "extremely high") to "the type of work". In other words, not having the opportunity to perform "a similar or an equally interesting work" in their home country, has substantially influenced many scientists' decision to emigrate. Finally, getting a better salary/ "compensation package" is another important motivator for Romanian researchers' professional emigration. 68% of our sample indicated this factor had a "high", a "very high" or an "extremely high" importance in their personal decision to work abroad. In conclusions, the survey outcomes confirm the first two research hypotheses.

3. The Relations with the University/ Research Institute, Former Colleagues and the Scientific Environment in Romania, while Pursuing a Career Opportunity Abroad

After leaving Romania, two-thirds of participants kept in touch with their former university or research institute ***and*** (some of) their former colleagues. However, less than a quarter (23%) considered that relation "substantial and quite frequent". As expected (see Hypothesis 3), most participants had "limited relations" with their former university/ research institute (44%), or kept in touch only with some of their former colleagues (25%). Other 8% did not maintained contact with their former university/ institute or colleagues in Romania.

While abroad, the relation with the former university/ research institute and/ or colleagues in Romania, consisted of: discussions regarding new developments in one's domain of activity (40% of respondents); discussions about socio-economical, political, and/or cultural developments in Romania (37%); consultation-collaboration on professional topics (35%); discussions/ information about career opportunities in Romania (27%); none of

the issues mentioned above: it was simply a friendship or a "courtesy" relationship (20%). Three quarters of the respondents[4] indicated only one or two of the answer alternatives mentioned above. However, 14% of the respondents mentioned also "other professional aspects". Most of these people declared they maintained a substantial relation with their former university/ research institute in Romania.

The category "other professional aspects" include a variety of elements such as[5]: making donations of scientific articles and books to former colleagues, to the university or to a library in Romania; publishing scientific articles and/ or books, in collaboration with colleagues from Romania; intermediating professional visits for former colleagues/ professors to their host university abroad, thus facilitating the exchange of experience and future collaborations; helping colleagues from Romania to find career opportunities abroad etc.

While pursuing a career opportunity abroad, 25% of participants did not keep an active interest in the scientific developments in Romania. Other 60% indicated one or two of the following answer alternatives: "I have kept in touch with Romania's scientific community through Ad-Astra" (32%)[6]; "I have participated in workshops, conferences and other scientific events in Romania" (30%), "I have not kept in touch with the Romanian scientific community, but I read about scientific developments in Romania" (28%), "I have collaborated in research projects in Romania" (16%). About one fifth of the respondents declared they kept in touch in "other ways", such as[7]: personal relations with members of the scientific community in Romania (including, in some cases, former professors or colleagues); communication through e-mail; mutual visits, common workshops and conferences; direct contact at international congresses; publications in Romanian magazines (either scientific or general interest magazines) etc.

An analysis of the data indicates a significant correlation between:

a. (the intensity of) the relation with one's former university/ research institute and colleagues, while pursuing a career opportunity abroad, and
b. one's preference to work in Romania, upon completing his/her current projects in other countries (see *Table 2*).

Considering the entire sample (the respondents who answered both questions, irrespective of their country of residence – see the numbers in **bold**), the correlation between the two variables presented in *Table 1* is statistically significant (Total $\chi^2 = 17.32$; p=0.044; 9 degrees of freedom; critical value for p=0.05 [5%]: 16.919). Consequently, the scientists who intend to return to Romania have maintained stronger relationships with colleagues in Romania then those who do not intend to return. Indirectly, this finding leads us to the following conclusion: *the percentage of people who prefer (and tend to) remain abroad is likely to diminish, to the extent a relation is maintained between them and their former university/ research institute and colleagues in the home country.*

Table 2.

No. participants who answered both questions (out of which ... persons in Romania)		**Upon completing my current professional projects, I prefer to work in Romania**				
		Fully agree: My 1st choice	Partially agree: My 2nd choice	I do not agree	I don't know yet	***Total***
While abroad, have you kept in touch with your former university/ research institute and/ or with your former colleagues in Romania?	a) **Yes,** I have had **substantial and quite frequent relations** with my former university/ institute and colleagues	**4** (1)	**17** (4)	**2**	**6** (2)	***29*** *(7)*
	b) **Yes,** I have kept in touch with my former university/ institute and colleagues, **but to a limited extent**	**10** (5)	**21** (2)	**18**	**16**	***65*** *(7)*
	c) I have NOT maintained a relation with my former university/ institute, but I kept in touch with my colleagues	**2**	**9** (1)	**6**	**16** (2)	***33*** *(3)*
	d) **No**, I have NOT kept in touch either with my colleagues or my former university/ institute	**0**	**4**	**2**	**3** (1)	***9*** *(1)*
	TOTAL	***16*** *(6)*	***51*** *(7)*	***28***	***41*** *(5)*	***136*** [8] *(18)*

As anticipated in Hypothesis 3, *the participant preference for a career in Romania is weak*. Only one tenth indicated working in Romania as a first choice. The preference towards working in Romania is lower amongst the respondents who reside abroad. 24% of them declared they "did not agree" to return and work in Romania, upon completing their current projects. Most respondents residing abroad (two thirds) "partially agree" with the idea of working in Romania or "did not make their minds up".

