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We are happy to announce the winners of JAQM 2009 Awards.

After deliberations, the winners are:

1st Category

For his very important contribution in promoting and developing Quantitative Methods in Academia, as a recognized scholar, we grant to:

Dimitri GOLENKO-GINZBURG

from **Ben-Gurion University of the Negev, Beer-Sheva, Israel and Ariel University Center (AUC) of Samaria, Ariel, Israel**

the ***2009 JAQM Medal of Honor***

2nd Category

For the most valuable, Quantitative Methods related, paper published in JAQM:
"Induction of Mean Output Prediction Trees from Continuous Temporal Meteorological Data", JAQM Winter Issue, 2009, pp. 485-495
we granted to:

Dima ALBERG

from **Ben-Gurion University of the Negev, Beer-Sheva, Israel**

and

Mark LAST
from **Ben-Gurion University of the Negev, Beer-Sheva, Israel**

and

Avner BEN-YAIR[1]
from **Sami Shamoon College of Engineering, Beer-Sheva, Israel**

the **2009 JAQM Best Paper Award**

3rd Category

For the most promising young researcher in Quantitative Methods area, we grant to:

Daniel Traian PELE
from **University of Economics, Bucharest, Romania**

*the **2009 JAQM Distinction***

[1] The current affiliation of Prof. Avner Ben-Yair is: SCE - Shamoon College of Engineering, Beer-Sheva, Israel.

JOURNAL OF APPLIED QUANTITATIVE METHODS

SECURITY EVALUATION IN COLLABORATIVE M-LEARNING SYSTEMS

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Abstract: *The paper analyses the security issues related to m-learning applications. The collaborative systems are classified, emphasizing on collaborative systems from the mobile learning field. The security of informatics applications is analyzed inside an m-learning system in order to reveal vulnerabilities of different applications. M-learning applications are tested in order to discover possible security vulnerabilities. Metrics are built to measure the security level of each application and to achieve the security assessment of collaborative-learning systems.*

Keywords: *Collaborative System; Mobile Application; Software Security, Security Testing, Metric*

1. Introduction

The collaborative systems are used today in different activity fields, like banking, medicine, education, military and aviation. The educational system is a collaborative system in which new standards are needed. If the followings collectivities are considered: T - the set of teachers, L - the set of learners and S - the set of supervisors, then the collaboration exists between elements of T and L, elements of T and S and between elements of T, L and S. The design of collaborative educational systems is oriented to all partners: teachers, learners and

supervisors, and the security evaluation of informatics applications from this system is very important [1].

From informatics point of view, software applications collaborate and are integrated into an information system. Through the informatics applications that are integrated in a collaborative educational system, the share of mobile applications is reduced because the security reasons.

The mobile applications in the field of m-learning have been constructed having in mind the connection with the elements used in the learning activities, such as learners and technology users, and the control components in the learning activity system [2].

Security is a key aspect of how collaboration can be successful and fruitful for each one of the parties involved in the process of education. Security must exist as a separate layer which comes as a shell on top of the collaborative processes. Security must be considered and treated separately for each one of the aforementioned collectivities as unfolded below:

- SL – the security applied for the level associated with learners; represents measures that help individuals to benefit the most updated services and the best information in the area without any concern about the alteration and/or violation of the presented knowledge to which they must rely on;
- ST – security measures for teacher level; consists of procedures and techniques through which teachers are protected from being surprised by malicious actions of attackers; their access to mobile learning systems is regulated by means of roles and privileges, having a wide range of actions at their disposal.
- SS – security aspect for the level of supervisors; the supervisors are the ones who mediate the communication between learners and teachers by having into account the complexity of the interaction rules; the security aspects, partially should be managed by supervisors but they also must follow the rules applied to them by security measures needed to trace actions and keep logs of every operation made.

The implications of collaborative mobile learning systems from a security perspective are much greater than in a normal e-learning system due to the fact that mobile communication must also be managed by security measures additional to the ones that help and protect the communication between the application components.

2. Types of collaborative information systems

In the knowledge-based society there are encountered many types of collaborative information systems, classified by followings criteria: level of complexity, field of application and manner of organization.

Using the field of application criteria, collaborative systems are classified into several categories:

- *collaborative educational systems*, which are applied in the educational field and have the objective to evaluate and increase the performance of the educational process;
- *collaborative banking systems*, which are encountered in banking field and are used by various financial units;

- *collaborative systems of defense*, that are encountered in military field and are defined by strict rules of organizing and functioning;
- *collaborative systems in production*, their objective being to increase production capabilities and product quality within different goods and services production units;
- *collaborative functional systems*, refers to all the activities taking place in the economy, providing necessary information and overall coordination for production and finance management;
- *collaborative micropayment systems*, that allows customers and content providers to use their payment system of choice;
- *collaborative planning systems*, which present the most appropriate way to tackle certain kind of planning problems, especially those where a centralized solving is unfeasible;
- *collaborative tagging systems*, which provide a new means of organizing and sharing resources;
- *collaborative writing systems*, their major benefits include reducing task completion time, reducing errors, getting different viewpoints and skills, and obtaining an accurate text;
- *collaborative medical systems*, in which modern communication technologies allow doctors from around the world to work on the same patient, in the same time [3].

The collaborative m-learning systems are part of collaborative educational systems and refer to effective collaborative environments in which people and mobile equipment cooperate in order to achieve certain learning objectives.

These collaborative environments acts as an extension of the traditional e-learning model, providing a set of suitable tools for students and teachers to achieve their goals in anytime and anywhere manner.

M-learning or mobile learning is a new educational paradigm in which e-learning technologies are combined with mobile computing to improve the cooperation between students and teachers [4].

M-learning creates a new learning environment and allows learners to access learning material related applications anytime and anywhere through several mobile devices. Figure 1 shows the collaborative m-learning environment and its components:

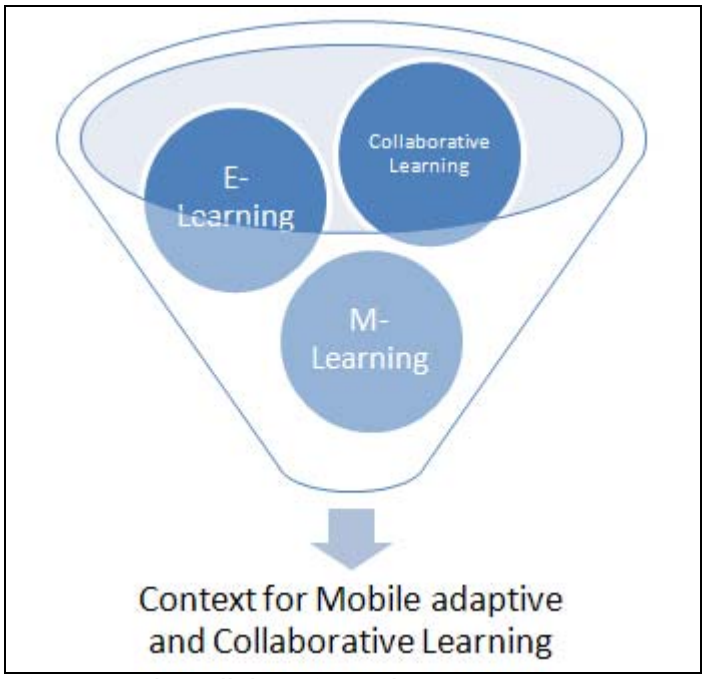

Figure 1. The collaborative m-learning environment [5]

The mobile devices, as being important components of collaborative m-learning systems, should not only provide the context information, but also must take part of the behavior adaptation, in order to achieve the given learning objectives [2].

Using mobile phones as an interactive tool for learning activities requires minimal technical and financial support because the majority of students already have the needed devices and software, and the communication occurs via existing mobile networks.

Mobile technologies contribute to promote, facilitate, and enhance student collaboration, cooperation and communication, processes that serve as a means for accessing, discovering, discussing, and sharing environmental concerns.

The role of mobile phones as a means of collaborative learning was established by the common use of these devices for facilitating friendships and socialization, in order to develop a suitable system for environmental education via mobile technologies [6].

3. Security inside m-learning systems

M-Learning systems are emerging technologies used more and more in common activities and for this reason the vulnerability level is growing rapidly as the number of mobile applications is expanding to multiple users that don't know anything about how is the backstage of such applications or what security standards could protect the user from unwanted events. Having a wide and heterogeneous users community as target, implies a special focus on technical requirements

The importance of mobile education, the process of learning by means of mobile technologies, is certified by the evolution of technology and the growing need of mobility, a direct consequence and also a demand for being efficient and obtaining the best of results.

The main advantages of mobile devices relates to hardware efficiency, portability aspects or their widespread use, features that are meant to improve the education process

quality and influence the final decision of users to implement and make use of such technologies in their everyday educative process.

The way how these mobile technologies are implemented has direct connection with the final decision with the final quality assessment of each activity which makes use of them. For this reason, security must always be carefully managed and security characteristics measured to determine the following state of attributes:

- the actual level of user's ability to trigger some unwanted actions with major impact in the final results provided by the application system's internal vulnerabilities;
- the level of threats that could virtually affect the mobile learning system's functionality;
- the degree of protection, confidentiality, of data which are sent between mobile agents.

A security event in mobile applications is described as an action which triggers a chain of undesired repercussions affecting the quality characteristics of the entire architecture. The security events for mobile applications can be classified from an affected subject perspective in:

- security events which are affecting only statically the application's functionality, with no damage on a long term view; these types of security events are usually originating inside the application and create unpleasant stops with the possibility of losing unsaved data;
- security events originated from outside the mobile application and which are, in general, driven by the malicious attacker's action; these types of security events could perpetuate and bring significant damage to users.

Security events could also originate in different types of mobile applications depending on the architecture used for developing them:

- stand-alone mobile applications; security events could be triggered by a bad implementation of the application algorithm;
- web based distributed mobile applications for mobile devices; security events are found at all levels, starting from implemented algorithm on the mobile client user up to the server on which other processes are running;
- mobile distributed architecture for Bluetooth services; security events can be triggered by a bad implementation of the communication between each device.

Collaboration in mobile distributed infrastructure needs a plus of vigilance and extra care because of the nature of the activity. The communication is vital in the collaboration process, that's way security must always be present in such applications. The access channels between mobile agents are now mature channels but still with lack of features to protect the final user. Types of different channels implement different security protocols, existing significant aspects that cannot be found all at the same technology like costs, throughput, availability, latency and others. For this developers are confronting several methods of communications like: WLAN with the standards IEEE 802.11x, WEP, WPA; Bluetooth, Infrared with IrDA or telephony GSM, GPRS, UMTS.

Types of security protocols that can be used in the implementation of collaborative M-Learning systems:

- Bluetooth security protocol for Bluetooth services [8] – implementing methods for controlling security layers for mobile learning services that are using Bluetooth protocol for communication between mobile agents;

- 3D security protocol [9] – a secure and reliable payment system, 3Domain Security Protocol, could be used for paying for educational services in a secure manner and very efficiently.

A set of security requirements that must be present in mobile applications are presented in [10] explaining why those can't be treated in general for all mobile architectures:

- authentication – feature which is required only if important information should be accessed in a restricted manner; different types of authentication can be used like: password, biometric, OTP, multi factor authentication depending on the application requirements;
- network security – is the characteristic that usually is missing or is very limited due to the technological restrictions that are still present;
- application security – for applications that are always online, the security can be controlled through a server but for the ones that aren't special rules must be applied like the concept of running into a protected environment called sandbox;
- secrecy – is given by the power in which a mobile device is able to implement encryption to protect its sensitive data;
- availability – the feature which provide permanent access to application no matter what undesired actions are taken place.

For implementing as much characteristics as possible, often multiple ways of communication between mobile agents in a collaborative process should be used in this way increasing also the complexity of the final architecture which was implemented and partially increasing also the security risks associated with possible discrepancies between used technologies.

4. Testing the security of m-learning systems

Testing the security of distributed mobile learning applications is very important and challenging compared with stand alone applications. Security testing is designed to identify security issues like:

- unauthorized access to a system or application;
- obtaining privileges in order to view and access confidential information;
- unauthorized data changes;
- prevent other users to use application (denial of services).

Figure 2 depicts a system under security test. If the attack used in a test is successfully completed (the application allows the access, although it wouldn't have) it is considered that the application is uncertain at such attacks. Otherwise, the application is considered safe, taking account of the completion of the attack [11].

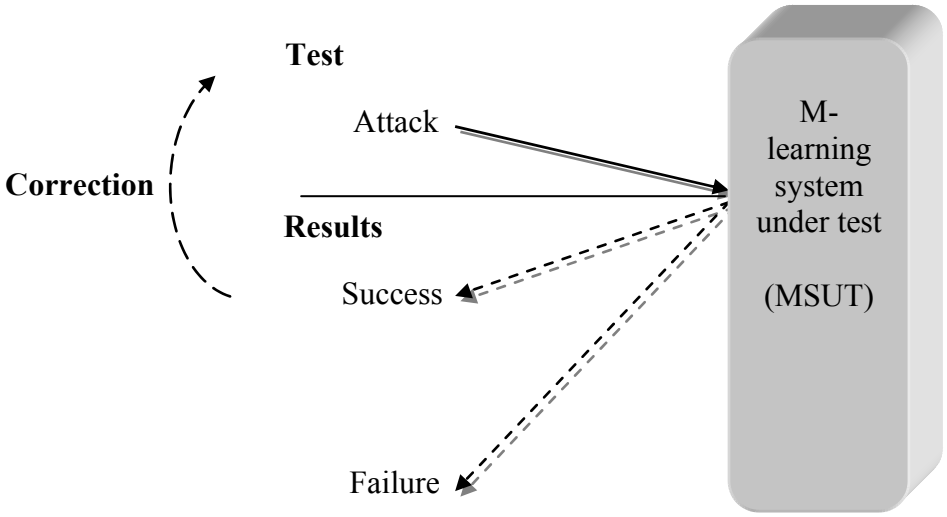

Figure 2. Security testing of IT applications

The success of an attack and is considered a failure of system security and, conversely, a failure of the attack is considered a success in terms of system security test [11]. If an attack is successfully then corrective plans and action are taken and the system is tested again.

There are several areas where the security requirements for an m-learning application are high and they need special attention.

Table 1 presents some security concerns regarding the mobile learning solutions, based on [12].

Table 1. Security concerns of m-learning applications

Action	Security requirements
Online exams	High
Homework, Projects Assessment	High
User management	High
Content management	Medium-High
Quizzes	Medium
Feedback management, Forums	Low-Medium

Each of actions from Table 1 requires a certain degree of security, depending on the importance and data sensitivity.

The databases with tests, marks and users contain sensitive data and they need a special attention. All accesses to database have to be monitored. Database security testing will focus on:

- SQL injection
- database files access rights
- unauthorized access
- data validation.

The security requirements for examinations, homework/project assessment and user management are very high due to the importance of data and information they use. Security testing involves, in addition to database security testing, identity validation and access rights checking.

The quizzes and content management have medium security requirements, because the data manipulated is less sensitive.

Feedback management and messaging for these systems usually does not use sensitive data.

These issues can be managed earlier in the development cycle using several methods and techniques like:

- different authentication levels;
- password management;
- data encryption;
- location services.

One way to simulate an intrusion attack is through penetration testing. This method leads to the identification of weaknesses of systems such as:

- vulnerable services
- ineffective security policies
- configuration issues.

Penetration testing is used for different aspects of networks and different network topologies, firewalls, operating systems and applications [11]. It is based on passwords breakers, network packet filtering and other tools.

Wireless data monitoring is very important for security testing. The majority of mobile learning applications connect to a network or Internet through wireless networks (EDGE/UMTS/Bluetooth/Wi-Fi). For an attacker it is easier to analyze wireless traffic and to access system resources. Monitoring and analyzing wireless data during the security testing can reveal security issues that need to be fixed.

5. Metrics for security evaluation

Collaborative m-learning systems have special quality characteristics, according with their field of interest.

The *security* is the main quality characteristic of collaborative m-learning systems, which require the existence of the followings: *confidentiality*, that means protecting data leaking to unauthorized parties, *integrity*, meaning to avoid data corruption and *availability*, which suppose ensuring that data and applications are always available to authorized entities with no interferences.

In order to measure the performance level of one student that give a test on a mobile device, a base question will be chosen from the test and the following indicator will be calculated:

$$PL = \frac{\sum_{i=1}^{n} p_i}{n}$$

where:

- *PL* – the performance level of the student from the collectivity that participate to the test;

- p_i – the points received by the student *i* if he give the correct answer to the base question ($p_i = 10$ if the student *i* responded correctly and $p_i = 0$ if the student *i* has given an incorrect answer).

An m-learning application for students' evaluation it is considered, based on Android operating system. For 12 students that gave a test with 5 questions, the results in Table 2 were obtained. Each question is passed (mark 10) or not (mark 0).

Table 2. The points received by students to the test questions

Students\Questions	Q1	Q2	Q3	Q4	Q5
S1	10	0	10	10	0
S2	10	10	10	0	10
S3	0	10	10	10	10
S4	10	10	0	10	10
S5	0	0	10	10	0
S6	10	10	10	10	10
S7	0	0	0	0	10
S8	10	10	10	10	0
S9	10	0	10	0	10
S10	0	10	0	0	0
S11	10	10	10	0	10
S12	10	0	10	10	0

For student S12, the performance level indicator is calculated as follows:

$$PL_{S12} = \frac{10+0+10+10+0}{5} = 6$$

The value obtained for the performance level indicator means that the student gave incorrect answer for two questions.

Another metric for assessing the security is the attack rate, *AR*, upon an m-learning application:

$$AR = \frac{NIP}{TNIP} * 100$$

where:

- TNIP – the total number of accessed IP addresses;
- NIP – the number of IP addresses from which a different type of attack was launched.