Amongst the respondents residing in Romania (see the numbers written in parentheses in *Table 2*), one third would prefer a career abroad, as a first choice, but none of them excludes the option of remaining and working in their home country. While pursuing a career opportunity abroad, *more than three quarters of this group* kept in touch, to a more or less extent, with both their university/ research institute and colleagues in Romania.

A complementary analysis can be made based on the data presented in *Table 3*. This reflects the answers given by the researches who didn't keep in touch with the scientific developments in Romania, on the other hand, and the rest of the sample, on the other hand. The numbers in parentheses represent the respondents residing in Romania. The numbers in bold represent total participants (irrespective of their country of residence).

The information in *Table 3* confirms the previous conclusions, respectively: *the preference for working in Romania is weak, especially amongst those researchers who did not keep in touch with Romania's scientific environment, while pursuing a career opportunity abroad*. Thus, only 36% of this group (4+9 respondents) declared Romania was an option for their professional future. An almost equal number of people in the same group (12 out of

36 respondents, that is 33%) did "not agree" to return and work in Romania, after completing their current projects abroad.

Table 3.

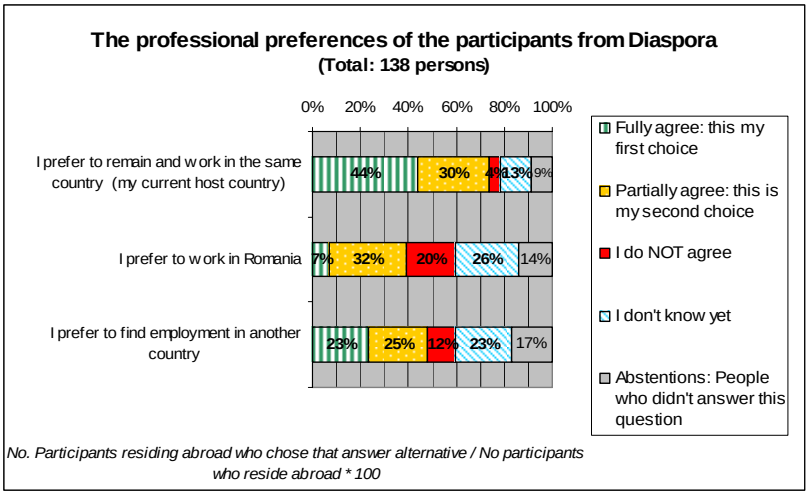
Total No. participants who answered both questions (out of which ... persons in Romania)		**Upon completing my current professional projects, I prefer to work in Romania**				
		Fully agree (My 1st choice)	Partially agree (My 2nd choice)	I do NOT agree	I do NOT know yet	***TOTAL***
After leaving the country, how have you kept in touch with the scientific develop-ments in Romania?	**a) I have NOT kept in touch with the scientific developments in Romania**	**4** (1)	**9** (1)	**12**	**11** (1)	***36*** *(3)*
	The rest of the sample (people who kept in touch with the scientific community in Romania, or got informed, in a way or another, on Romania's scientific developments)	**12** (5)	**43** (7)	**16**	**30** (4)	***101*** *(16)*
	TOTAL	***16*** *(6)*	***52*** *(8)*	***28***	***41*** *(5)*	***137*** *(19)*

On the other hand, more than 50% of those participants, which kept in touch with Romania's scientific environment, showed interest in working in Romania. Not surprisingly, in most cases, this option was a "second choice" for the people concerned. On the positive side, only 16% of this group (16 out of 101 respondents) disagreed with the idea of working in their country of origin, after completing their on-going projects. Also, the majority of the participants who returned to Romania (16 out of 19 individuals) kept in touch with the scientific developments in their home country, while working or studying abroad.

4. The Participant Career Plans: Preferences upon Completing the Current Projects

Most researchers residing abroad prefer to remain and work outside Romania, in the same host country (the country in which they currently reside) or in a third country (neither Romania, nor their current host country). Only 7% of respondents "fully agreed" to return and get employed in Romania, after completing their current projects abroad (see *Figure 3* below).

Figure 3.



As expected (see Hypothesis 4), the propensity towards remaining and working in the same host country increases with the period of time spent abroad. Thus, when dividing the participants residing abroad in three groups, based on the time spent outside Romania, one gets the following results regarding the statement "I prefer to remain and work in the same country") – option "Fully agree: this is my first choice" (see *Table 4*).

Table 4.

Period of activity abroad (No. years)	Total respondents in each time interval [9]	No. respondents who chose the option "Fully agree"	Average time spent abroad: no. years (X)[10]	Respondents who chose "Fully agree" / Total group (Y)
Under 5 years	44	15	3.386	0.34
5 - 10 years	56	28	7.071	0.5
10-15 years	21	14	12.5	0.66

The correlation coefficient between the variables "X" and "Y" in *Table 2* is not only positive, but also very high (r = 0.995), allowing us to draw the following conclusion: *the more time spent abroad, the higher the percentage of people who prefer to remain in the host country in which they reside*.

One the other hand, the percentage of participants, whose first preference is to work in a "third country" (neither Romania, nor their current host country), tends to decrease in time, reaching the lowest value in the "7-10 years" interval. Consequently, the percentage of survey participants, which prefer to continue working abroad, either in the same country or in a third country, does not differ substantially, based on the period of time spent abroad. *Irrespective of how long their international experience has been so far, more than half of the Romanian researchers from Diaspora prefer to remain and work abroad* (the average percentage for the entire sample is about 60%).