In the m-learning application for students' evaluation an encryption algorithm was implemented for increase the user security.

The attack rate metric was measured before and after the implementation of TDES encryption algorithm inside the m-learning application. Before the moment when the application was secured, the attack rate was bigger and has diminished in time. In Table 3 are presented the AR values measured between September 2009 and June 2010.

Table 3. The measured values of attack rate indicator

Month	Attack rate (AR) value
September 2009	70%
October 2009	68%
November 2009	65%
October 2009	61%
December 2009	60%
January 2010	54%
February 2010	45%
March 2010	32%
April 2010	26%
May 2010	12%
June 2010	3%

The data was automatically acquired from defects, times moments, errors, and based on their values were calculated the indicators for each metric.

For implementing security on mobile devices and maintaining in the same time the efficiency and performance of a collaborative mobile learning system, an optimization process should be carried out because of the mobile devices lack of energy. When implementing robust, but efficient encryption algorithms to protect data, the mobile processor is intensively used. That's way a security optimization process should be conducted in order to establish equilibrium between the total amounts of resources spent for implementing the security measures in collaborative mobile learning systems.

In order to measure the security efficiency for mobile devices on which collaborative learning systems are implemented an indicator should be calculated for determining if the added security is actually worth the energy spent in process it.

Let SA_i, be the security benefit for the security component S_i. If SC_i represents the security costs in terms of energy spent for sustaining and executing the security component S_i, than the security efficiency can be seen as:

$$SE_i = \frac{SA_i}{SC_i}.$$

For determining the energy costs for implementing one security feature, a simple process of measurement can be conducted by using the following algorithm as presented in [8]:

1. full charge of the device's battery;
2. measuring the amount of energy spent in processing without a security component, EB;
3. charging again the device's battery 100%;
4. measuring again the amount of energy spent in processing data but this time with the security component turned on, EA;
5. determining the amount of energy used for a specific security component AES, AES = EA – EB.

Based on the aforementioned procedure the ratio from the total amount of energy used for processing information without a security component, necessary for covering the needs for it, can be declared as:

$$S_r = \frac{EA - EB}{EB}.$$

If $S_r > 1$ than the amount of energy spent is more than twice greater than the amount used without the security component. In this case the difference of energy must be justified by the security advantage brought by the component.

When implementing a security architecture for a collaborative mobile learning system, than the total amount of resources, *TAR*, available should not be exceeded by the resources needed for running the processes together with their security features.

$$TAR > \sum_{i=1}^{n} EB_i + AES_i,$$

$$n - \text{the number of security components}.$$

The level of energy resources is highly sensitive when mobile devices are working in multithreading state, processing huge amounts of data for collaborative purposes. For this reason a collaborative mobile learning architecture should be carefully designed to relieve each one of the mobile devices caught in the process from unnecessary tasks by trying to call different services that can be run on a server.

The efficiency of security testing method (EST_i) is related to the number of security issues found in software under test:

$$EST_i = \frac{NSIi}{NTSI} \times k$$

where:

NSI_i – number of security issues found using method *i*;

NTSI – number total of total security issues found;

k – coefficient depending on the system type; it has values from 0 to 1 and it is calculated based on empirical data.

The m-learning application for students' evaluation was tested against security vulnerabilities. Two different methods were used and the results are presented in Table 4.

Table 4. The number of security vulnerabilities

	NSI	NTSI
Testing method 1	183	220
Testing method 2	197	220

The efficiency of the second testing method is calculated as follows (the coefficient *k* has been empirically established to 0.4):

$$EST_2 = \frac{197}{220} \times 0.4 = 0.358$$

The result means that the second testing method is very efficient, the value of the efficiency indicator being near to the value of *k* coefficient.

The cost of work resources involved in security testing (CST) takes into account the category of resources and the cost per unit for each category:

$$CST = \sum_{i=1}^{NC} \sum_{j=1}^{NR_i} d_{ij}\, p_{ij}$$

where:

NC – number of resource categories;

NR_i – number of resource from the category *i*;

p_{ij} – price per unit for the resource category *i*;

d_{ij} – units of usage for the resource category *i*.

In order to test the m-learning application against security vulnerabilities, the categories of resources in Table 5 were considered.

Table 5. The categories of resources used in the security testing process

Resources category	Role	NRi	Price (EUR/unit)	Units
Management	Project manager	2	20	10
	Team leader		15	20
Programming	Programmer	2	5	10
	Senior programmer		10	20
Testing	Tester 1	2	10	20
	Tester 2		14	15
Security	Specialist	1	25	10

The cost of resources involved in security testing process for the data presented in Table 5 is the following:

CST = (20 x 10 + 15 x 20) + (5 x 10 + 10 x 20) + (10 x 20 + 14 x 15) + 25 x 10 = 11410 EUR.

These metrics need to be validated using several sets of data and applying various methods and techniques.

6. Conclusions and future work

When designing a collaborative m-learning system should be taken into account the context in which it will be used and the views of the social group that will use it. Learning should be seen not only as a process of information transfer from teacher to student, but as knowledge-building process while interacting with other participants of the group to a specific educational activity [7].

The learning process from a collaborative m-learning system can be achieved through an internet mobile learning platform. The collaborative m-learning system should focus on how to instruct and stimulate learners to achieve knowledge, and the system to simulate traditional classroom education and learning environment.

The increasing adoption of mobile devices and applications, combined with the large availability of wireless technologies and networks, provide new ways for supporting learning across a variety of settings [2].

Testing the security of mobile learning systems is very important during the development. It is an expensive process and has to be planned from the earlier stages of the development cycle.

An efficient collaborative mobile learning system has to be sensitive to the context that characterizes the interactions between humans, applications and the surrounding environment [5].

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[2] **Paul POCATILU** graduated the Faculty of Cybernetics, Statistics and Economic Informatics in 1998. He achieved the PhD in Economics in 2003 with thesis on Software Testing Cost Assessment Models. He has published as author and co-author over 45 articles in journals and over 40 articles on national and international conferences. He is author and co-author of 10 books, (Software Testing Costs, and Object Oriented Software Testing are two of them). He is associate professor in the Department of Economic Informatics of the Academy of Economic Studies, Bucharest. He teaches courses, seminars and laboratories on Mobile Devices Programming, Economic Informatics, Computer Programming and Project Management to graduate and postgraduate students. His current research areas are software testing, software quality, project management, and mobile application development.

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[4] **Mihai DOINEA** received a PhD scholarship from the Academy of Economic Studies, Bucharest, Romania in Economic Informatics at the UvA Research Center. He has a master diploma in Informatics Security (2006). He is assistant lecturer and he teaches data structures and advanced programming languages at the Academy of Economic Studies. He published more than 20 articles in collaboration or as single author and co-published two books in his area of interest. His research interests are given as follows: informatics security, distributed applications, optimization criteria, databases, artificial intelligence, information management, security policies, mobile devices, networking and wireless communication.

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SECURE ARCHITECTURE FOR AUTOMATIC TICKETING SYSTEMS - ONLINE ENABLED

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Abstract: The paper presents a solution for endcoding/decoding access to the subway public transportation systems and the quantitative indicators about the validation process. First part of the paper is dedicated through section one to the most used 2D barcodes used in the market – QR and DataMatrix. The sample for DataMatrix is author propietary. The section two presents MMS and Digital Rights Management topics used for issuing the 2D barcodes tickets. The second part of the paper, starting with section three shows the architecture of Subway Ticketing Systems and the proposed procedure for the ticket issuing and the validation tests. The conclusions identify trends of the security topics in the public transportation systems.

Key-Words: 2D barcode, Ticketing System, DataMatrix code – ISO/IEC 16022, QR code – ISO/IEC 18004, MMS – Multimedia Message Service, M-DRM – Mobile Digital Rights Management , 2D Barcode Automatic Ticketing System – 2D BATS

1. DataMatrix – ISO/IEC 16022 and QR – Quick Response ISO/IEC 18004

Data Matrix is a 2D matrix symbology. Parts from this section are copyrighted by ISO/IEC 16022 [1]. According with [1], there are 2 types of symbologies:

- ECC 200 which uses Reed-Solomon error correction. ECC 200 is recommended for new applications.
- ECC 000 - 140 with some levels of convolutional error correction, referred to as ECC 000, ECC050, ECC 080, ECC 100 and ECC 140 respectively. ECC 000 - 140 should only be used in closed applications where a single party controls both the production and reading of the symbols and is responsible for overall system encoding/decoding procedures.

The characteristics of Data Matrix are [1]:

- Encodable character set:
  - values 0 - 127 in accordance with ISO/IEC 646, i.e. all 128 ASCII characters (equivalent to the U.S. national version of ISO 646)
  - Values 128 - 255 in accordance with ISO 8859-1. These are referred to as extended ASCII.
  - Representation of data: A dark module is a binary one and a light module is a zero.

- Symbol size in modules (not including quiet zone):
  - ECC 200 is for 10 x 10 to 144 x 144 even values only
  - ECC 000 – 140 is for 9 x 9 to 49 x 49, odd values only
- Data characters per symbol (for maximum symbol size in ECC200):
  - Alphanumeric data: up to 2335 characters
  - 8-bit byte data: 1555 characters
  - Numeric data: 3116 digits.
- Selectable error correction:
  - ECC 200: Reed-Solomon error correction.
  - ECC 000 - 140: Four levels of convolutional error correction, plus the option to apply only error detection
- Code type: 2D Matrix
- Orientationindependence: Yes

ECC 200 alignment patterns for 32x32 square symbol – figure 1.1:

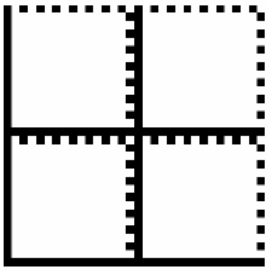


Fig. 1.1 Datamatrix 32x32 square symbol – copyright to [1]

The sample from the Table 1.1 is author property and is NOT a replacement of the standard [1]. For a complete reference please checkout ISO store for ISO/IEC 16022 standard [1]. Starting from the sample from Annex O (informative) [1], there is a description of another encodation type at byte level for word *"Ana"*:

Table 1.1 – ECC200 Paper Sample

Step 2: Error checking and correction

Error correction codewords are generated using the Reed-Solomon algorithm and appended to the encodation data stream – keep in mind, that the one should add 1 for each codeword in data, in order to obtain the ASCII encoding and the proper Reed-Solomon correction codes.

The resulting data stream is:

Data: Ana

CW No:	1	2	3	4	5	6	7	8
decimal:	66	111	98	20	66	57	160	115
hex:	42	6F	62	14	42	39	A0	73
	___data___/				_____check_____/			

Annex E in [1] describes the error correction process for ECC 200 and Annex E.3 in [1] gives an example of a routine to perform the calculation of the error correction codewords for the data "123456".

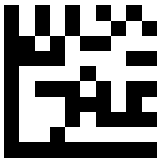
Step 3: Module placement in matrix

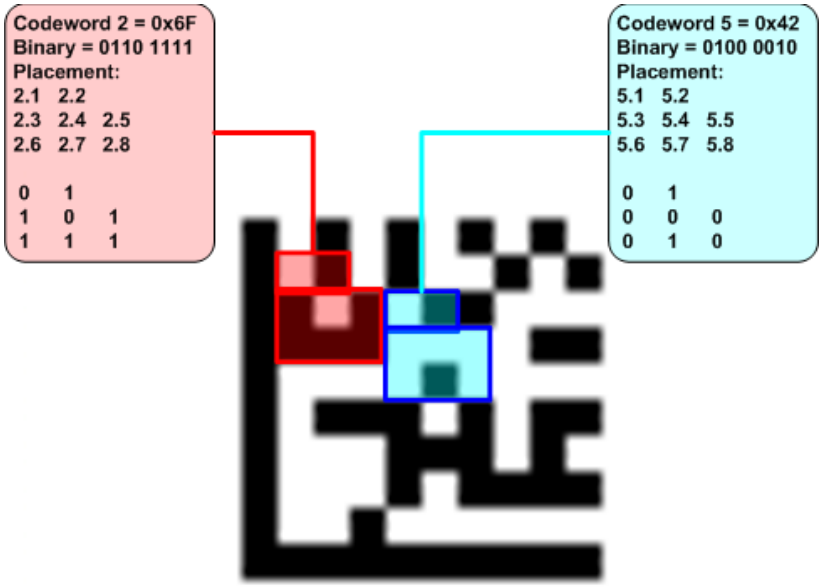
The final codewords from Step 2 are placed in the binary matrix as symbol characters according to the algorithm described in [1] section 5.8.1 (also see Figure F.1 and F.9 from [1]) - Where 2.1 is the first bit, 2.2 is the second bit from codeword 2, and so on:

2.1	2.2	3.6	3.7	3.8	4.3	4.4	4.5
2.3	2.4	2.5	5.1	5.2	4.6	4.7	4.8
2.6	2.7	2.8	5.3	5.4	5.5	1.1	1.2
1.5	6.1	6.2	5.6	5.7	5.8	1.3	1.4
1.8	6.3	6.4	6.5	8.1	8.2	1.6	1.7
7.2	6.6	6.7	6.8	8.3	8.4	8.5	7.1
7.4	7.5	3.1	3.2	8.6	8.7	8.8	7.3
7.7	7.8	3.3	3.4	3.5	4.1	4.2	7.6

Step 4: Actual symbol

The final Data Matrix symbol is produced by adding the finder pattern modules and converting the binary ones to black and binary zeroes to white. For instance, the second byte has value 0x6F = 0110 1111 and the fitfh codeword has value 0x42 = 0100 0010, the following figure highlights this issue:





QR – ISO 18004

QR – Quick Response is a 2D matrix symbology invented by Toyota, subsidiary Denso-Wave in 1994. The QR code is one of the most popular types of two-dimensional barcodes.

The characteristics of QR are [2]:

- Encodable character set:
  - numeric data (digits 0 - 9);
  - alphanumeric data (digits 0 - 9; upper case letters A -Z; nine other characters: space, $ % * + - . / :);
  - 8-bit byte data (JIS 8-bit character set (Latin and Kana) in accordance with JIS X 0201);
  - Kanji characters (Shift JIS character set in accordance with JIS X 0208 Annex 1 Shift Coded Representation.)
- Representation of data: A dark module is a binary one and a light module is a binary zero.
- Symbol size (not including quiet zone): 21 x 21 modules to 177 x 177 modules (Versions 1 to 40, increasing in steps of 4 modules per side)
- Data characters per symbol (for maximum symbol size – Version 40-L):
  - numeric data: 7089 characters
  - alphanumeric data: 4296 characters
  - 8-bit byte data: 2953 characters
  - Kanji data: 1817 characters
- Selectable error correction: Four levels of error correction allowing recovery of the symbol codewords:
  - L 7%
  - M 15%
  - Q 25%
  - H 30%

- Code type: 2D Matrix
- Orientation independence: Yes

The structure of QR code is in figure 1.2 and 1.3 – copyright [2] and [8] – for more details please consult the standard ISO/IEC 18004 from [2]:

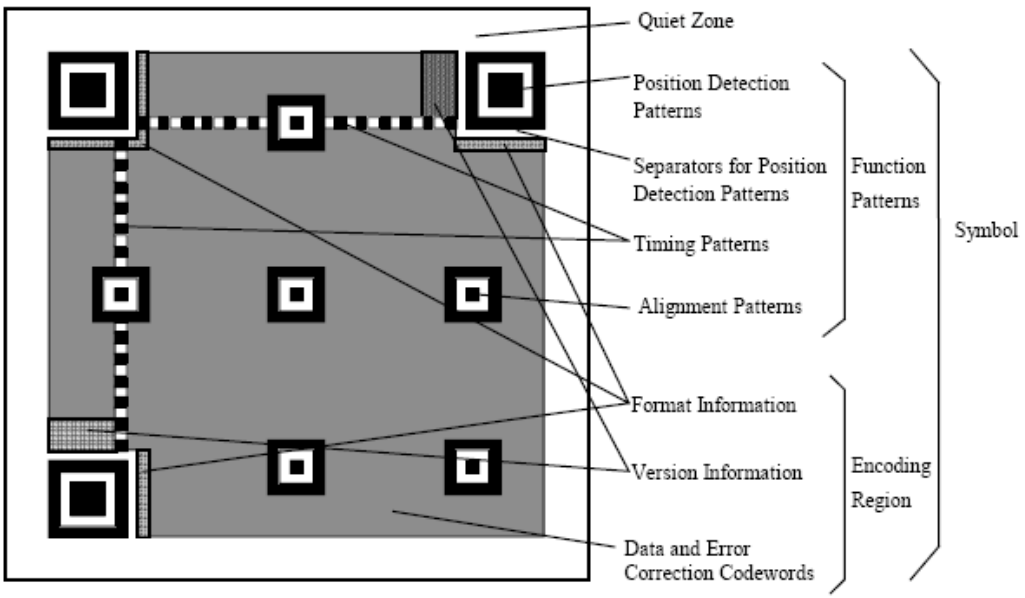


Fig. 1.2 QR Structure from standard – copyright to [2]

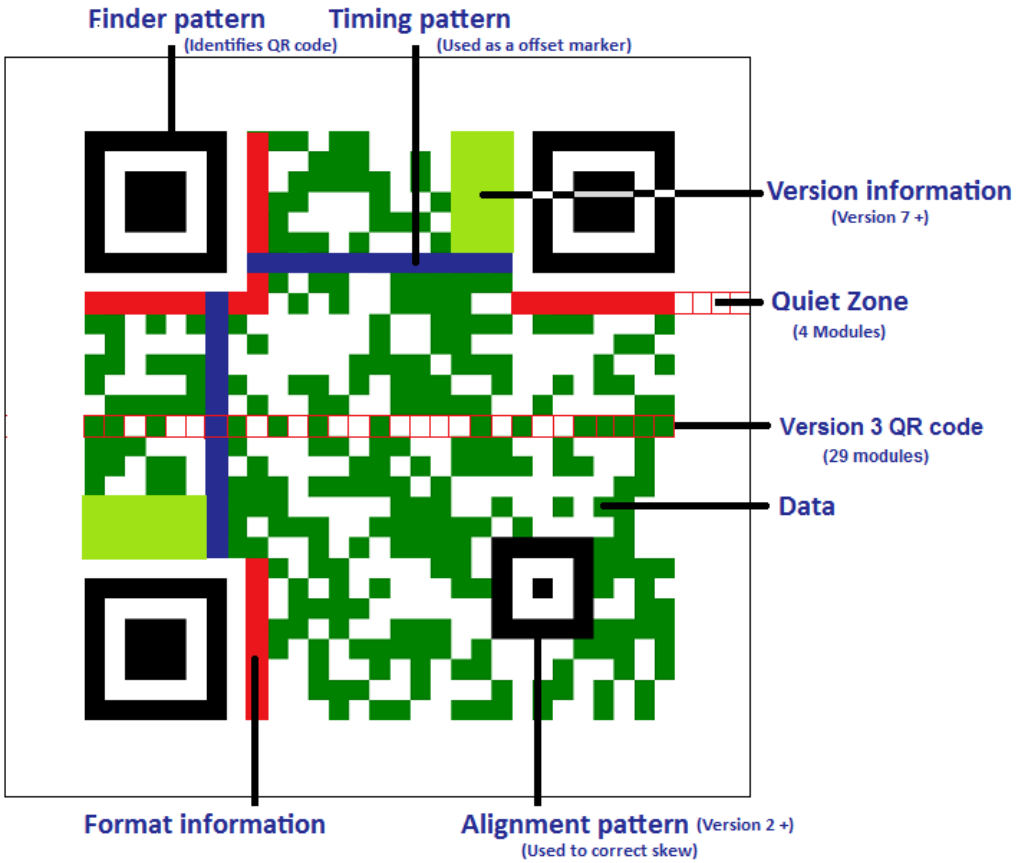


Fig. 1.3 QR Structure – copyright to [8]

Before presenting the utility of barcode in the ticket of the public transportation system, figure 1.4 shows a business card encoded in QR code – created using tool from [9]:

Fig. 1.4 Business Card with QR code [9]

Table 1.2 shows the encoded information in QR code:

Table 1.2 QR Decoding of Business Card

MECARD:**N:**Toma,Cristian;**ADR:**Calea Dorobantilor Ave., No. 15-17, Bucharest,7000,Romania;**TEL:**+40 21 319 19 00-310; **EMAIL:**cristian.toma@ie.ase.ro;**NOTE:**IT&C Security Master;**URL:**http://www.ism.ase.ro;

The following section presents the MMS and DRM topics which are the foundation for the ticket issuing and validation procedure.

2. MMS using DRM

For complete reference regarding MMS = Multimedia Message Service, is recommended, Open Mobile Alliance W@P Forum [10] and especially [11] – MMS Architecture and [14] – MMS Encapsulation protocol. For complete OMA DRM – Digital Rights Management standards [15], [16] is recommended for study [17] – OMA DRM Architecture, [18] – OMA DRM Specs, [19] – OMA DRM Content format and author paper and book which contain topics about mobile digital rights management from [20] and [21].

The figure 2.1 presents a MMS without DRM – it encapsulates in this case:

- MMS standard headers
- SMIL headers
- Text file
- Image JPG file

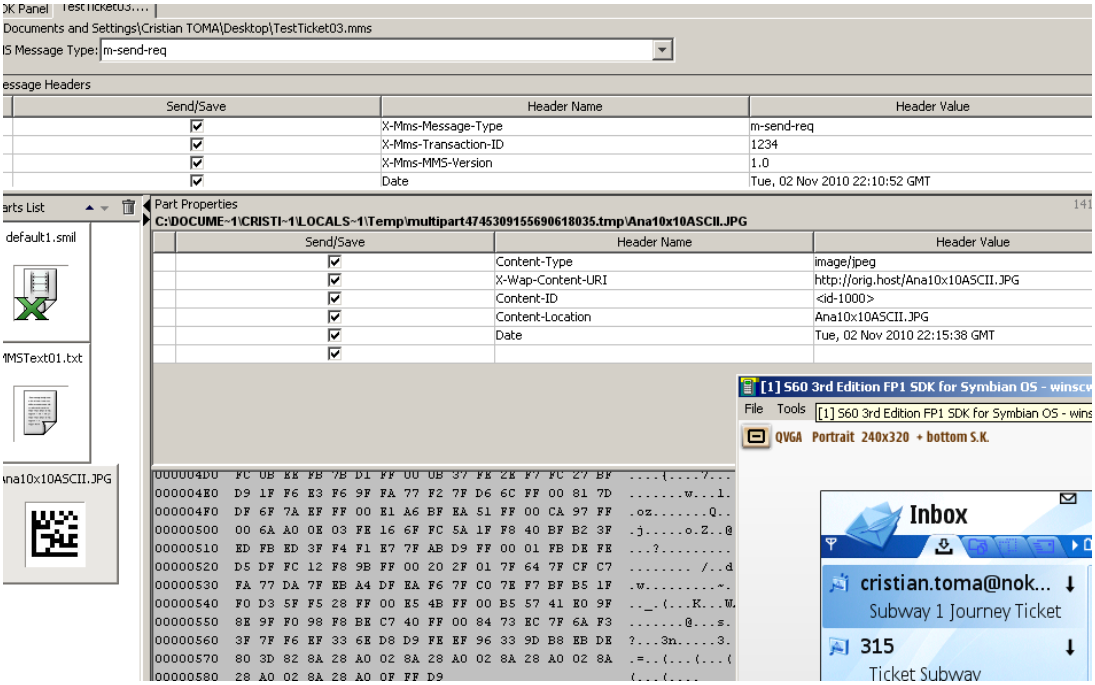


Fig. 2.1 Ticket Test MMS without DRM

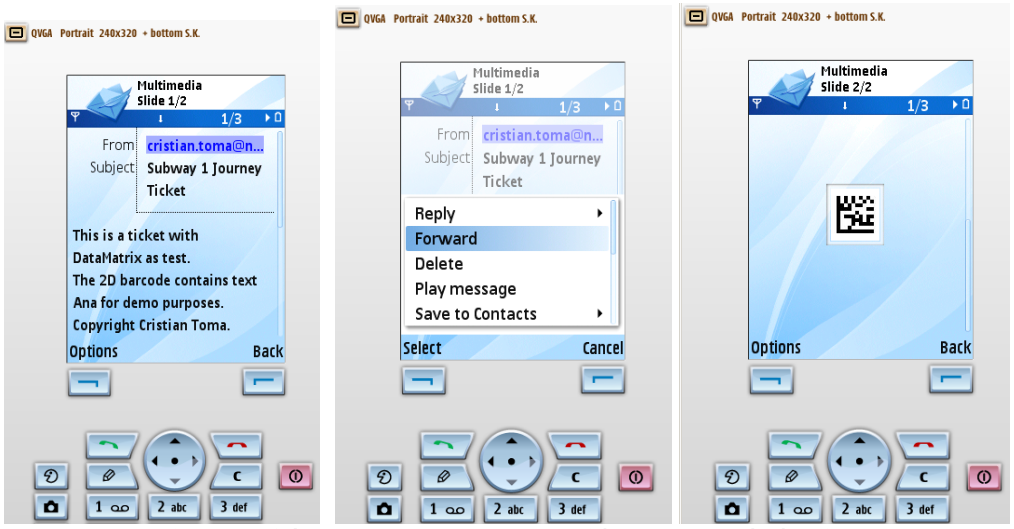


Fig. 2.2 Ticket Test MMS Content without DRM - behavior

Figure 2.2 shows the behavior of MMS encapsulated in figure 2.1. Because the MMS is not DRM prtected the "Forward" feature is activated at the mobile device.

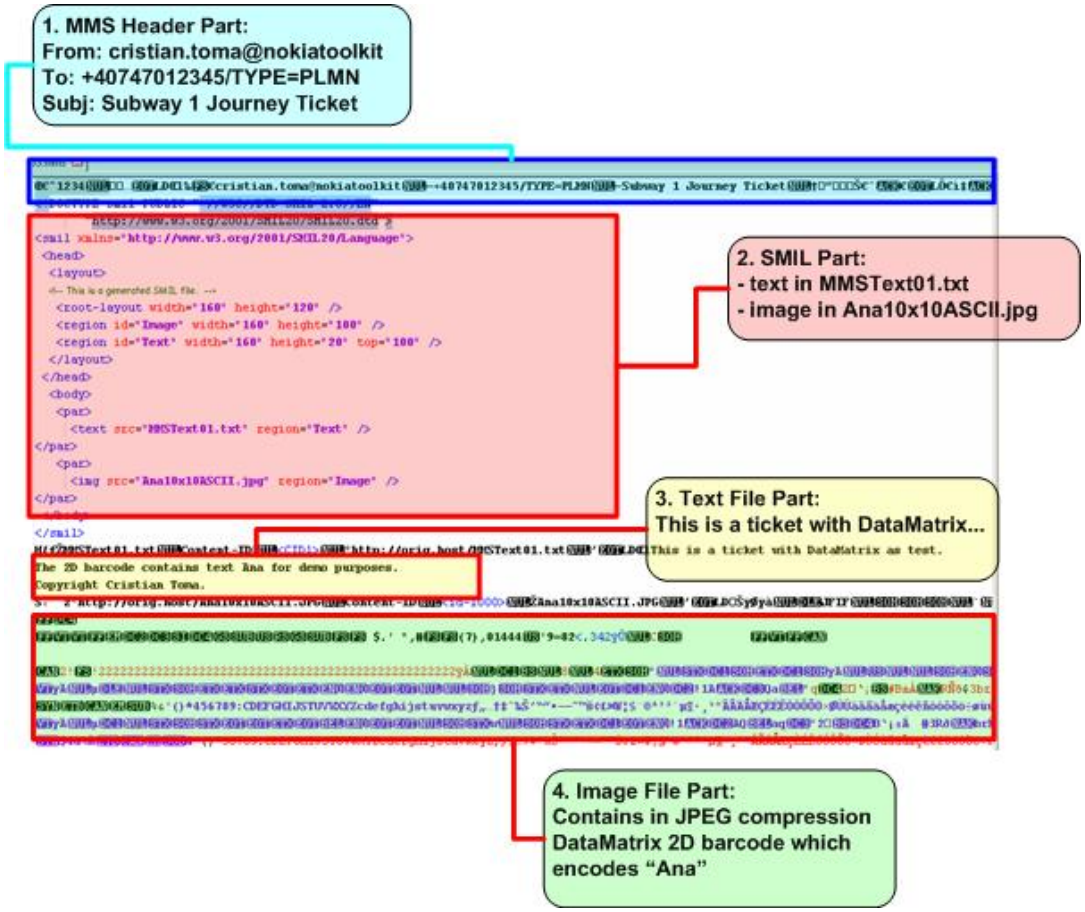


Fig. 2.3 MMS parts format

TestTicket03.mms | TicketTest04.dm

Address	0	1	2	3	4	5	6	7	8	9	a	b	c	d	e	f	Dump
00000000	8c	80	98	31	32	33	34	00	8d	90	85	04	4c	d0	8c	6c	Œ€˜1234.□□….LÐŒl
00000010	89	1c	80	63	72	69	73	74	69	61	6e	2e	74	6f	6d	61	%.€cristian.toma
00000020	40	6e	6f	6b	69	61	74	6f	6f	6c	6b	69	74	00	97	2b	@nokiatoolkit.—+
00000030	34	30	37	34	37	30	31	32	33	34	35	2f	54	59	50	45	40747012345/TYPE
00000040	3d	50	4c	4d	4e	00	96	53	75	62	77	61	79	20	31	20	=PLMN.–Subway 1
00000050	4a	6f	75	72	6e	65	79	20	54	69	63	6b	65	74	00	86	Journey Ticket.†
00000060	81	94	81	90	81	8a	80	88	06	80	04	4c	d4	80	ec	87	□"□□□Š€ˆ.€.LÔ€ì‡
00000070	06	80	04	4c	d0	8c	6c	8f	80	84	1f	28	b3	89	61	70	.€.LÐŒl□€„.(³‰ap
00000080	70	6c	69	63	61	74	69	6f	6e	2f	73	6d	69	6c	00	8a	plication/smil.Š
00000090	3c	70	72	65	73	65	6e	74	61	74	69	6f	6e	2d	70	61	<presentation-pa
000000a0	72	74	3e	00	03	65	84	4e	61	70	70	6c	69	63	61	74	rt>..e„Napplicat
000000b0	69	6f	6e	2f	73	6d	69	6c	00	43	6f	6e	74	65	6e	74	ion/smil.Content
000000c0	2d	49	44	00	3c	70	72	65	73	65	6e	74	61	74	69	6f	-ID.<presentatio
000000d0	6e	2d	70	61	72	74	3e	00	b0	68	74	74	70	3a	2f	2f	n-part>.°http://
000000e0	6f	72	69	67	2e	68	6f	73	74	2f	64	65	66	61	75	6c	orig.host/defaul
000000f0	74	31	2e	73	6d	69	6c	00	8e	64	65	66	61	75	6c	74	t1.smil.Ždefault
00000100	31	2e	73	6d	69	6c	00	92	04	4c	d0	8c	6c	3c	3f	78	1.smil.'.LÐŒl<?x
00000110	6d	6c	20	76	65	72	73	69	6f	6e	3d	22	31	2e	30	22	ml version="1.0"
00000120	3f	3e	0d	0a	3c	21	44	4f	43	54	59	50	45	20	73	6d	?>..<!DOCTYPE sm
00000130	69	6c	20	50	55	42	4c	49	43	20	22	2d	2f	2f	57	33	il PUBLIC "-//W3
00000140	43	2f	2f	44	54	44	20	53	4d	49	4c	20	32	2e	30	2f	C//DTD SMIL 2.0/
00000150	2f	45	4e	22	0d	0a	20	20	20	20	20	20	20	22	68	74	/EN".. "ht
00000160	74	70	3a	2f	2f	77	77	77	2e	77	33	2e	6f	72	67	2f	tp://www.w3.org/
00000170	32	30	30	31	2f	53	4d	49	4c	32	30	2f	53	4d	49	4c	2001/SMIL20/SMIL
00000180	32	30	2e	64	74	64	22	3e	0d	0a	3c	73	6d	69	6c	20	20.dtd">..<smil
00000190	78	6d	6c	6e	73	3d	22	68	74	74	70	3a	2f	2f	77	77	xmlns="http://ww
000001a0	77	2e	77	33	2e	6f	72	67	2f	32	30	30	31	2f	53	4d	w.w3.org/2001/SM
000001b0	49	4c	32	30	2f	4c	61	6e	67	75	61	67	65	22	3e	0d	IL20/Language">.
000001c0	0a	20	3c	68	65	61	64	3e	0d	0a	20	20	3c	6c	61	79	. <head>.. <lay

Fig. 2.4 MMS binary format

The figure 2.3 shows the main parts of the MMS and 2.4 is the binary form representation in hex:

Table 2.1 – Binary representation of MMS

8C 84 .... Message type - MMS Message of type: *m-retrieve-conf:* A message received by an MMS device containing MMS media content. For *m-send-req:* A message sent from an MMS device containing MMS media content should be the value: **0x8C 0x80**
....
8D 90 .... MMS Version
85 04 4C D0 8C 6C – time and date in TLV ASN.1 DER format with values in secs from 1970 => aprox 357982 hours => 14915 days => 40.86 years => year 2010 sometimes in november
89 1c 80 63 72 69 73 74 69 61 6e 2e 74 6f 6d 61 40 6e 6f 6b 69 61 74 6f 6f 6c 6b 69 74 – 0x1c bytes length of 'From' field – 0x89 with value: cristian.toma@nokiatoolkit
00 – the fields separator
97 2b 34 30 37 34 37 30 31 32 33 34 35 2f 54 59 50 45 3d 50 4c 4d 4e – tag 0x97 is field 'To' with the value: +40747012345/TYPE=PLMN
00 – the fields separator
96 53 75 62 77 61 79 20 31 20 4a 6f 75 72 6e 65 79 20 54 69 63 6b 65 74 – tag 0x96 is field 'Subject' with value: Subway 1 Journey Ticket
00 – the fields separator
...
SMIL Part - Synchronized Multimedia Integration Language to control the presentation of the parts of MMS message.
...
TEXT Part – from file 'MMSText01.txt' with content: "This is a ticket with DataMatrix as test.
The 2D barcode contains text Ana for demo purposes.
Copyright Cristian Toma."
...
IMAGE Part – binary JPEG encodetion of DataMatrix for word "Ana"

The proposed model for 2D barcodes distribution is to generate OMA DRM MMS – minimum with "forward-lock" for each issued ticket – see figure 2.5 for different MMS delivery in terms of DRM.