As expected, the tendency to extend one's activity outside Romania is higher (71%) amongst the researchers with an extensive international experience (more than 10 years). However, one fact we did not anticipate (see Hypothesis 4) is the high percentage (73%) of people with little international experience (less than 3 years), which prefer to remain and work abroad, after completing their current professional projects.

Besides the action measure specified in the questionnaire, attracting and (re)integrating scientists in the Romanian research system involves, according to our participants, efforts towards[11]:

- *Improving the academic and research system*, by: involving in Romania's education and research reform a number of personalities who have clearly demonstrated professional success, according to internationally accepted criteria; changing the attitudes and mentalities in the academic and research system; creating a scientific and moral meritocracy in the Romanian universities; making job promotions based on the individual's international scientific merit; improving the research funding system, with an accent on flexibility, transparency and objectivity; correctly defining the research activity: where, how and by whom it should be done; automatically recognizing the university degrees earned in USA and Western Europe etc.
- *Creating "de novo" a "system of excellence",* including: elite research institute, having world-class human, technical and financial resources; a National Institute for Multidisciplinary Research; a national agency for leveraging the research results; incubators of start-ups etc.
- *Stimulating the entrepreneurial activity and "private research" sector* by: a) facilitating the access to financial resources for entrepreneurs and b) improving the legal framework.
- Other action directions: about 20 suggestions have been made. They refer to a large variety of issues. Some recommendations are quite specific, while others are more general, such as: "accepting and supporting the principle of intellectual freedom".

Remark: The most frequent comments were geared towards the amelioration of the existing research and academic system in Romania. Several participants recommended setting up "de novo" a "system of excellence" in research. We think these two approaches are not mutually exclusive. Actually, they can be used as complementary action strategies.

5. Final Remarks and Recommendations: A Brief Discussion from the International Career Management Perspective

The international work experience provides the scientists with the opportunity of expanding their know-how and know-who, which in turn could bring important benefits for their organization and country of origin. Such benefits may consists in enhancing research productivity and quality, better connecting the internal research activity to the international scientific circuit and, ultimately, stimulating the national economic development, in general.

However, such outcomes occur to the extent the scientists' international professional mobility is managed according to the interests of their organization and country of origin. In the case of many states, including Romania, this involves simultaneous efforts in two directions, that is: a) limiting the permanent emigration amongst the most talented individuals and b) stimulating the transfer of capital and expertise from highly skilled migrants towards their country of origin.

A key prerequisite for attracting researchers towards Romania (and/or other developing country) consists in ameliorating their work conditions and career opportunities

in that country. As this study has confirmed, reaching this goal involves more (and better) investments in the research sector. However, certain improvements can be made from the point of view of the international career management. In this sense, the universities, research institutes, the Ministry of Education and Research, other governmental and nongovernmental organizations should consistently and systematically apply (some of) the "retention measures" recommended by the experts in expatriation management[12].

First of all, it is necessary to *keep in touch with the (national) scientists residing abroad*. As suggested by one of our survey participants, this requires to set up – and regularly up-date – a special database, including the highly skilled migrants' contact information and specialization. While abroad, these individuals should be informed about scientific and cultural events in their country of origin, projects they could cooperate in, and so on.

Maintaining a relation with the scientific environment in the country of origin (through collaborations in national and international projects, professional visits, common conferences, symposia and workshops etc.) is positively correlated with the likelihood of coming back, upon completing one's on-going projects abroad. Furthermore, these relations facilitate the exchange of experience between the scientists from Diaspora and their peers in the home country. Since most researchers work in developed countries, such exchange could bring major advantages to their country of origin. Regarding this issue, our study revels the following:

- Although only 30% of respondents participated in workshops, conferences and other scientific events in Romania, 77% considered this was a way to capitalize on Romanian scientists' international experience, to the benefit of their country of origin.
- Only 16% of participants collaborated in projects in Romania, while 71% declared such collaborations would be beneficial to Romania.
- 81% thought the scientists from Diaspora should be invited to give presentations (in workshops, laboratory classes etc.) at universities; however, only a couple of respondents declared they made presentations in a Romanian university, while abroad.

This comparative analysis underlines the need for organized and systematic efforts, at university and institute level, for stimulating (temporary, short-term) collaborations with the Romanian scientists residing abroad. This is particularly important because many talented Romanian nationals might not return for a full-time job in Romania (see *Table 2*).

Nevertheless, two thirds of survey respondents "did not make their minds up" or declared their return to Romania would be "a second choice". In our opinion, the repatriation of (some of) these individuals can be stimulated by providing them with correct and prompt information regarding various career opportunities in Romania (e.g. vacant positions in their field of expertise). Unfortunately, only 27% of participants in this study declared they had discussions with their former colleagues about possible career opportunities in Romania.

Apparently, after 3-4 years of activity abroad (towards the end of a PhD programme, for instance), a slightly higher percentage (15.4%) of Romanian researchers prefer to return to their country of origin, *as a first choice*. Although most of the respondents in this group (38.5%) didn't make their minds up, *relatively* few of them (less than 20%) "did not agree" to work in Romania, upon completing their current projects (see *Table 5*).