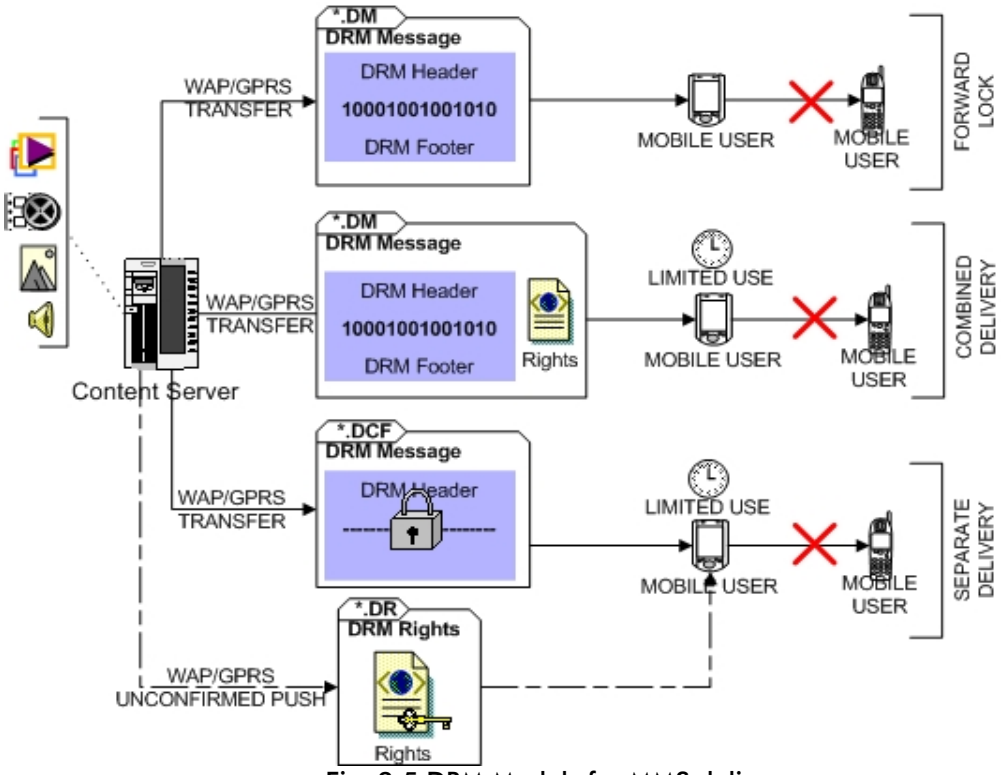


Fig. 2.5 DRM Models for MMS delivery

According to the OMA DRM standards and represented in figure 2.5, there are three DRM models for the content delivery:

- *Forward-lock* – the content provider sends to the mobile browser a binary file (image, movie, game or application) with special header and footer like in table 2.2 with "*dm*" extension. The mobile browser launches an application called the DRM agent that allows the browser to display and play the m-content without a "*Send*" option, so the end-user has no possibility of forwarding the content to another device via Bluetooth or MMS.

Table 2.2–Forward-lock Representation of "dm" file

--boundary-1 **Content-type: image/jpeg** **Content-Transfer-Encoding: binary** ÿØÿà…Binary representation of the M-CONTENT **--boundary-1--**

- *Combined-delivery* – before the binary content there is an XML representation of the "rights object" like in table 2.3 (encapsulated also in a "dm" file), which allows the browser to play only 3 times between 01.10.2010 – 01.12.2010 and does not allow it to forward the m-content.

Table 2.3–Combined Delivery Representation of "dm" file

```
--boundary-1
Content-type: application/vnd.oma.drm.rights+xml
Content-Transfer-Encoding: binary

<o-ex:rights
  xmlns:o-ex="http://odrl.net/1.1/ODRL-EX"
  xmlns:o-dd="http://odrl.net/1.1/ODRL-DD"
  xmlns:ds="http://www.w3.org/2000/09/xmldsig#/">
  <o-ex:context>
    <o-dd:version>1.0</o-dd:version>
  </o-ex:context>
  <o-ex:agreement>
    <o-ex:asset> <o-ex:context>
        <o-dd:uid>cid:http://content-id-here</o-dd:uid>
     </o-ex:context></o-ex:asset>
    <o-ex:permission>
      <o-dd:play>
        <o-ex:constraint>
          <o-dd:count>3</o-dd:count>
          <o-dd:datetime>
           <o-dd:start>2010-10-01T20:59:10</o-dd:start>
           <o-dd:end>2010-12-01T20:59:10</o-dd:end>
          </o-dd:datetime>
        </o-ex:constraint>
      </o-dd:play>
    </o-ex:permission>
  </o-ex:agreement>
</o-ex:rights>

--boundary-1
Content-type: image/jpeg
Content-ID: <http://content-id-here>
Content-Transfer-Encoding: binary

ÿØÿà…Binary representation of the M-CONTENT
--boundary-1--
```

Separate-delivery – the model allows the content provider to send the m-content that is encrypted with a symmetric key as in table 2.4 and 2.5. Therefore, within the separate delivery model, the content provider first sends the binary encrypted data with a header, encapsulated as in table 2.4 and figure 2.5 in a "dcf" file. The browser of the mobile device requests or receives the "rights object" file (the XML encapsulated in a "dr" file) from the URL included in "Rights-Issuer" field from "dcf" file. The rights object, if not request, can be pushed using WAP (Wireless Application Protocol) MMS – Multimedia Message Service or Push message (SI – Service Indicator or SL – Service Locator) mechanisms.

Table 2.4–Separated Delivery Representation of "dcf" file

→image/jpegcid:http://content-id-here gŽŒ┼Encryption-Method: AES128CBC
Content-Name: "NameOfContent"
Rights-Issuer: http://rights-issuer.com/content
Content-Description: "DescriptionOfContent"
Content-Vendor: "VendorName"
Icon-Uri: http://vendor.com/content-icon.gif
"¶{…Binary encrypt representation of the M-CONTENT using AES-Rijndael symmetric key algorithm in CBC mode

Table 2.5–Separated Delivery Representation of "dr" file

```
<?xml version="1.0" encoding="utf-8"?>
<!DOCTYPE o-ex:rights PUBLIC "-//OMA//DTD DRMREL 1.0//EN"
    "http://www.oma.org/dtd/dr">
<o-ex:rights
   xmlns:o-ex="http://odrl.net/1.1/ODRL-EX"
   xmlns:o-dd="http://odrl.net/1.1/ODRL-DD"
   xmlns:ds="http://www.w3.org/2000/09/xmldsig#/">
  <o-ex:context>
    <o-dd:version>1.0</o-dd:version>
  </o-ex:context>
  <o-ex:agreement>
    <o-ex:asset>
      <o-ex:context>
        <o-dd:uid>cid:http://content-id-here</o-dd:uid>
      </o-ex:context>
      <ds:KeyInfo>
       <ds:KeyValue>
        joVbFmkmi3bSO6gC98HE1Q==
      </ds:KeyValue>
     </ds:KeyInfo>
    </o-ex:asset>
  <o-ex:permission>
    <o-dd:play>
      <o-ex:constraint>
        <o-dd:count>2</o-dd:count>
        <o-dd:datetime>
          <o-dd:start>2006-09-27T20:59:10</o-dd:start>
          <o-dd:end>2007-09-27T20:59:10</o-dd:end>
        </o-dd:datetime>
      </o-ex:constraint>
    </o-dd:play>
  </o-ex:permission>
  </o-ex:agreement>
</o-ex:rights>
```

In conclusion, there are two ways of delivering the content rights object to the user, taking into consideration the number of files that are sent to the mobile device:

- to the consuming devices, together with media object (DRM Forward Lock and Combined Delivery Model);

- the rights separately from media content (DRM Separate Delivery Model).

Regardless of which of the three models is implemented a *download descriptor file* such as in table 2.6 can be used in order to improve the user experience.

Table 2.6–Download Descriptor Representation "dd" file

```
<media xmlns="http://www.openmobilealliance.org/xmlns/dd">
   <DDVersion>1.0</DDVersion>
   <name>Name Of Product</name>
   <size>1234</size>
   <type>image/jpg</type>
   <vendor>Media Vendor Company</vendor>
   <description>Description</description>
   <objectURI>http://object-url</objectURI>
   <iconURI>http://icon-url</iconURI>
   <infoURL>http://info-url</infoURL>
   <nextURL>http://next-url</nextURL>
   <installNotifyURI>
     http://install-notify-url
  </installNotifyURI>
  <installParam>-param1 -param2</installParam>
</media>
```

The mobile device downloads the download descriptor file and the browser is redirected to the URL (the address between "<**objectURI**>" tag from "dd" file – table 2.6) that contains or generates the "dm" or "dcf" file depending on which of the DRM models present. The table 2.7 presents the MIME (Multipurpose Internet Mail Extensions) media types of the objects, according to the DRM message format.

Table 2.7–MIME media types

DRM method	MIME media types
Forward-lock	application/vnd.oma.drm.message
Combined delivery	application/vnd.oma.drm.message application/vnd.oma.drm.rights+xml
Separate delivery	application/vnd.oma.drm.rights+xml application/vnd.oma.drm.rights+wbxml application/vnd.oma.drm.content

The DRM message is based on a MIME multipart composite type in which one ore more objects are combined in a single body. The body of the DRM message must be according to the body of the multipart media type defined in RFC 2045 and 2046. The Digital Right Management message must contain one or two body parts, one for each object. If HTTP (Hyper Text Transfer Protocol) or a MIME compliant protocol is used to transport the Digital Right Management message, the boundary delimiter must be included as a parameter within the media type definition.

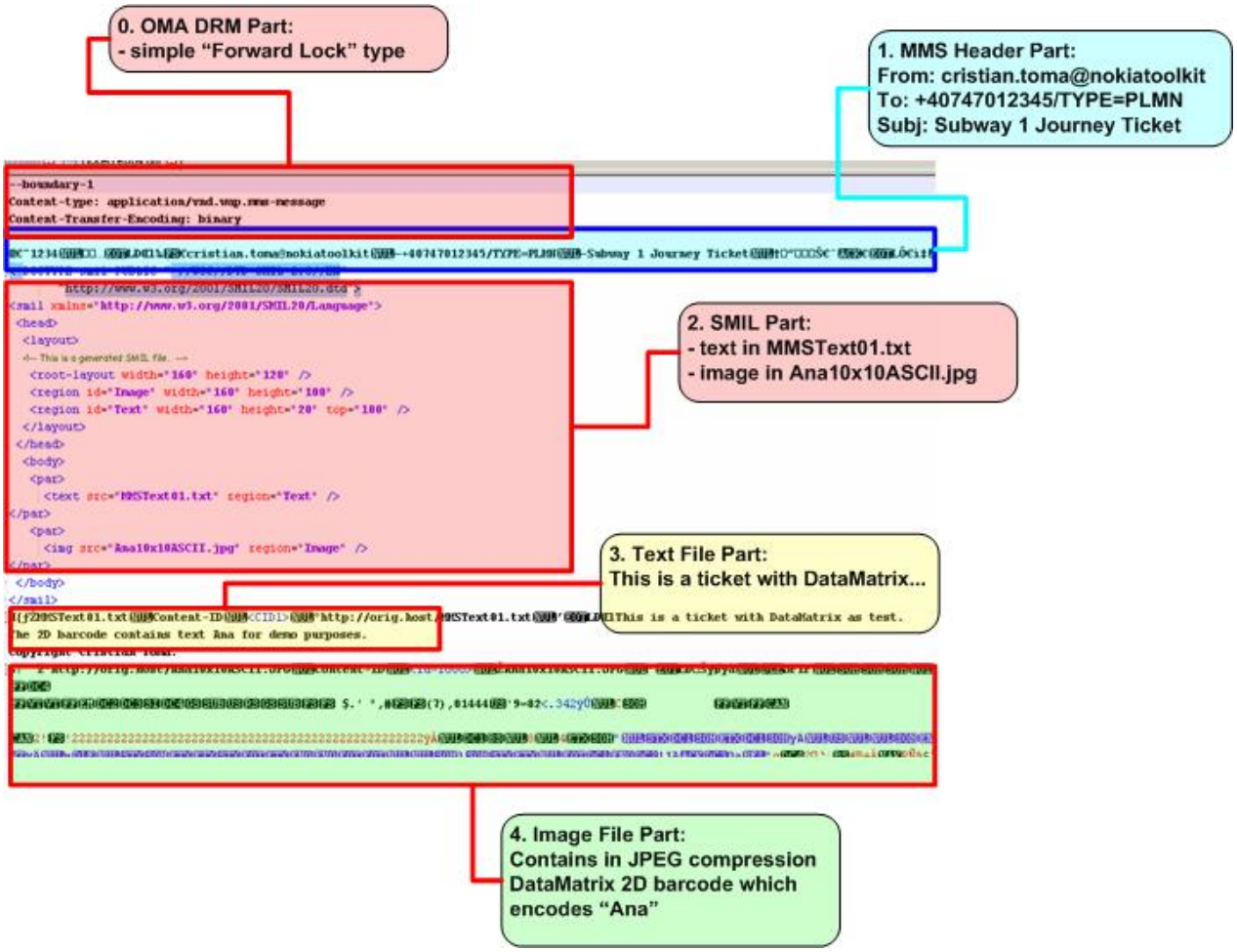


Fig. 2.6 MMS with DRM main Parts

TestTicket03.mms | TicketTest04.dm

Address	0	1	2	3	4	5	6	7	8	9	a	b	c	d	e	f	Dump
00000000	2d	2d	62	6f	75	6e	64	61	72	79	2d	31	0d	0a	43	6f	--boundary-1..Co
00000010	6e	74	65	6e	74	2d	74	79	70	65	3a	20	61	70	70	6c	ntent-type: appl
00000020	69	63	61	74	69	6f	6e	2f	76	6e	64	2e	77	61	70	2e	ication/vnd.wap.
00000030	6d	6d	73	2d	6d	65	73	73	61	67	65	0d	0a	43	6f	6e	mms-message..Con
00000040	74	65	6e	74	2d	54	72	61	6e	73	66	65	72	2d	45	6e	tent-Transfer-En
00000050	63	6f	64	69	6e	67	3a	20	62	69	6e	61	72	79	0d	0a	coding: binary..
00000060	0d	0a	8c	80	98	31	32	33	34	00	8d	90	85	04	4c	d0	..Œ€˜1234.□□….LÐ
00000070	8c	6c	89	1c	80	63	72	69	73	74	69	61	6e	2e	74	6f	Œl‰.€cristian.to
00000080	6d	61	40	6e	6f	6b	69	61	74	6f	6f	6c	6b	69	74	00	ma@nokiatoolkit.
00000090	97	2b	34	30	37	34	37	30	31	32	33	34	35	2f	54	59	—+40747012345/TY
000000a0	50	45	3d	50	4c	4d	4e	00	96	53	75	62	77	61	79	20	PE=PLMN.–Subway
000000b0	31	20	4a	6f	75	72	6e	65	79	20	54	69	63	6b	65	74	1 Journey Ticket
000000c0	00	86	81	94	81	90	81	8a	80	88	06	80	04	4c	d4	80	.†□″□□□Š€ˆ.€.LÔ€
000000d0	ec	87	06	80	04	4c	d0	8c	6c	8f	80	84	1f	28	b3	89	ì‡.€.LÐŒl□€„.(³‰
000000e0	61	70	70	6c	69	63	61	74	69	6f	6e	2f	73	6d	69	6c	application/smil
000000f0	00	8a	3c	70	72	65	73	65	6e	74	61	74	69	6f	6e	2d	.Š<presentation-
00000100	70	61	72	74	3e	00	03	65	84	4e	61	70	70	6c	69	63	part>..e„Napplic
00000110	61	74	69	6f	6e	2f	73	6d	69	6c	00	43	6f	6e	74	65	ation/smil.Conte
00000120	6e	74	2d	49	44	00	3c	70	72	65	73	65	6e	74	61	74	nt-ID.<presentat

Fig. 2.7 MMS with DRM binary format

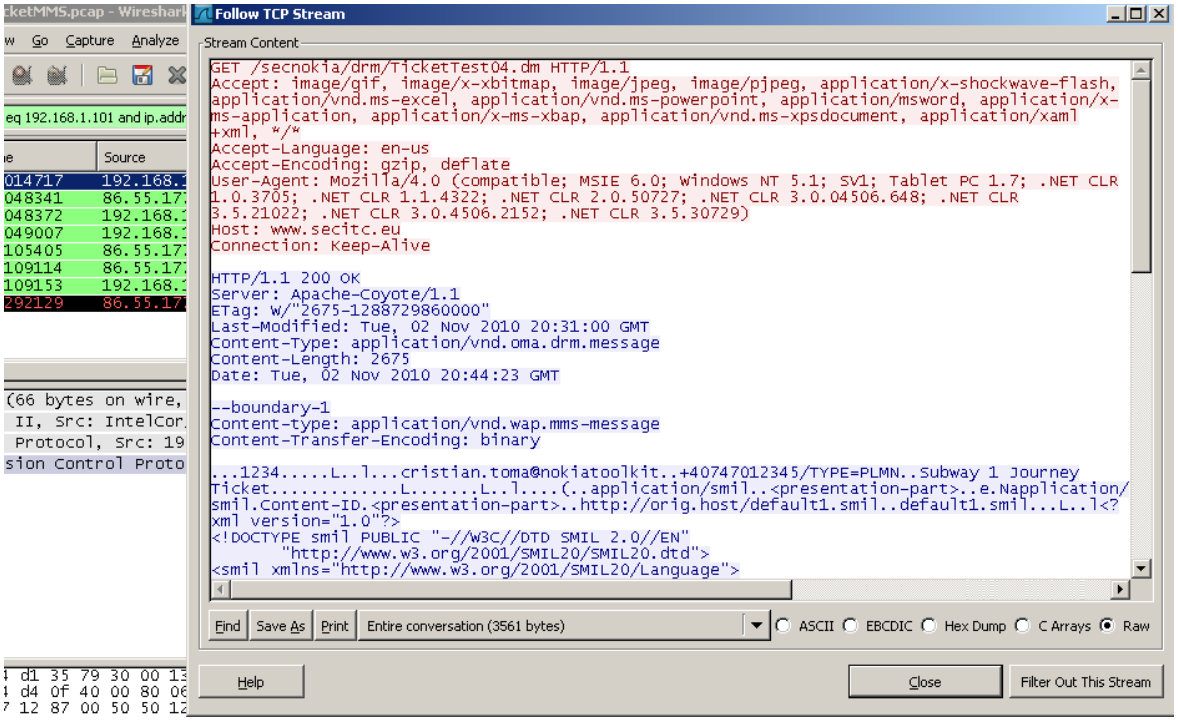


Fig. 2.8 MMS with DRM HTTP analysis

Figure 2.6 is related with figure figure 2.3 but because of OMA DRM Forward Lock, it is an extra with text:

Table 2.8 OMA Header for Forward Lock

--boundary-1 **Content-type: application/vnd.wap.mms-message** **Content-Transfer-Encoding: binary**

Figure 2.7 is related with figure 2.4 with the same binary interpretation but with the binary bytes as plus for the text from table 2.8.

3. The Subway 2D Barcode Automatic Ticketing System – 2D BATS

The speed and the accuracy of reading process is a MUST in Public Transportation Ticketing Systems. Figure 3.1 presents the evolution of QR code – copyright [22]:

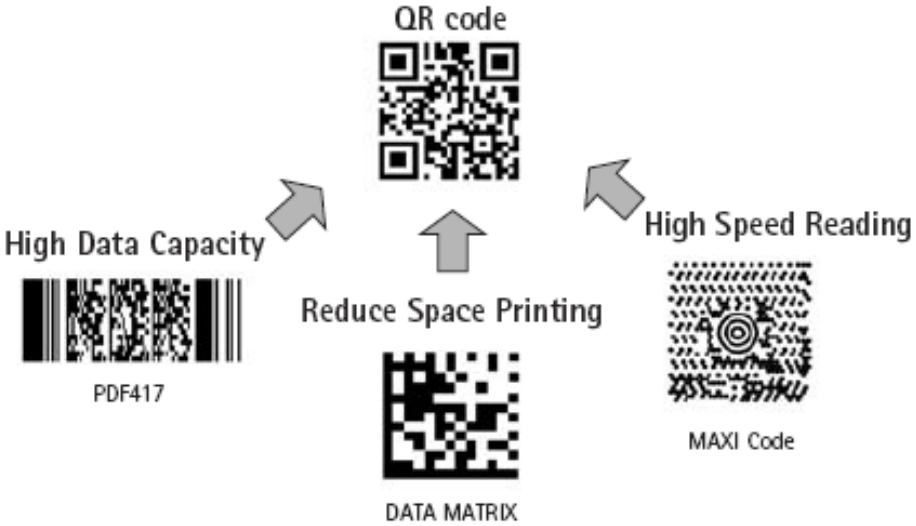


Fig. 3.1 QR Code Evolution – copyright to [22]

In 2D BATS will be used QR code for encoding tickets. The ticket representation is in table 3.1, 3.2 and figure 3.2:

Table 3.1 Text Preparation of anonymous ticket before Base64

METICKET:**N:**-;**ADR:**-;**TEL:**-;**EMAIL:**-; **ENCINFO:***Base64(* ***Encrypt(line:blue;sdate:20101101Z112345;edate:20101201Z112345;nojrns:1)****)*;**PTSYS:** Boston Subway;**URL:** http://www.mbta.com/;

Table 3.2 Text Preparation of anonymous ticket after Base64

METICKET: **N:**-; **ADR:**-; **TEL:**-; **EMAIL:**-; **ENCINFO:**bGluZTpibHVlO3NkYXRlOjIwMTAxMTAxWjExMjM0NTtlZGF0ZToyMDEwMTIwMVoxMTIzNDU7bm9qcm5zOjE=;**PTSYS:** Boston Subway;**URL:** http://www.mbta.com/;

Fig. 3.2 QR code for 1 journey ticket scale 2:1

In terms of encapsulated info table 3.1 and 3.2 are self descriptive. In figure 3.2, the QR encoding was at byte level, version 9, correction level M (9-M).

The Base64 algorithm is highlighted in figure 3.3 for sample word "Man" and the "Encrypt(…)" function from table 3.1, is proprietary for each public transportation system.

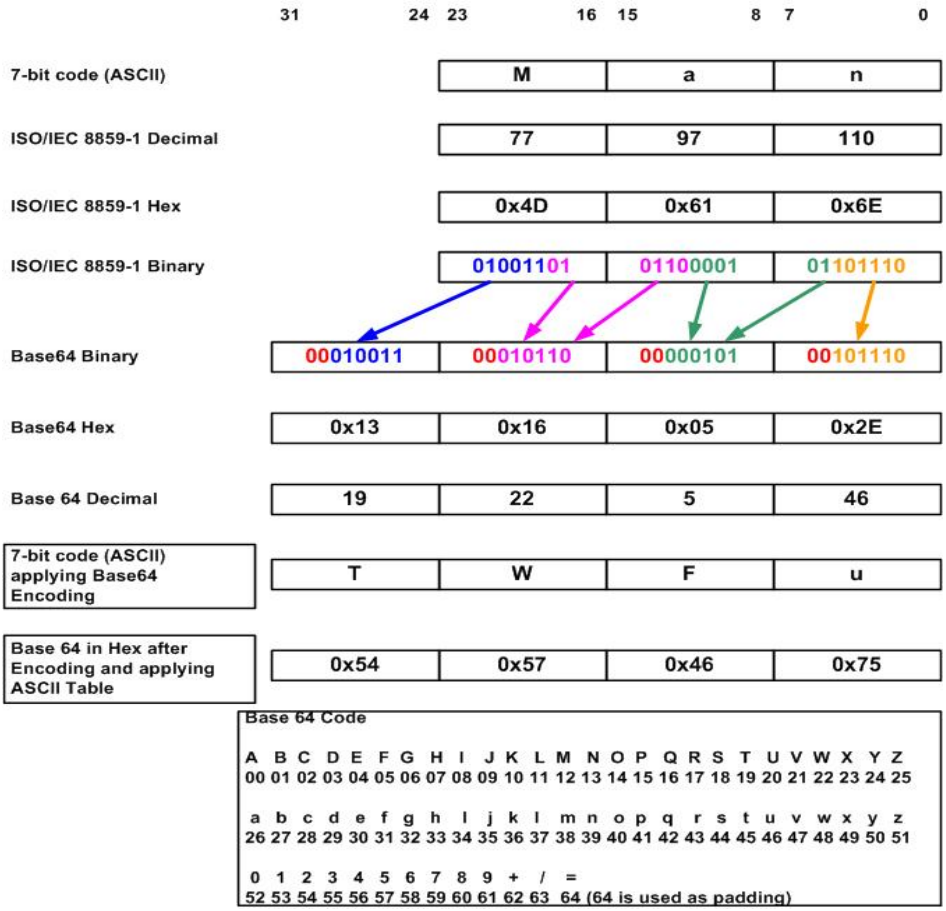


Fig. 3.3 Base64 for word "Man"

The 2D BATS Archiecture is presented in figure 3.4.

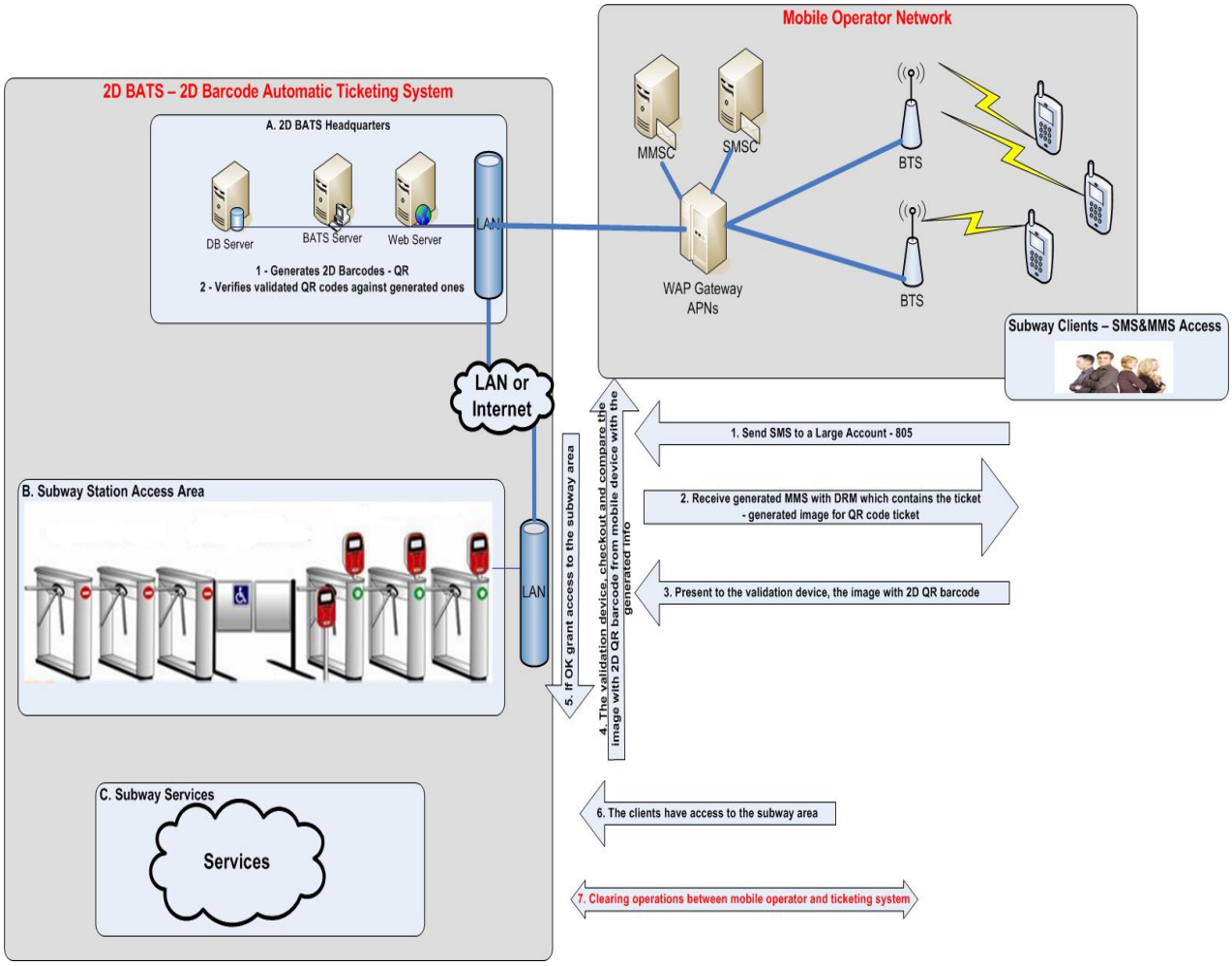


Fig. 3.4 2D BATS Architeture

The data flow is the following:

- The clients access via SMS a large account with premium tax fee;
- The mobile operator sends the requests to the 2D BATS back-end systems;
- The back-end systems generate the 2D barcode QR encapsulated in a MMS with OMA DRM – minimum "forward lock";
- The MMS with DRM arrives to the clients via MMSC and the proper APNs equipments – mobile operator premises;
- The MMS is received and the clients can not send the MMS content to them – first security level;
- The clients presents the MMS to the validation devices from the subway stations;
- The validation devices decode QR code, decrypt the content of the field ***ENCINFO***, and decode from Base64 in byte arrays.
- The validation devices prefrm security checks about info encapsulated in QR code - ticket and send info to the back-end servers of 2D BATS.
- If 2D BATS back-en systems confirm that everything is OK, the access in the station is granted by the validation device to the client.

4. Conclusion and Statistics

The main advantages of 2D BATS solution are: the optimization, low cost and speed of the distribution chain which is in charge for the tickets issuing.

Regarding the tests performed on varios validation devices the table 4.1 presents the results:

Table 4.1 Comparison in terms of seconds for the validation devices

No	Device OS	Processor	Camera	DataMatrix Speed Read+Process	QR Speed Read+Process
1	Symbian 9.2 3rd Edition	Dual Core ARM 11 332 MHZ	Camera Resolution - 2582 x 1944 px CMOS Sensor - 5.0 Megapixel	1.23 s	1.04 s
2	Symbian 9.4 5th Edition	Single Core ARM 11 434 MHZ	Camera Resolution - 2048 x 1536 px CMOS Sensor - 3.2 Megapixel	0.96 s	0.85 s
3	Android OS, v2.1	ARM Cortex A8 1GHz	CMOS 5 MP, 2592 x 1944 pixels	0.97 s	0.67 s
4	Microsoft Windows Mobile 7	Qualcomm Snapdragon QSD8250 1 GHz	CMOS 5 MP, 2592x1944 pixels	0.98 s	0.91 s

It is obvious that the most important features for the validation process speed are: the camera type, the processor type and the operating system type. In table 4.1 there are the time in seconds spent for reading and processing the 2D barcodes for the tickets in DataMatrix and QR symbology. The best results have been obtained with devices from the position 2 and 3 from the table 4.1.

In the future, the optimization of the barcode info, the encryption/the signing process of the sensitive info from the tickets, the DRM improvement and the frontend/backend validation process speed enhancement, and the tests on the various devices should be research topics for security issues in such kind of systems.

Acknowledgement

This work was supported by CNCSIS – UEFISCSU, project number PN II – IDEI 1838/2008.

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-http://www.openmobilealliance.org/tech/affiliates/wap/wap-209-mmsencapsulation-20020105-a.pdf
-http://www.openmobilealliance.org/Technical/release_program/drm_v1_0.aspx
-http://www.openmobilealliance.org/Technical/release_program/drm_v2_0.aspx
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JOURNAL OF APPLIED QUANTITATIVE METHODS

Quality-Quantity Paradigm in Assisted Instruction

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Abstract: The purpose of this article is to introduce and develop an approach educational research oriented, in order to integrate assisted instruction in assisted didactics design, based on a quality-quantity paradigm. In this context, the analysis focuses on a methodological approach, permanently reframed by the conceptual, analytical and theoretical updated frameworks. This manner reflects the versioning process of the hardware and software development, and highlights the educational technology concept integrated in a classical teaching-learning activity.
Key words: e-education, standardized instruction, concepts map, individualized learning, zone of proximal development

Introduction

Scientific research in e-education consists of recursive processes as a theoretical feature and evolves as iterative activities as a practical feature. This statement forces reconsidering the theory – practice relation, emerging new methodologies grounded on quality-quantity paradigm in assisted instruction. Such an approach requests conceptual delimitations and redefined notions dedicated to merge the learning process in e-environment.

Considering *the article* as the basic action of a researcher and the main paper types (conceptual paper, case study, general review, literature review, viewpoint), we define the working model of this approach, developed as a paradigm, as we can see in Figure 1. Conceptual framework is analyzed in order to obtain the construct named analytical framework and the same conceptual framework is synthetized in order to obtain the construct named theoretical framework. An analytical framework is developed as an iterate process finalized as a case study while the theoretical framework is developed as a recurrent process finalized as a case study. The case study could develop the conceptual framework, the analytical framework or/and the theoretical framework, so the working model reflects a perpetual research activity.

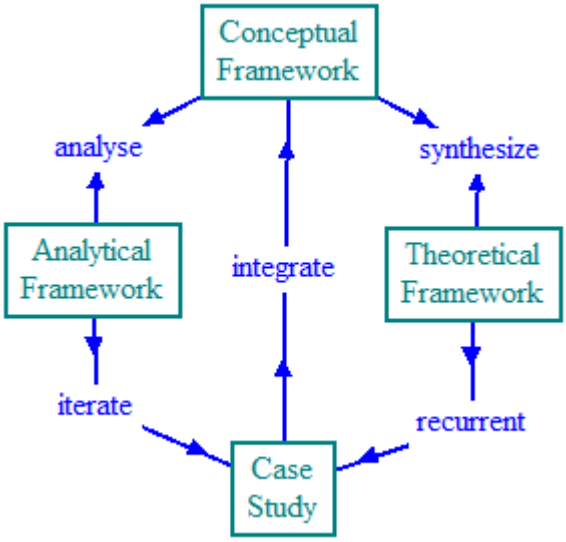

Figure 1 – The working model developed as a paradigm

Scientific research activity, using a meta-language, represents a recursive process for education, and scientific research activity, using an object-language, represents an applied process in technology. Both types of languages develop subjects in the background of a specific group of working terms, expanded as a meta-subject. The group of working terms has a double function: a descriptive one (knowledge function) and an explanatory one (understand function). At the same time, two main theories about metacognition are reviewed, each of which claims to provide a better explanation of this phenomenon [Arango-Muñoz, 2010]. The author considers that we have to distinguish two levels of this capacity - each having a different structure, a different content and a different function within the cognitive architecture. From the point of view of the meta-representational theory, metacognition refers to 'thinking about thinking', i.e., to the self-ascription of mental states carried out by forming a second order thought about a first order one, and more generally forming an (n+1)-order thought about an n-order thought. The control view on metacognition claims that it is mainly a capacity to evaluate and control our cognitive processes and mental dispositions by means of mental simulation. The author highlights two levels of metacognition: the high-level, theory-based metacognition and the low-level, experience-based metacognition.

Conceptual framework

Classical education includes instruction, considered as an interaction between teacher and student, while e-education assumes assisted instruction, developed as a process based on interactivity between student and teacher, mediated by personal computer; e-education includes the classical form, and it is developed as an extension of the previous one; e-learning represents just an electronic support for this process [Zamfir, 2009b].