Table 5.

Period of time spent abroad	Upon completing my current professional projects, I prefer to work in Romania				Total
	Fully agree: this is my 1st choice	Partially agree: this is my 2nd choice	I do NOT agree	I do NOT know yet	
Under 3 years	6.7%	33.3%	40%	20%	100%
3-5 years	**15.4%**	26.9%	19.2%	38.5%	100%
5-7 years	9.1%	33.3%	24.3%	33.3%	100%
7-10 years	4.5%	45.5%	27.3%	22.7%	100%
More than 10 years	4.3%	56.6%	8.7%	30.4%	100%

Consequently, the *repatriation efforts have the highest chance to succeed when directed towards those researchers, which have been abroad for 3-5 years*. After spending more years in a foreign country, the highly skilled migrants become gradually integrated in their new professional and socio-cultural environment. Not surprisingly, the perspective of returning to their home country becomes, for many of them, "a second choice".

Numerous suggestions and comments made in this survey belong to researchers whose coming back to Romania is only "a second choice". To the extent their recommendations are applied, it is likely that Romania becomes "a more attractive option" for scientists, either for temporary collaborations, or for regular, full-time jobs.

Some ideas can be implemented as such, while others may be modified, to a more or less extent, according to the national strategy and priorities in the research and development sector. For instance, the suggestion regarding the automatic recognition of university degrees obtained in Western Europe and USA could be amended as follow: "the automatic recognition of graduate degrees obtained at *top 100* universities abroad (including, among others, ‹A-universities› in USA as well as well-known universities in Europe). The list of eligible universities will be periodically up-dated and communicated to the Romanian nationals, which are studying or are planning to study in universities abroad."

Considering the current problems in Romania's (and other developing countries') research system, any action plan directed towards scientists' repatriation may have limited impact. Therefore, ***in the short term***, we recommend to stimulate and facilitate temporary, short-term collaborations between researchers and academic personnel in the country and their peers abroad. This can be done by: creating part-time jobs in universities/ research laboratories for scientists residing abroad; organizing international conferences, symposia and workshops in the country concerned; inviting highly skilled migrants (and their foreign colleagues) to collaborate in projects in that country and so on.

In the medium to long term, a more radical approach should be adopted, for a better integration of the national academic and research system in the international scientific circuit. For a maximum efficacy, this approach should have both a financial dimension (adequate investment in research) and a "cultural" dimension (changes in mentalities, attitudes, criteria used for performance assessment, promotions, compensation etc.). Based on the participants' input, this is extremely important for enhancing the research sector and attracting scientists (both national and foreign scientists) towards Romania (and other countries faced with similar challenges).

A complementary requirement refers to the implementation of special action plans for encouraging the repatriation of highly skilled migrants and facilitating their socio-cultural and professional reintegration in the country of origin. In the case of Romania, certain steps

have been already taken into this direction. For instance, in December 1999, the International Research & Exchanges Board (IREX) Bucharest have launched the "Return to Romania" Program, meant to help Romanians returning from studies in the United States to find rewarding careers in their home country[13]. Another notable example refers to the "Online Project for the Romanian Scientific Community", initiated by the "Ad-Astra" Association. However, much remains to be done. The actions taken at organization level (professional associations, institutes etc.) should be stimulated and complemented by government initiatives.

6. Study Limitations & Further Research Directions

This study revels a significant correlation between the preference to return and work in Romania, on the one hand, and the relations with one's former university/ research institute, colleagues and the scientific developments in the home country, on the other hand. However, further research is necessary to better understand the impact of the relation type and quality (intensity, consistency, frequency, means of communication etc.) on the propensity to return in one's home country.

The period of time spent abroad is strongly correlated with Romanian scientists' career preferences. One could expect their professional preferences to be conditioned by a variety of situational and personal factors. These variables may include certain characteristics of the host country[14], the researcher's specialization (domain of activity), his/ her life stage and family situation, and so on. It was not our objective to identify the independent and/ or moderating variables, which influenced the Romanian scientists' decision to remain abroad, upon completing their on-going projects. Another study should tackle this issue.

Finally, additional research is necessary to better define the ideas presented in this report. This is important because our study reveals substantially different view points on certain issues. For instance, while some respondents consider "an excellent compensation" to be necessary for attracting scientists from Diaspora to work temporarily in Romania, others argue that the title "professor" would be the most important motivator in this respect (the money earned as a part-time professor in Romania being less relevant).

The repatriation measures should be gradual and "selective", encouraging first and foremost the return of the best scientists, in the priority (or "key") fields of interest for the country. Therefore, it is important to better understand their expectations. Thus, a more in-depth, sector-based research, involving (selected) scientists in certain domains of activity could help determine the priorities for Romania, in order to design efficient action plans. Last, but not least important, the (re)integration issue into the Romanian professional and socio-cultural environment needs additional attention/ future investigations.

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[4] This question did NOT apply to those participants who chose the option *"No, I have not kept in touch either with my former university/ institute or colleagues in Romania",* when answering the previous question.

[5] This list includes the most frequent categories of answers. For instance, six participants mentioned they made donations of books and/ or scientific articles; five participants claimed they published in Romania etc.

[6] Since almost one third of the sample indicated this answer alternative, we can conclude that "Ad-Astra" is an important way to keep in touch with the Romanian scientific environment, while residing abroad.

[7] These are the most frequent answers given by the participants.

[8] The rest of the sample did not answer (at least) one of these two questions.

[9] Only 121 participants, which completed this question, were residing abroad when the study was conducted.

[10] "X" is calcultated as an arithmetic mean, considering the middle point of each time interval and the number of participants in that group. For instance, based on the questionaire, the interval "5-10 years" is made up of two sub-intervals (5-7 years) and (7-10 years), having as middle point 6 and 8.5 years, respectivelly. There are 32 respondents in the first group and 24 respondents in the second group (sub-interval). Therefore, the average number of years spent abroad by the respondents, which spent abroad 5-10 years, is calculated as follow: (6*32+8.5*24)/(32+24)=7.071years.

[11] This is a synthesis of the most frequent comments and suggestions made as "other possible approaches".

[12] See, for instance, "Repatriation Planning Checklist" by Charlene Marmer Solomon (1995) and

"The Art of Coming Home" by Craig Storti (2001).

[13] See http://www.itcnet.ro/irex/irex_eng.html

[14] For instance: the host country's immigration and naturalization policies and practices, its strategy and policies in the field of research and development, its socio-cultural and economic particularities etc.

JOURNAL OF APPLIED QUANTITATIVE METHODS

ON QUALITY AND MEASURES IN SOFTWARE ENGINEERING

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Abstract: *Complexity measures are mainly used to estimate vital information about reliability and maintainability of software systems from regular analysis of the source code. Such measures also provide constant feedback during a software project to assist the control of the development procedure. There exist several models to classify a software product's quality. These models often include different measures and on their basis it is established a degree to which the product satisfy each quality attribute. Each model can have a different set of attributes at the highest level of classification, and also, the attributes can be defined differently at all levels. Actually, more and more activities are based on computer programs and they become highly dependent on their quality. In principle, everyone agrees that quality is important, but few agree on what quality is. In this paper, we will present the most important models and standards for measuring software quality. Afterworlds', we will give some metrics for software complexity and we will explain its relationship with the quality.*

Key words: *quality, source code, ISO, metrics, cyclomatic complexity, complexity, testing, reengineering*

1. Introduction

The problem of quality's evaluation is quite an old one; it was approached long time ago and led to the publication of the first quality standards by ISO (International Standards Organization) since the late 80's. The goal of these standards was to eliminate products amateurism by certifying some of their values or qualities. Nowadays, the quality control methods are more and more implemented in all companies in order to provide products and services in conformity with the clients' demands. Organizations all over the world are more and more concerned with the raising of software products quality, which may lead to success in many directions, from programmed microwaves to watches and toys. The quality, when present, is transparent, but easily recognizable when missing.

Software complexity is one branch of software metrics dedicated to direct measurement of software quality attributes, being distinct to indirect software measures such as reported system failures, project milestone status, etc.

Complexity measures are mainly used to estimate vital information about reliability and maintainability of software systems from regular analysis of the source code. Such measures also provide constant feedback during a software project to assist the control of

the development procedure. During testing and maintenance, complexity measures are providing detailed information about software modules to help pinpoint areas of potential instability.

There exist several models to classify a software product's quality. These models often include different measures and on their basis it is established a degree to which the product satisfy each quality attribute. Each model can have a different set of attributes at the highest level of classification, and also, the attributes can be defined differently at all levels.

2. General quality standards

Different people may have different views on what software quality is. For some, it is a largely aesthetic and practical issue, dealing with the question of how efficiently and elegantly, a computer program performs a task and source code looks. For others, quality is defined as strict conformance to requirements and absence of bugs. In both cases, there are sets of practices that are either required, or highly useful in this pursuit.

Thus, the standards have been introduced in the attempt to assure some universal reference systems. They are used on a large scale since they assure a background for the organizations to define a quality model for a software product. This way, however, each organization has the possibility to specify with precision its own quality model. This can be done by establishing some reference values for the attributes quality.

In accordance with ISO 8402, the quality is in fact presented by a set of characteristics, which can be divided as follows:

- Economic characteristics: expressed by means of costs, resources economies, as well as productivity and growth performance.
- Social and psycho-sensorial characteristics: manifested by rendering profitable the creative elements, by eliminating the routine and the stereotypy as well as by operators assisted training;
- Technical characteristics: presented in the specialized literature and very well systematized by ISO 9126 - a standard that exclusively deals with the software systems evaluation.

Among the quality characteristics, there are a lot of subordination relations, the interdependence, hierarchy, unit, decomposition, and the complexity of these relations leads to the quality characteristics assembly to make up a system. The quality characteristics are aggregates of the quality attributes, which correspond to actual properties that the programming systems must have.

Further on, in this article, one will analyze the technical characteristics due to the fact that these are most important for software systems evaluation.

3. ISO 9126 - International standard for evaluating software products

In 1991, the ISO published its first international consensus on the terminology for the quality characteristics for software product evaluation (ISO 9126 / 1991). From 2001 to 2004, the ISO published an expanded version, containing both the ISO quality models and inventories of proposed measures for these models. The standard is divided into four parts which addresses, respectively, the following subjects: quality model, external metrics, internal metrics, and quality in use metrics:

- Quality models - ISO 9126-1.