The basic structure of a personal computer consists of hardware (physical resources), firmware (logical resources integrated in physical resources), software (logical resources) and dataware (informational resources). Each part is based on an architecture which enables configurations with different effects in different approaches: logical,

technological and functional. Our activities mean permanent cognitive restructuring: configuring and maintaining the infrastructure that makes technology works. From this point of view of the cognitive restructuring, three kinds of infrastructure are likely to emerge: technological infrastructure, conceptual infrastructure of the new study programs, and the cognitive infrastructure of all the participants involved in the learning process. Technology is usually 'embedded' in a device or an approach that, potentially, changes the way an activity is carried out. A device with embedded technology may be able to be used to carry out certain functions within an activity. Thus it may be useful to think of technology more in terms of functionality rather than devices. This generated context becomes infrastructure. In relation to teaching and learning, appropriate infrastructure has potential functionality in areas such as clarifying the zone of proximal development for a learner, scaffolding learning activities, mediating learning while in progress. Considering pedagogy to be the activities that assist understanding, and teaching to be scaffolding learning activities and mediation of learning experience, technology could be used in activities for developing learning objects, or as tools, in order to contribute to the completion of tasks [Zamfir, 2007].

One of the most important impacts of technology to the social context was the possibility of developing and implementing standards, as well as defining levels of knowledge, for the cognitive domain. This was the first condition of a base for the standardized instruction. Scaffolding in assisted instruction consists in developing and using dedicated applications in order to match tacit knowledge to explicit knowledge in zone of proximal development.

Based on the 'knowledge cube' proposed in [Zamfir, 2008], Figure 2 presents the concepts map for a practical and theoretical interaction in assisted instruction, where the personal computers become an educational context and sustain producing learning objects. This metaphorical construct leads to the 'workplace learning' concept, a basic one in organizational learning.

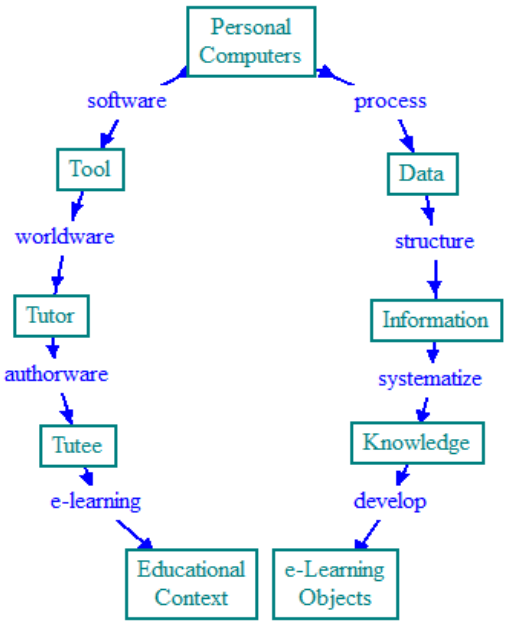

Figure 2 – The working model in assisted instruction

Theoretical framework

Based on a volume which introduce and discuss the foundations of research [Grix, 2004, p. 18-34], we present the idea that while discipline specific terms and concepts exist and have theirs uses, generic research terms and concepts have the same fundamental meaning in whatever discipline they are used. So, the author promotes the tools of research, that have as their role to describe and finally to explain, and they are concept, paradigm, ideal type, typology and model. In a distinct section of the same volume [Grix, 2004, p. 100-115], the author affirm that the role of the theory in social research is complicated by the fact that it is utilized for different purposes by different academic perspectives working in different philosophical traditions within the human sciences.

[Zamfir, 2009a] introduce a theoretical framework for scientific research in e-education, based on the technology domain, which is synthetized in Figure 3. A general analyze of the role of technology in the sustainability transitions of the society is presented in [Paredis, 2010]. This approach builds on insights from recent traditions in the philosophy and sociology of technology, in particular the social construction of technology and actor-network theory, which include the education perspective as a default contextual one. Also, the article studies the different conceptualizations of technology in the sustainability debate.

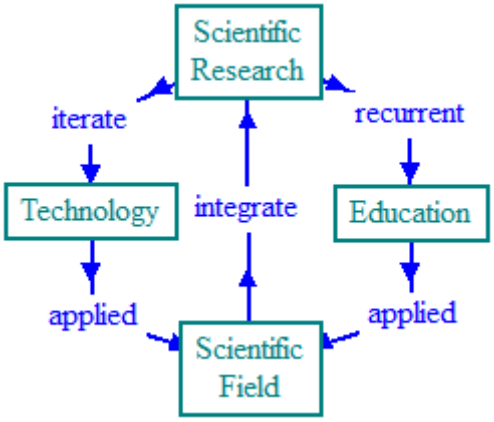

Figure 3 – A theoretical framework for scientific research in e-education

As soon as knowledge developed by scientific research is recorded in technology, from a social perspective, the difficulty lies precisely to teach the knowledge workers in order to understand and apply available technology [Zamfir, 2010], and, as a key of this question, to train the trainers in a dynamic technological infrastructure.

Based on the classic structure of levels in producing education, Figure 4 reflects the specific competencies for teaching in assisted instruction and offers a typology for the students' stages in learning activities.

According to [Sicilia, 2006], organizational learning can be considered as systematic behavior oriented to acquire capacities for dealing with the needs and challenges of organizations in competitive environments. Competencies understood as the workplace capabilities of individuals or groups can be used as one of the approaches for managing such capacity-acquisition behavior. The management of competencies through information technology for improved effectiveness and efficiency require significant tasks and reliable solutions in the information systems discipline. For an educational organization, the dynamic

content has a double impact in recalibrating competencies: both for the trainers and for the students. Developing this theoretical framework, the explanation becomes part of the body of the content knowledge that constitutes the research field.

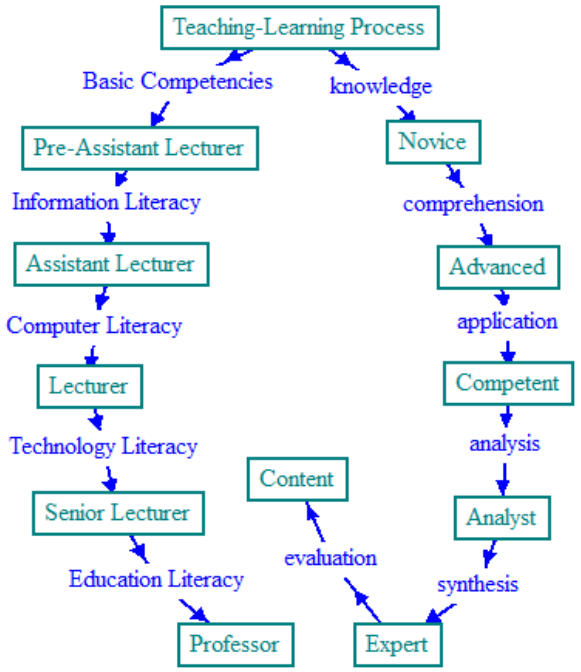

Figure 4 – Levels of competencies in assisted instruction

Analytical framework

The central concept in assisted instruction is the learning process, considered as a chain of experiences rather than being specific to particular disciplines. [Davies, 2008, p.11-15] started his analyze with David Kolb's definition: *Learning is the process whereby knowledge is created through the transformation of experience*. Building on the work of Dewey, Lewin and Piaget, Kolb put forward a model of learning from experience which consists of four discrete phases: concrete experience, reflective observation, abstract conceptualization and active experimentation. Considering Kolb's cycle helpful in illuminating the ways in which we learn from experience, [Davies, 2008] considers that it presents only a partial picture of the various elements that are usually involved, but he mentions the work carried out by Kolb in the United States, and Peter Honey and Alan Mumford in the UK, into learning styles or types. Both approaches give names to the various phases of the cycle. Kolb has Diverger, Assimilator, Converger and Accommodator, whilst Honey and Mumford have Activist, Reflector, Theorist and Pragmatist. Taking the four phases of the cycle, they said that individuals may have preferences for and particular abilities in, one or more of the phases.

Integrating Kolb's model of experiential learning in the concepts map approach, specific for this research, we consider necessary to highlight connections for the four phases and the result is presented in Figure 5. Connections are made with the levels of Bloom's Taxonomy for the cognitive domain, and the model illustrates the generic student. For a trainer, the last connection, represented by analysis, includes also synthesis and evaluation, two fundamental activities in assisted didactics design. This approach replaces the idea that

individuals may have preferences for particular abilities in one or more of the phases with the necessity of improving the basic competencies of the student.

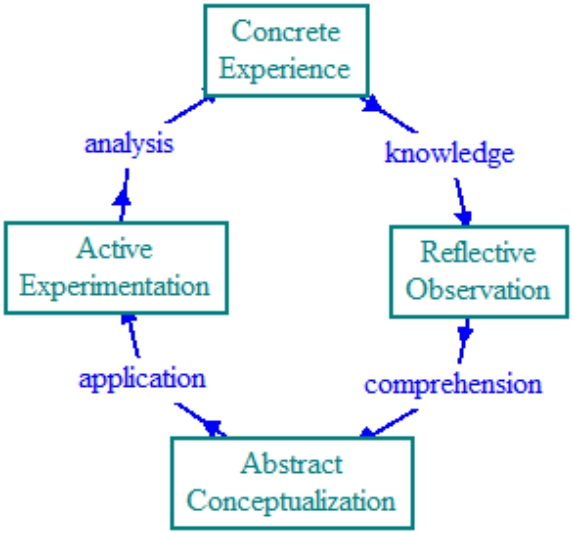

Figure 5 – Kolb's model of experiential learning integrated in concepts map approach

The second base concept in assisted instruction is the teaching process, developed on a pyramid of concepts to know, understand and apply and extended on a concepts map to analyze, systematize and evaluate the content of the discipline.

The content in teaching-learning activities implies the language (see Figure 6), and the language means content statements (nouns, verbs, adjectives, adverbs) and grammatical statements (pronouns, prepositions, conjunctions, determiners) as terms. The terms are entries for the cognitive infrastructure of the trainer, where they are transformed in concepts for a particular discipline; and the results of the design process are the learning applications. The same image could represent an application based learning in assisted instruction as soon as the cognitive infrastructure is a student's one. When all the components of the proposed structure are reflected in a virtual space as digital resources, we define e-learning, as a learning support or as an assisted instruction environment.

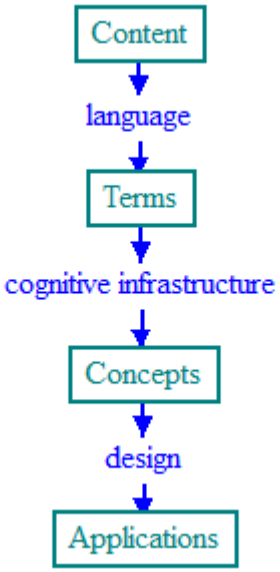

Figure 6 – Application based teachingin assisted instruction

The cognitive construct presented in Figure 6 reveal a quality-quantity paradigm in assisted instruction: quantitative components (content, terms, concepts and applications) are connected through qualitative processes (language, cognitive infrastructure and design). As any working model, developed as a paradigm, this one's purpose is twofold: first, a quantitative structure for teaching-learning activities is offered, and second, a qualitative functionality in order to turn the theory into practice is promoted. Our world is one of constant and increasing rates of change; in this world, one of the most prevailing trends and traits is that of convergence. Concepts converge to form completely new concepts. The individual's cognitive infrastructures "absorb" concepts as basis, threshold, or aggregate. At the same time, the concepts are classified as being perceptual, relational and associative. Vygotsky's work showed that the individual's thinking emerges through interaction with the environment. Cognitive development requires social interaction, and learning is restricted to a certain range at any given age. As each level of learning is achieved, the teacher sets new targets within a new zone of estimated ability of the student. This process of helping is termed "scaffolding". Vygotsky takes Piaget's notion that development leads learning, but approaches it from the opposite direction, arguing that, in fact, learning leads development. Vygotsky noticed that individual's levels of learning are more accurately reflected by what they can do with help, rather than what they can do on their own. This led him to develop the notion of a "zone of proximal development" (ZPD), which represents an individual student's potential level of learning if helped by teacher. Scaffolding in assisted instruction consists in developing and using dedicated applications in order to match tacit knowledge to explicit knowledge in the zone of proximal development. This approach invokes active learning design and ensures student-centered learning [Zamfir, 2008]. This is why the concepts give this paradigm stability through convergence

Case study

First application of the approach described in this article is the e-Class. Qualitative components of this concept consist of the technological infrastructure, including e-services (network, web, and e-mail), conceptual infrastructure (content, including software applications) and cognitive infrastructure (teachers and students); these elements determine the quantitative components of the e-Class: the numbers of the students, considering that each student uses his own personal computer. The concepts map of the e-Class is presented in **Figure 7**, and the structure highlights quantitative objects and connections reflecting qualitative processes, as a didactics overview.

In general, the key feature of a teaching-learning process is signified by the threshold concepts. A threshold concept can be considered as akin to a portal, opening up a new and previously inaccessible way of thinking about something. It represents a transformed way of understanding, or interpreting, or viewing something without which the learner cannot progress [Meyer & Land, 2003]. In assisted instruction, the key feature of a teaching-learning process in an e-Class is reflected by the granularity of the e-learning objects. As soon as the teaching-learning process is knowledge's application, and e-Class is an assisted instruction's application, the granularity of the e-learning objects is determined by the assisted didactics design when converting tacit or personal knowledge in explicit or codified knowledge. Such a process is defined in the image presented in Figure 8.

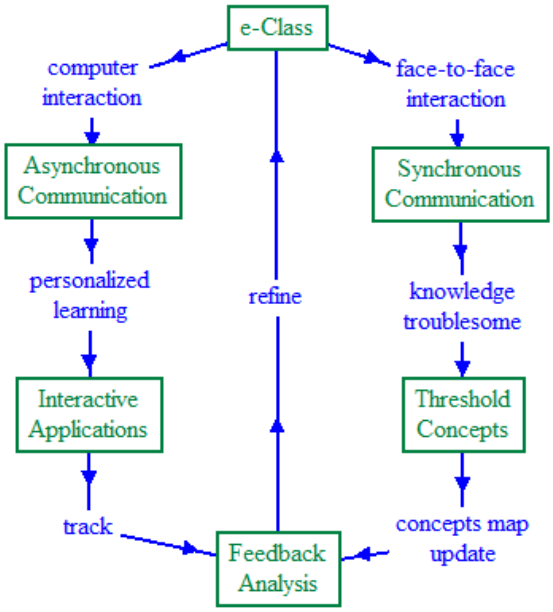

Figure 7 – The concepts map of the e-Class

The conceptual framework designed for constructing explicit knowledge from data was developed from [Zamfir, 2010], and highlights the difference between learning objects and e-learning objects.

Conclusions

As any studying framework in educational research, this one's purpose is twofold: first, developing a teaching-learning environment individualized oriented, and second, developing a teaching-learning environment, training the trainers oriented.

Considering e-Class being an extension of the traditional class, the quality-quantity paradigm becomes a documented model, and the learning environment grows into an appropriately measurable one.

Next step of this approach is a quantitative one, qualitative implemented: developing interactive applications with high granularity of the e-learning objects, based on a conceptual infrastructure of the updated study programs.

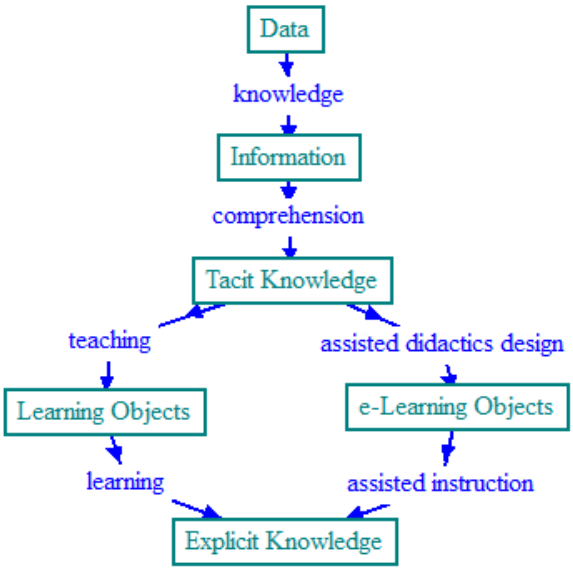

Figure 8 – Conceptual framework for developing explicit knowledge

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CONSIDERATIONS ABOUT COMPUTER NETWORKS SECURITY UNDER VARIOUS OPERATING SYSTEMS

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Abstract: Importance of security issues in computer networks has increased with the expansion of electronic data processing and transmission via the network. When operating on confidential information, it is important that the benefits of sharing and communication of a computer network to be supported by substantial security facilities. This is essential given that computer networks have come to be used including the development of banking, shopping or fees. Following the implementation of security mechanisms in a computer network, information can not be accessed or intercepted by unauthorized people (or curious, possibly even malicious) and will prevent falsification of information transmitted or illegal use of certain services.
Keywords: computer network security, protection, open system, encryption, MS Windows 7, UNIX, Mac OS X, firewall

1. Introduction

The security of computer networks means usually, integrity, availability, reliability and best possible protection of resources. Most times there is no total protection solutions, each implementing of a computer networks security are a compromise between efficiency, cost and settlement operations. A well-secured system can hamper current operations traffic and also it is more expensive then others. Security should be conceived as an inclusive property of a computer system that is embedded in an environment [1]. Security management objective is to eliminate or minimize the vulnerabilities of the computer.

Computer network security protection covers all computer and network connected together [18]. A computer network is a set of computers and other devices interconnected

through communication media, thus ensuring the sharing of a large number of users of all physical resources (disks, printers, scanners), logical (system or application programs) and information (databases, files) available to all connected computers. A computer network consists of two or more devices connected to allow the exchange of information [4]. A computer network should primarily ensure connectivity between multiple computers. For a private network, it may be sufficient to connect two computers to each other directly, and users may, for example, transfer files from one computer to another. But, for Internet, the network must be built so that it can grow to a level to cover the whole world [9].

Technologies that are used for a computer networks have grown dramatically in recent years and the need for interoperability became evident. It had developed a new path for communication between computer systems. An open system is a system based on a common design of a network architecture and supported by a suite of protocols. Open architecture system (open system) maximizes the opportunity for interoperability [15]. OSI (Open System Interconnection) reference model is based on a proposal developed by ISO (International Standards Organization), as a first step in standardizing the various protocols, model is called ISO / OSI-RM (Open Systems Interconnection Reference Model), as it relates to interconnection open systems. OSI model has helped to change the image of computer networks. Is the most discussed and the most mentioned model for a network architecture. However there is no computer network based on this model [6].

One of the most important thing in a computer network is the protocols that are used. A protocol is a set of rules that define how data is formatted and processed into a computer network [15]. If a computer network architecture is open, not only one vendor has the technology for it and control principle and its development. Anyone who has access to it and he can model software and hardware architecture based on that network. The architecture of TCP / IP (Transmission Control Protocol / Internet Protocol) is used in Internet. TCP is able both to transmit and receive simultaneous data streams, even though this may seem opposed to the basic concept of data transmission in many based computer network technologies [14].

Because the need for a increasingly mobility and connectivity, wireless communication has seen a boom in recent years. Spread of mobile devices (laptop computers, PDAs and smartphones) which is largely led to the development of wireless communication technologies, but they were not the only engine. Computers connected by wireless networks are characterized as having a low bandwidth, high latency and unpredictable availability and stability, unlike wired computer networks. In addition, all these features range from device to device and from network to network [19]. Wireless perspective is very appealing.

2. Security threats to computer networks

In the first decades of their existence, computer networks were used by researchers in universities to send e-mails and by corporations employee to share printers. In these circumstances, the security was not so important. But now, when millions of ordinary citizens using the network for banking operations, purchases and tax payments, network security is a major potential problem. Network security problems can be divided in four interconnected areas: privacy, authentication, integrity and non-repudiation.Confidentiality refers to keeping information away from unauthorized users. Authentication is determining the

identity of the person. Non-repudiation involving signatures and integrity checks to ensure accuracy and data protection [10].

Internet was designed to create standards for communication between computers. Internet supports data transfer trough a mechanism called Protocol. Protocols are rules stereotipizate, very detailed, explaining exactly how to change a set of messages. Communication between computer networks is called *internetworking*. The Internet as we know it today is essentially the largest and ultimate computer network, spread across the globe [15].

Security policy of a computer networks should define the approach to be tackle when pursuing a suspected intrusion. Procedures that deal with this type of problem must be clearly specified. A large number of questions about security must be made before an incident happen, so that must responses be as clear and objective. A security policy is a set of rules and procedures that have potential impact and limiting freedoms and, of course, individual security levels of all users. Security policies are very important in system security plan [8], [13].

National Computer Security Center (NCSC) of National Security Agency (NSA) of USA has published a series of documents that define the criteria for classification of trusted and security systems. These criteria represent the frame to develop security systems. Well known "Orange Book" defines seven classes trusted systems:

- Class D - minimum protection - systems that have been evaluated, but have decided not to bring equipment or software for a higher security level;
- Class C1 - discretionary protection - placing the control system only as they need and maintain separation of data users;
- Class C2 - protection of access control - systems which implement access control in C1 class and record actions by user authentication procedures (login);
- Class B1 - type security protection - systems that implement a formal model of political and security;
- Class B2 - structured protection - a system that includes all of the class B1 and it is expected that all topics and articles relating to systems;
- Class B3 - areas of security - systems that meet requirements for monitoring and include administrative intrumente security mechanisms and the ability to signal relevant current events;
- Class A1 - design verification - similar systems in class B3, but with additional architectural features and design requirements associated with formal specification and verification techniques.

3. Models and methods of protecting computer networks and data

For network security is important to implement specific mechanisms based on the physical level (Physical Protection of transmission lines), followed by procedures to block access to the network (firewalls), application of techniques to encode data (encryption) , specific method for the protection of such communication between application processes running on different computers on the network. Security mechanisms also could be related to: preventing violation of security, limiting the damage caused by security violation as they occur and offset their consequences [1], [7].

Cryptographic algorithms are only one piece of the puzzle when it needs to securing a computer network. Using encryption algorithms increases every day as more information becomes digitally encoded and published on the Internet. All this information must be secure with the best encryption method [18]. The main methods of protecting computer networks and data are encryption schemes, digital signatures, digital seals, digital envelope, software protection and security review [11].

An important issue in designing software that will operate, control and secure information system and computer network is the security model that the system or network will be based. Security model implements security policy, which was chosen and implemented by designers of system and computer network [18]. To protect against unauthorized access to computers in a network there are several solutions: using firewalls and secure the network area, authentication and authorization access, creating of secure communication channels, etc.. The main methods of securing a computer network are: firewalls, authentication and authorization external access, NIS service, SSL protocol, S-HTTP protocol, PCT protocol, IP-level security, Secure Shell (SSH). A firewall is a system placed between the internal network (intranet) and external network (internet). The main role is to protect the intranet in accordance with certain rules and criteria that can be set by configuration. The simplest form of protection wall is shown in Figure 1.

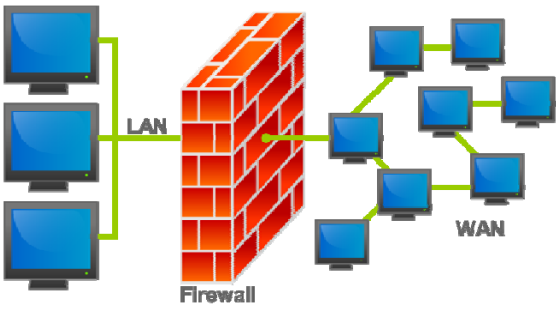

Fig. 1. – Simple form of a firewall

4. Computer networks security under various operating systems

An operating system (OS) is a set of system software programs in a computer that regulate the ways application software programs use the computer hardware and the ways that users control the computer. A computer being secure depends on a number of technologies working properly. A modern operating system provides access to a number of resources, which are available to software running on the system, and to external devices like networks via the kernel. Network services include offerings such as file sharing, print services, email, web sites, and file transfer protocols (FTP), most of which can have compromised security. At the front line of security are hardware devices known as firewalls or intrusion detection/prevention systems. At the operating system level, there are a number of software firewalls available, as well as intrusion detection/prevention systems. Most modern operating systems include a software firewall, which is enabled by default. A software firewall can be configured to allow or deny network traffic to or from a service or application running on the operating system. Therefore, one can install and be

running an insecure service, such as Telnet or FTP, and not have to be threatened by a security breach because the firewall would deny all traffic trying to connect to the service on that port.

MS Windows

MS Windows operating systems have been criticized many times because of the two major weaknesses: the security and reliability. Reliability of an operating system is usually quantified by the time of working without having problems. Unfortunately, MS Windows tends to become unstable after a period of time, unlike other operating systems. Of all desktop operating systems, Windows has a reputation as the most vulnerable to viruses, worms, trojans and other attacks of this kind. Some parts of the MS Windows vulnerability is because it's database of users is very large. MS Windows has many security holes that are found and exploited by malicious people. While Microsoft is vigilant in its efforts to fix these security holes, its developers are always one step behind hackers, and while users waits for security patches their computers are vulnerable [17].

Versions of MS Windows was originally designed for use on a single computer without a network connection, and did not have security features built from begining [20]. However, MS Windows NT and its successors were designed for security (including network security) and multi-user computers, but were not originally designed with an advanced Internet security, since they were first developed in the early 1990s, Internet use was not widespread. Microsoft releases security patches through Windows Update service approximately once a month, although critical updates are available at shorter intervals of time when necessary. While MS Windows 9x operating system series functionality offered to have profiles for multiple users, they had no concept of access privileges, and also does not allow simultaneous access, so that the concept of multi-user was rather false one. On the other hand, they have implemented only partial memory protection. Series of MS Windows NT operating systems, by contrast, were well implemented multi-user functionality, and an absolute memory protection. However, a lot of benefits that made a multi-user system, highly tuned operating system, were canceled because, before MS Windows Vista and MS Windows 7, the first user account created during setup process was an administrator account, which was also default for the next newest accounts. Although MS Windows XP had limited accounts, most home users had fewer rights set for new accounts (because of the large number of programs which unnecessarily required administrator rights). Therefore most users hade accounts on a computer with administrative rights all the time. MS Windows Vista and MS Windows 7 solves this problem by introducing a system of privilege User Account Control. When a person is authenticated from a standard user, a session is created and is assigned a process that contains only basic privileges. In this way, the new session is impossible to make changes that would affect the entire system.

An attack that should be considered when using wireless technology is the threat of data interception. The interception of data, one of the main advantages of wireless technologies, paradoxically, lead to one of its biggest weaknesses. Because wireless transmissions are sent by air to the target device, any system set up correctly in broadcast radio can also receive these messages. Thus, the devices should not be in the computer network can receive transmissions. Expanding computer network through wireless technology has also increased the area of attack by malicious users. Some methods of

ensuring security of computer networks connected by wireless technology are: Protected Access WPA, WEP, 802.1x authentication, etc [12].

UNIX

UNIX operating system with TCP / IP suite for communication and NFS file system is a convenient solution to form a complete operating system in a computer network. Many years before, Dennis Richie said about UNIX security: "It was designed from the outset to be secure. It was designed with the characteristics required to make security services. In other words, Unix can be secured, but any particular system of UNIX may not be secure when it is delivered. Unix has a sophisticated security system that controls user access to files, change the system database and system resources.

Currently there are many techniques that were used to secure computer networks with UNIX operating systems:

- use encryption to protect against violation of access rights;
- strengthening the operating system and applications against attackers;
- physical isolation of system vulnerability;
- firewalls implementing;
- development of advanced authentication systems not based on IP address or hostname;
- development of system traps to detect potential attackers;

In MS Windows operating systems, the user has often and management rights and this can create security problems. Linux operating systems is a clear distinction between the system administrator rights and use rights system. Therefore, only one user has full administrative rights. This is one special user called root. Root has full rights in Linux operating system. He can make configuration, can change how the system starts operating, grant partial rights to other users etc.

Because everything in UNIX is represented as a file, it means that to be able to communicate two UNIX computers on the same network, those must be able to share files. Sharing files is a useful way to distribute information to many users, whatever of their connection to the network. NFS (Network File System) is the method of sharing files between UNIX computers. It is a standard but has some security issues. NFS enables filesystems physically residing on one computer to be used by other computers on the network, and to show users on remote stations like any other local drives.

One of the most powerful and widely used authentication service is Kerberos Authentication Server. Kerberos is a set of protocols that can be used to authenticate access to a computer. It allows network users to communicate in order to reveal the identity and to authenticate, preventing lines of listening situations. Kerberos data encryption performed secrecy. Also, Kerberos provides real-time authentication in an insecure distributed environment.

Advantages of computer network security under UNIX

Unix system's strengths are numerous. It is highly configurable, is well understood by many programmers in the security industry and is the most remarkable existing operating system. Many researches are devoted to understanding and repair any security problems that might arise. Unix is considered a very stable and high performance operating system. In addition, because it was designed to run on multiple hardware platforms (including IBM and

SGI servers) and many versions of these platforms, that can support high data rates required for any firewall that supports a network of computers. It is also immune to the need of restart the computer after the configuration changes, which never happens in Windows NT systems.

Disadvantages of computer network security under UNIX

Problems arise when inexperienced Unix administrators do not know how to install the firewall and disable many vulnerable programs and services (but potentially valuable to a non-firewalled system) which are enabled by default. Many of these vulnerable programs and services (*called daemons*) are configured to run in the security context of root, they can create an attacker with full access to the system once they have exploited vulnerable components. A UNIX *daemon* is a program that works in the background and perform services or functions useful for all users. These programs have been called "daemons" because their operations are hidden from user. Disabling them its relatively simple. Administrators easily delete or rename scripts that activate their start up, or comment code lines from *inetd.conf* configuration file.

Mac OS X

Security is available for different levels in the operating system Mac OS. Mac security architecture must be understood in light of its overall architecture of network security. There are two main network protocols used on the Mac today: AppleTalk and TCP / IP. In general the local AppleTalk provides services that are not available on the Internet: print, share files with other machines on the same network, and applications from homegroup. TCP / IP provides several services globally, including Internet services such as email and websites access. TCP / IP also provides services that have traditionally been available only on AppleTalk, including file sharing and related programs (AppleScript and Apple Events) on the Internet or intranet.

Mac OS X has a reputation of being an operating system easy to use, reliable and very safe.Core operating system Mac OS X is UNIX-based and includes powerful features memory protection that contributes to a low incidence of errors and failures. Also inherits a strong foundation in UNIX witch tends to limit the number of security holes and any damage that can be made by hackers. Another factor that ensures a better security is the small number of viruses that have been developed for attacks against Mac OS X, because most attacks were directed to other operating systems like Windows [17].

In Mac OS X, Apple has implemented a security strategy that is central in operating system design. Security strategy aims: open-source based, security default settings, modern security architecture, innovative security applications, rapid response. Mac OS X security model has four layers. Layers are not independent so that an attacker can exploit a weakness in a single layer of protection offered to pass over one or all four layers. The four-layer security model of the operating system Mac OS X are: physical security, security of Open Firmware, login passwords, user accounts. Figure 2 below shows the network security architecture when Open Door products are included. The lower layer presents two main protocols, AppleTalk and TCP / IP. Even if the AppleTalk protocol is local and is not accessible through the Internet, security remains a concern in many environments.

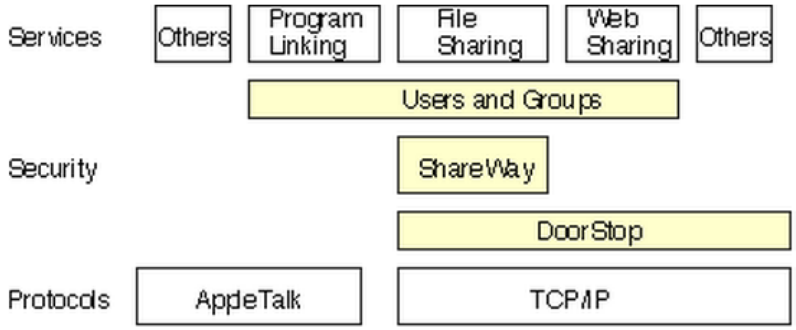

Fig. 2 Macintosh networks security architecture

Advantages of computer network security under Mac OS X

Because Mac operating system is open-source (open source) and Unix based, OS X offers the same advanced security features like other Unix systems. Also, because the operating system core is open source, you can make improvements on it to solve security bugs and add new features. In addition, most implementations OS X Server are based on the Unix components such as Apache Web Server, MySQL database server and Sendmail e-mail. There is a widespread thinking that running a firewall on a Mac is usually safer because most crackers are not familiar with Mac technology. Though there are some reports showing vulnerability in applications running on a Mac, some of them even show the weaknesses of the operating system. There are also easy to configure firewall services. BrickBouse is a user interface API firewall built into Mac OS.

Disadvantages of computer network security under Mac OS X

Significant weaknesses are actually the opposite side of strengths from a Mac operating systems. Because the system is not very known yet, there are many vulnerabilities that waits to be discovered by hackers, who could make a serious attempt to enter the system, especially in areas that are not public for users (eg graphic support areas). Also, because a Mac server has only a limited number of options developed into a firewall API, administrators may feel that they lack something, such as the ability to customize the API to include additional security features, such sophisticated intruders detection. Although some existing open source solutions provide these features, there is no company to produce an enterprise version of a firewall product for OS X [2].

5. Microsoft Windows 7 security

MS Windows 7 is the latest desktop operating system from Microsoft, which was built on the strengths and weaknesses of its predecessor, MS Windows XP and Windows Vista. In addition to basic system enhancements and new services, MS Windows 7 provides more security functionality, enhanced auditing, monitoring capacity and the ability to encrypt personal data and remote connections. MS Windows 7 also has recently developed internal improvements to protect the internal system such as Kernel Patch Protection, Service Hardening, Data Execution Prevention, Address Space Layout Randomization, and required levels of integrity. MS Windows 7 is designed to be used safely. First was developed frameworks Microsoft's Security Development Lifecycle (SDL) and it was designed to support

the Common Criteria requirements, enabling it to carry out Evaluation Assurance Level (EAL) certification, which fulfil Federal Information Processing Standard - FIPS).

MS Windows 7 was built on the foundation of MS Windows Vista security, although improvements have occurred several places such as Group Policies, User Account Control (UAC), BitLocker and Windows Firewall. In addition they have opened several new features such as BitLocker To Go AppLocker and [18].

Firewall Windows Firewall was introduced in MS Windows Vista a step forward from MS Windows XP. Thus, with this major change it became a serious competitor in the market for firewall software. Overall of MS Windows 7's firewall is only slightly better then the one from MS Windows Vista. It has support for filtering outgoing traffic and it also can analyze traffic for all applications in a bidirectional way.

DirectAccess DirectAccess is a new feature may be significant long-term. Using different softwares becomes increasingly complex, and DirectAccess provides easier access to them. This means that there will be no need to make a VPN connection, because this new component do this automatically. This allows a remote machine to remain connected in a business network for as long as it exist an interoperable connectivity.

BitLocker BitLocker is a full disk encryption component included in Ultimate and Enterprise versions of MS Windows Vista and MS Windows 7, also in MS Windows Server 2008 and MS Windows Server 2008 R2 platforms. It is designed to protect data on a hard disk using encryption. It use default encryption technology AES (Advanced Encryption Standard) in CBC mode on 128-bits, combined with the Elephant diffuser for additional disk encryption specific security not provided by AES.