- External metrics - ISO TR 9126-2.
- Internal metrics - ISO TR 9126-3.
- Quality in use metrics - ISO TR 9126-4.

Internal metrics are those that do not rely on software execution (static measures) while external metrics are applicable to running software. Ideally, the internal quality determines the external quality and this one determines the results of quality in use.

The quality model established in the first part of the standard, ISO 9126-1, classifies software quality in a structured set of factors as follows:

- Functionality - A set of attributes that bear on the existence of a set of functions and their specified properties. The functions are those that satisfy stated or implied needs. This characteristic has the following attributes: Suitability, Accuracy, Interoperability, Compliance, Security;
- Reliability - A set of attributes that bear on the capability of software to maintain its level of performance under stated conditions for a stated period of time. This characteristic has the following attributes: Maturity, Recoverability, Fault Tolerance;
- Usability - A set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users. This characteristic has the following attributes: Learnability, Understandability, Operability;
- Efficiency - A set of attributes that bear on the relationship between the level of performance of the software and the amount of resources used, under stated conditions. This characteristic has the following attributes: Time Behavior, Resource Behavior;
- Maintainability - A set of attributes that bear on the effort needed to make specified modifications. This characteristic has the following attributes: Stability, Analyzability, Changeability, Testability;
- Portability - A set of attributes that bear on the ability of software to be transferred from one environment to another. This characteristic has the following attributes: Installability, Conformance, Replaceability, and Adaptability.

The sub-characteristic *Conformance* is not listed above and applies to all characteristics. Examples are conformance to legislation concerning *Usability* or *Reliability*.

Each quality sub-characteristic (as Adaptability) is further divided into attributes. An attribute is an entity which can be verified or measured in the software product. Attributes are not defined in the standard, as they vary between different software products.

ISO 9126 distinguishes between a defect and nonconformity, a **defect** belongs to the application space being the nonfulfilment of intended usage requirements, whereas **nonconformity** is defined upon the application specification space and is defined as being the nonfulfilment of specified requirements.

4. Software complexity measures

Software measurement method is a rule designed for assigning a number of identifier to software in order to characterize it. It is essential to distinguish between the characteristics which one would wishes to measure and the way by which this characteristic is evaluated and appreciated. Code complexity, as an example, is a characteristic used to describe a piece of a code. There are many different measures to evaluate this characteristic. One could find in literature measures as the number of lines code lines, testability, easiness

in fixing error, code understandability and many other ways used to evaluate code complexity.

The term software complexity means mostly the degree to which a system or component has a design or implementation that is difficult to understand and verify (testable). Still, there is no total consensus concerning this definition, another interpretation sees the complexity as a measure of the resources expended by a system while interacting with a piece of software to perform a given task. If the interacting system is a programmer, then complexity is defined by the difficulty of performing tasks such as coding, debugging, testing or modifying the software.

All these definitions associate the software complexity with the difficulty or performing a task on the software. An implicit assumption is that software complexity correlates well with the work effort (man-hours) required developing or maintaining the software.

Among the most well-known attempts to measure the complexity are: Software Science, which deals with the difficulty of understanding the code, Cyclomatic Number, which deals with the code's complexity structure, and Information Flow, which deals with the relation between modules. During the last years, six metrics have been proposed to measure some baselines in terms of Object Oriented Design, like Number of Class, Number of Children, Depth of Inheritance Tree etc.

5. Complexity, Reengineering and Testing

There is in common usage hundreds of software complexity measures, ranging from the simplest, such as source lines of code, to the complex, such as number of variable definition/usage associations. It is essential to use a low complexity subset of these measures for implementation. One of the most important criterions for metrics selection is uniformity of usage. One can read mostly in all papers that the key idea here is *open reengineering*. The reason that makes *open systems* so popular for commercial software applications stems in the fact that the user is guaranteed a certain level of interoperability - it means that the applications work together in a common framework, and software systems can be ported across different hardware platforms with minimal effort. Complexity measurement using metrics is a primary request, but open reengineering extends to other modeling techniques such as flow graphs, structure charts, and structure-based testing. Common complexity measures as the *Halstead Software Science* metrics are a significant step up in value. Halstead measures were introduced in 1977 and have been used and experimented with extensively since that time. They are one of the oldest measures of program complexity. By counting the number of total and unique operators and operands in the program, measures are derived for evaluating program size, programming effort, and estimated number of defects. Halstead metrics are, in fact, independent of source code format, so they are able to measure intrinsic attributes of the software systems. Halstead metrics are considered by several authors as being a little bit controversial, especially in terms of the psychological theory behind them, but they have been used productively on many projects. The main weakness, however, is that the derived mathematical formulas of the main Halstead metrics are considerably unconcerned from the measured code, so there isn't a strong prescriptive component.

One can identify code of an application as being potentially unpredictable, but the Halstead theory doesn't say much about how to test it, if it is testable, or how to improve it, if one proves to be necessary. Despite these limitations, Halstead Software Science metrics are very helpful and constructive for identifying computationally-intensive code with many dense formulas, which represent possible sources of inaccuracy or errors that other complexity procedures are likely to miss. However, their properties are well-known and, in they have been shown to be a very strong component of the *Maintainability Index Technique* measurement of maintainability method.

The McCabe *Cyclomatic Complexity Measure* is very flexible and extensively used for software systems complexity evaluation, mostly for existing ones. It measures the number of linearly-independent paths through a program module. The McCabe complexity is one of the more widely-accepted software metrics; it is intended to be independent of language and language format. The complexity number is generally considered to provide a stronger measure of a program's structural complexity than is provided by counting lines of code, previously used. It is widely proposed as the foundation of every software complexity tool. It may be considered a broad measure of soundness and confidence for a software system. This complexity measure is based purely on the code's decision structure. It makes this method to be uniformly applicable across projects and languages being completely insensitive to cosmetic changes in code. Many studies have reported its correlation with errors in software code, so it is used to predict reliability. More significantly, experimental studies have shown that the risk of errors is rising for functions having cyclomatic complexity over 15, so one could consider it as a validated threshold for reliability screening. If a function has a cyclomatic number of 15, there are at least 15 (but probably more) execution paths through it. More than 15 paths are hard to identify and test. Functions containing one selection statement with many branches make up an exception. Also, this assessment can be performed step by step during development and can even be estimated from a detailed design. Considering a specified software module, one can easily calculate cyclomatic complexity, in a manual way, by counting the decision constructs in the code. This approach allows building up continuous control during project development, so that unreliable code is prevented early at the unit development stage. A reasonable upper limit cyclomatic number of a file is 100. Using automated tools one can verify code compliance at any stage of the project development. McCabe's cyclomatic complexity measure gives precise testing rules. Most complex function being most error prone piece of code has to be first considered in order to receive required testing.

One of the most successful measurement concepts, used for quantitative productivity levels is function point metrics. Software measure based on *function points* techniques (FP) reflects the user's view of a system's functionality and gives size as functionality. One unit (the function point) represents the amount of information processing that a module offers the user. The unit is viewed separately from the way in which the information processing is carried out in principle. This concept was introduced in the mid-1970s when IBM commissioned engineer Allan J. Albrecht and his colleagues to explore software measurement and metrics. IBM was motivated for this assignment by the growing impact of software quality within the company tied with the difficulties and obvious limitations of the ubiquitous *line of the code* metrics, used before.

Functional point data has two targets. First one is an estimation variable used mainly to evaluate the size of each software module, while the second one is intended as a

baseline metrics collected from older projects developed by same team and used conjunctively with estimation variables helping to devise cost and effort projections. Function points are categorized into five groups: outputs, inquiries, inputs, files, and interfaces. Basically the approach proceeds to identify and count of unique function types:

- external inputs (file names, as example);
- external outputs (e.g. reports, messages);
- queries (interactive inputs needing a response);
- external files or interfaces (files shared with other software systems);
- internal files (invisible outside the system).

Function point metrics extended among many companies because they did provide substantial benefits to their users. The first benefit of function point metrics is that they are offering substantial ability to the software industry in order to carry out economical based studies for developed products [05, 09, 10, and 24]. These metrics have become the standard for studying topics associated with software, including but not limited to:

- Outsource contracts;
- Quality baseline and benchmarks ;
- Process improvement economics;
- Litigation analysis;
- Productivity baseline and benchmarks.

Function points are powerful metrics but successful usage of them is not a trivial task. Accurate counting of function points metrics require good training. Main feature of function point metrics is the fact that them are able to measure economic productivity or the defect volumes found in software requirements, design, and user documentation as well as measuring coding defects.

6. Conclusions

The quality of software is given by its capacity to be used effectively, efficiently and comfortably by any user, for a set of goals, in the specified conditions. The quality characteristics of a software product are described by a set of standardized properties described by the International Standards Organization (ISO). For example: the functionality, the reliability, usability and the others attributes of ISO 9126 on which the users are concerned.

The software complexity is highly connected with its quality for a simple reason. After the initial developing phase of a piece of code, one usually invests a lot in the maintenance and permanent updating of the respective software. In order to ensure the quality of a software program, one needs to have a good capacity to maintain and better organize the code sources. A program with an advanced complexity will always need big investments to permanently guarantee services in conformity with the client's demands.

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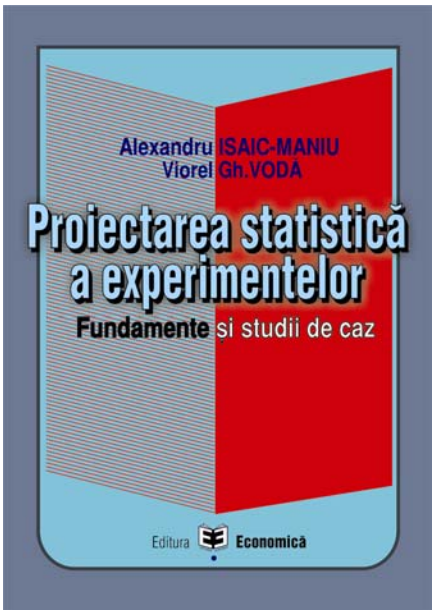
Key words: statistical experiments, experiments design, ANOVA, DOE, case studies, Alexandru Isaic-Maniu, Viorel Gh. Voda

Book review on
STATISTICAL EXPERIMENTS DESIGN. FUNDAMENTS AND CASE STUDIES ("PROIECTAREA STATISTICA A EXPERIMENTELOR. FUNDAMENTE SI STUDII DE CAZ")
by PhD Alexandru ISAIC-MANIU and PhD Viorel Gh. VODA
Editura Economica, Bucharest, 2006
Forewords by PhD Marius IOSIFESCU, vice-president of Romanian Academy of Science



The book is – as the forewords author's underlines – the first heavy monograph in Romanian on experiments design using statistical-probabilistic tools for analyses and interpretation.

The approach is set on multiple perspective: historical, philosophical, methodological and an applied one.

The two authors, well-known in qualitology, start – in a original manner – from an essay of our great poet and philosopher Lucian BLAGA (1895-1961) named „The Experiment and the Mathematical Spirit" („Experimentul si spiritul matematic") published at Humanitas, Bucharest in 1998. In this essay Lucian BLAGA launches the idea about a methodological couple between experiment (as an act or a physical element) and mathematical tool (as an abstract entity) for the analyses and interpretation.

Following this line, the authors research the nature and consequences of interferences between the experiment and thinking scheme which is frequently named as statistical. It starts with vocabulary terms (as: experience, experiment, experimental environment/ lab, level, block, factor, replica etc.) and it continues with the history of

„planned" (designed) experiments which gain a high level with the famous Britain scholars Sir Ronald A. FISHER (1890-1962), Frank YATES (1902-1994), William Sealy GOSSET (1976-1937) inside of Agricultural Laboratory for Experiments from Rothamsted. Next, the authors show in an exhaustive manner the DOE methodology (Design of Experiments) and adding toolbox which consists in ANOVA (Analysis of Variance) methods.

The book also presents some new approaches on problems like: reliability experiments, experiments theory of Genichi TAGUCHI, EVOP, the relations between DOE and ANOVA with so called SSM (Six Sigma Movement).

The V-th Chapter consists in 10 case studies on different areas such as chemistry, metrology, machine making etc that forms a valuable tool for qualitology.

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Key words: Quantitative approach, Religious phenomena, Censuses, Non-parametric regression, Stratified regression, Romania, Non-parametric statistics, Religious studies, Claudiu Herteliu

PhD Thesis Review on "STATISTICAL ANALYSIS OF RELIGIOUS PHENOMENA EVOLUTION IN ROMANIA" [2]

by Claudiu HERTELIU

"Statistical analysis of religious phenomena evolution in Romania" was elaborated by Claudiu Herteliu, under supervision of PhD, Univ. Prof. Alexandru Isaic-Maniu, in the Academy of Economics Studies in Bucharest, and it was presented for public criticism on the October, 30th 2006, with the permission of the Cybernetics, Statistics and Informatics Faculty.

The thesis's main objectives are to set up a set of statistical indicators in order to analyze the religious phenomenon evolution, with practical application

The PhD thesis consists of seven chapters that cover both theoretical aspects, and a practical application.

In the Introduction, Mr. Herteliu presents the knowledge status of the analyzed domain, within both national and international frameworks. Very interesting definitions concerning the phenomena linked with „the religious market" are presented in this section. The economics specifics methods that could be successfully used in the religious domain are, also, analyzed.

The general context regarding religious phenomenon is described in the first chapter. The author has realized an approaching from historical perspective, with a short focalization on the Max Weber's ideas. The historical context concerning Romania is analyzed taken into account the role of the orthodoxy as an important pillar in the Romanian history.

The statistical methods used to collect information about religious phenomena are shown in the second chapter.

Mr. Herteliu proposes, in the 3rd chapter, a complex and complete system of statistics indicators in order to analyze religious phenomena. The indicators grouped in six categories: context indicators; primitive indicators for classifying the religious phenomena; level and structural indicators; indicators of participation; quality, efficiency and outcomes indicators.

The following elements are presented in a unitary structure for each indicator: definition, goal, symbol, class/category, interpretation, and quality standards.

The indicators regarding quality, efficiency, and outcomes, proposed by the author, are very useful for the analysis. A synthetic indicator for measuring the religious freedom within a geographical area is, also, proposed.

This indicators system could be used as a base for future researches concerning the religious area.

As an application, in the 5th chapter, the author analysis, from statistical point of view, of the religious phenomena evolution in Romania, based on a large documentation, starting with the 19th century. Despite the difficulties, Mr. Herteliu has succeeded to approach and to present in a descriptive manner, using the analytical elements analyzed in the 4th chapter concerning the religious phenomenon in Romania.

In the 6th chapter the religious phenomena is analyzed taken into consideration the connections among religion and other fundamental elements of the society, such are: the level of education, nationality, fertility, health and tourism. The analysis is made within a historical context.

An analysis concerning the possible correlations, from econometrics perspective, between religion and economy, taken into account some Weber's ideas, is made in the 7th chapter.

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[1] A short presentation of Gheorghe Nosca is available at p. 7-8 of JAQM current issue.

[2] The PhD Thesis is written in Romanian and is on-line available: http://www.biblioteca.ase.ro/resurse/resurse_electronice/teza_capitole.php?dela=20&tid=686&criteriu=titlu&ordine=1