BitLocker To Go BitLocker To Gois an extension of the application BitLocker that supports encryption for detachable hard drive, such as flash memory and USB sticks. BitLocker To Go is only available to Enterprise and Ultimate versions of Microsoft Windows 7. To enable BitLocker To Go, insert a removable hard drive into your computer, and right click on the icon appeared in My Computer and choose the option "Turn on BitLocker".

User Account Control - aims to improve the security of Microsoft Windows by limiting application software to standard user privileges until an administrator authorizes an increase or elevation. In this way, only applications trusted by the user may receive administrative privileges, and malware should be kept from compromising the operating system. In other words, a user account may have administrator privileges assigned to it, but applications that the user runs do not inherit those privileges unless they are approved beforehand or the user explicitly authorizes it.

AppLocker - a set of Group Policy settings that evolved from Software Restriction Policies, to restrict which applications can run on a corporate network, including the ability to restrict based on the application's version number or publisher

Action Center - In MS Windows 7 security-related options were collected in Action Center, an application that replaces the center of security (Security Center) which is found in MS Windows XP and MS Windows Vista. Action Center is designed to work with third-party firewall, antivirus and antispyware programs, and programs implemented in MS Windows 7 (Windows Firewall and Windows Defender), but also with those available, such as Microsoft Security Essentials. The first line of defense in computer security is to protect from attacks from outside. After the computer is connected to the Internet, it becomes just another node on a wide global network. A firewall provides a barrier between your computer and network

that is connected by preventing the entry of unwanted traffic while allowing clear passage for authorized connections. The firewall in MS Windows 7 is enabled by default for all connections, and provide protection even from starting the computer [3].

Using Windows Firewall in different computer network locations

Firewall for MS Windows 7 maintains a separate profile (that is, a complete collection of settings, including rules for different programs, services and ports) for each of the three network location types: area, private and public. Windows Firewall is Control Panel application that provides a simple interface for monitoring the status of firewall and routine tasks such as allowing access to a program or firewall blocking all incoming connections [18]. Like Windows Defender, Windows Firewall can be found in Control Panel. To open the Windows Firewall such as in Figure 3 go to Start Menu > Control Panel > System and Security> Windows Firewall.

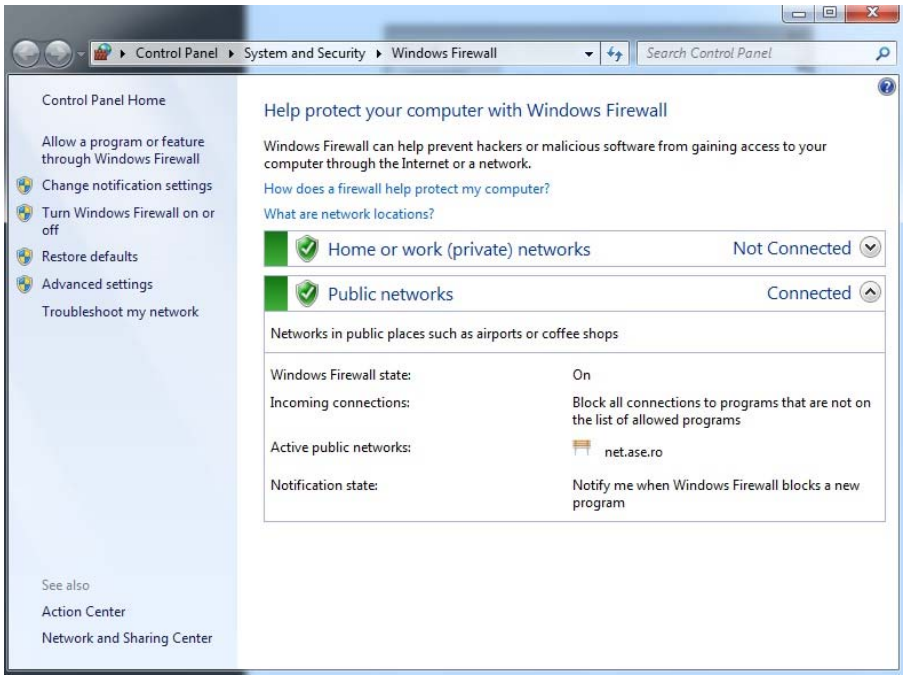

Fig. 3 Windows Firewall shows status and settings for each network connected.

Microsoft Security Essentials

Microsoft Windows 7 does not provide an antivirus program. If a user installs an antivirus program that is recognized and accepted by the Action Center. Microsoft, however, provides MSE (Microsoft Security Essentials), a free security program. It protects against viruses, spyware, trojans and malicious software. It can be free downloaded from *www.microsoft.com/security_essentials* and its installation makes Windows Defender automatically disable [5].

Managing access to resources in a computer network

In any computer network, there are resources to which users should have access to them. Sharing is a process that allows users access from a computer network a certain resource located on a computer. A share network provides a single location to manage data shared by several users. Sharing also provides, that an administrator can install an application once and manage it from one location. You can control user access by assigning permissions to share folders. Sharing permissions are less complex than NTFS permissions (New Technology File System) and can be applied only folders (unlike NTFS permissions that can be applied to both folders and files) [16].

6. Conclusions

Computer network security protection covers all computers connected to the network and devices connected to the network. General attributes that define security are: confidentiality, integrity, authentication, non-repudiation. For network security is important to implement specific mechanisms based on the physical level (physical protection of transmission lines), continuing with the procedure that block access to the network (firewalls), application of techniques to encode data (encryption) , specific method for the protection of such communication between application processes running on different computers on the network. Cryptographic algorithms are only one piece of the puzzle when it comes to securing a computer network. Using encryption algorithms increases every day as more as information becomes digitally encoded and published on the Internet. All this information must be secure and the best method is encryption. Given that there may be interest so many of "breaking" of a computer network, it is obvious that the designers of its hardware and software resources must take serious measures to protect against malicious attempts. Protection methods that can stop "enemies" may be useless or having a very limited impact on some opponents – that they are devoted and with considerable material possibilities.

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TESTING AND SECURITY IN DISTRIBUTED ECONOMETRIC APPLICATIONS REENGINEERING VIA SOFTWARE EVOLUTION

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Abstract: *The objective of this paper is to present the results gathered in research, regarding the testing and the security assurance as key components of distributed econometric applications reengineering. Consequently, the testing and security procedures will be formally shown in order to bring into light the robustness and stability of econometric applications reengineering. The **W** model for software testing in reengineering will be as well exposed as one of the contributions. Agility and iterative features of software reengineering are to be mentioned, with the intention of revealing their use during the lifecycle.*
Keywords: *security reengineering; W testing model for reengineering; distributed applications.*

1. Distributed Applications Requirements and Dynamics through Reengineering

Dynamics, as an important characteristic of distributed applications is brought into light by the software evolution. Distributed applications are constantly being subjected to several types of transformations. They consist of the updates of their structures, such as the addition of new modules or modifications in other modules, so as the software applications does conform to the new objectives they have to achieve. The evolution in objectives has a perpetual correspondent in the evolution of requirements.

Evolution of software is viewed in literature as the other the types of evolution, such as human evolution, social evolution or economic development. The desiderata of stability and concordance have to exist between changes in business processes and changes in software applications, done by means of software maintenance or by reengineering.

The concept of evolution is defined in *Encyclopaedia Britannica*, from a biological perspective. Then customizations are made to present this concept in other ways and for other sciences. In our point of view, software evolution is considered to be the starting point

in the analysis of reengineering, particularly when talking about distributed software or about econometric applications.

Definition 1[1]: *Evolution is the biological theory that plants and animals have their origins in pre-existing species and the differences that distinguish between them are due to changes that took place in successive generations.*

In [3] evolution is defined as a creative concept, an alternative to Charles Darwin's, by Henri Bergson in the work, Creative Evolution, published in 1907. According to this theory, the evolution is achieved due to the natural creative impulse and human motivation.

Definition 2 [2]: *Software evolution is the sub domain of the software engineering discipline that investigates ways to adapt software to the ever-changing user requirements and operating environment.*

The spiral software development model with agile elements that we used in our reengineering projects is observed and it extracts the trends of future iterations. In this way, reengineering and maintenance become predictive processes, more easily to be understood and continued by development teams.

Thus, certain aspects are provided in advance. Therefore, the activity of creating new software becomes an evolutionary process through successive stages of the projects evolution. It becomes straightforward then, to determine correlations between the social and economic developments and their coverage in distributed software applications.

Definition 3: *The evolution of software development is a scientific and technical set of creative phenomena. Creativity and willingness to develop new applications give impulses to specialists to create significant and valuable contributions in the development of new software systems, corresponding to the rapid and continuous changes in the real world.*

Regarding the dynamics of distributed systems and consequently of distributed applications, their evolutionary trend should be noted, while systems configuration changes over time. The successive stages of maintenance and reengineering transform the software entity, in such way that after a certain number of iterations, software applications are becoming very different in comparison to their initial configurations.

The spiral development model with agile elements shows that the integration elements of agility in application development cycle, software configurations are becoming more dynamic, so that the updates in real-world business processes are to be reflected in the structure and objectives of distributed applications in a shorter period of time.

We believe that the software development cycle should be defined correspondingly to the reengineering cycle, so that each stage of the development cycle should have a counterpart in the implementation of the reengineering process. This will offer to software applications higher levels of maintainability and adaptability in the future.

Distributed applications reengineering is an evolutionary and adaptive approach, which incorporates elements from existing IT systems and applications that proved to be valuable for the organization over time. These elements will then be integrated and exploited in the new stage of the system or distributed application, by transformation.

In [4] the text entities reengineering is taken into discussion. By analogy, we present the concept distributed applications reengineering with the involvement of the following aspects:

- the definition of a new objective that has to be achieved, which does not diverge significantly from the initial aim of the distributed application, but reflects a qualitative leap in the level of the outputs;

- the existence of a distributed applications that is to be subject to the transformation process; consequently, the components which remain in the structure and the new modules that should be introduced in the structure should be determined, so that the results should identify themselves within a well-coagulated software; some classes and objects remain in the structure, others being eliminated and others being modified in order to achieve new goals; furthermore, we formalize this by the reengineering function [5] which is defined on the basis of the development function relationship (4) by updating the modular structure of applications which is subjected to reengineering;
- the choice of appropriate technologies so as to reengineer the entire software system; it consists of the architecture, diagrams, classes of objects, databases, relational tables, all included in the new structure of software;
- the establishing of practical quantitative methods and indicators for a precise measuring the quality of each iteration of the process such as engineering, reverse engineering and reengineering; afterwards the software system reaches its final form by being iteratively transformed;
- the accurate description of the evaluation stages of the reengineering life cycle for the efficient management of the budget, people involved in the project and time resources;
- the management of risks related to software reengineering process; this stage is important for the security and integrity of the reengineering projects and contributes to the quality assessment of the reengineering process;
- the team composition, each team member will have specific tasks to be completed within the project; each member of the reengineering team becomes familiar with the applications state-of-art and current technologies.

Distributed applications reengineering is a complex process that presumes transformations and updates to all the levels of software such as client, business logic and database tier. The projects of reengineering assume higher costs and long development durations. Still, reengineering saves many financial resources and besides that, it reduces development costs and keeps the valuable modules of software for a longer period of time.

In distributed applications reengineering, the most common cases are made of migrations to new versions. The needs of such kind of projects are due to the following premises:

- the emergence of new fields of activity, which are to be reflected in the software application, such as economic growth, legislative or tax changes or structural changes;
- the appearance of new categories of goods and services, that are needed to be offered to the customers; depending on the operating activities of the company, it will comply with consumer demands by offering new products involving a high degree of innovation and quality;
- the materialization of new ways to deduct business expenses, due to legal developments and changes in financial accounting;
- new regulations relating to fixed capital depreciation, which update the categories of goods that are repaid, duration and the methods of calculation;
- the need to meet customers' demand in a shorter time and with greater suitability; increasing speed of response to the demand appeared on the market is essential to ensure competitiveness;

- organizational and structural changes are compulsory to be reflected in the computer system of the company;

The key element in software reengineering takes for granted the existence of the original software, which has proved its value in use over time. Due to numerous updates and phases of maintenance, there is a sufficient likelihood that soon the software will no longer achieve the necessary tasks, or his errors will exceed the established level of significance.

Unlike software development process that starts at the green field, with the original vision of the development team, interviewing beneficiaries, determining objectives, determining the preliminary architecture of the system by the time he entered into service, the reengineering project assumes as a starting point the analysis of the existing system in the organization and detection of the problems it faces.

As a result, the reengineering team will decide which of the parts of the initial structure are going to be kept in the new application and which of them are going to be updated or deleted. The key point of reengineering is to reuse the valuable components or modules of the application.

Another key issue in the process of software reengineering consists of identifying the optimal timing of application, based on formula (1). For each of the iterations in the development cycle a time resource *Ti* and a level of total cost CT_i are allotted. The inequalities given in the relations (1) and (2) present these desiderata. But for the maintenance process to be efficient, the cost and duration for the following iterations of adaptive maintenance have to be less or equal to the time and cost of the previous iterations.

$$T_1 >= T_2 >= \ldots T_i \ldots >= T_{n-1} >= T_n \qquad (1)$$

$$CT_1 >= CT_2 >= \ldots CT_i \ldots >= CT_{n-1} >= CT_n \qquad (2)$$

Each one of the iterations within the spiral reengineering model with agile elements reflects on the achievement of a new objective. The new objective is reflected in the requirements identified by the software development process management, due to the interactions with the target group of the IT application. This is shown also in the algorithm in Figure 1.

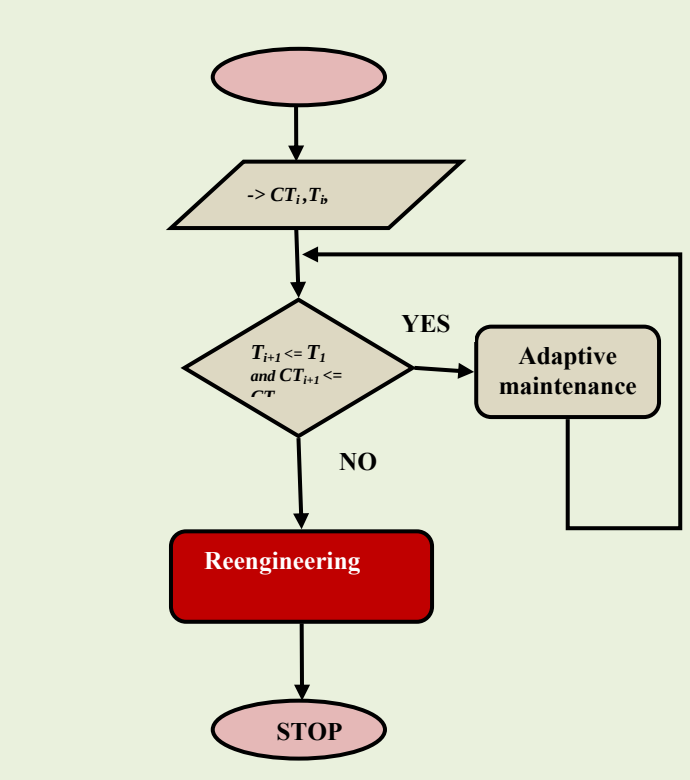

Figure 1. The choice between adaptive maintenance and software reengineering

In figure 1 it is presented how the management of the IT project decides between the continuation of the process of adaptive maintenance for the distributed application and the starting of a new project, which consists of software reengineering.

The idea of reengineering is brought into light because of the growing durations and costs of each adaptive maintenance process, correspondingly to the new objectives appeared in user requirements. Therefore, after several stages of adaptive maintenance, the complexity of the software application [13] is significantly growing and each of the new users' requirements engages additional costs and more and more time resources.

2. Software components reuse in the process of reengineering

The reuse of components constitutes the core element of the reengineering process. The components already existing in the system have to coexist with new elements added to the structure of the software entity.

The reuse of components in reengineering is carried out mostly by the upgrade of their existing structure and behaviour. It is a lot more productive to update the components through the process of software refactoring [10], in comparison to completely abandoning them and then to start the development process from the green field.

In software developers' communities, it is often understood by reuse of components the meaning of source code reuse. This point of view is partially correct, but in a simplistic manner, because distributed applications presume the existence of many other components, with the same importance and need for reuse in reengineering. The reuse of components consequently implies transformations and updates to the level of requirements, to the

architectural level, to the level of detailed design, to the level of unit testing and the database tier, as well as in the source code.

The refactoring process takes into account the existing methods in the classes of objects to give them a high level of quality, by identifying and removing duplicate sequences of code, so - called software clones. Refactoring has the role to provide a higher degree modularity and reusability in the following iterations of software reengineering.

When talking about the life cycle distributed applications reengineering, it is necessary to detect code duplication and subject the software entity to refactoring, because even from earlier stages of the adaptive or corrective maintenance, redundant elements of various types, such as classes of objects, methods, tables, or attributes, were added by method of copy / paste in order to meet the new requirements in a relatively short period of time. That aspect does greatly increase the complexity and the redundancy of software.

The reuse of components is based on the study and preliminary understanding of the basic elements existing in the application being reengineered. Each one of the data structures has to be identified and it should be determined how each data structure contributes to the objectives of the application. Just after that, decisions about the update or elimination of data structures are to be made. However, these decisions also take into account that all the work done by specialists is based on accurate requirements.

The duplication of code and of the databases structures in distributed applications condition the growing of redundancy. This phenomenon is identified and minimized through reengineering. Most of the reengineering process analysed in the community of specialists [6] reported that duplication of code has been detected from 7% to 23%, which in extreme cases went up to 59%. This is the reason why significant efforts have to be made for the detection and the minimization of the level of code duplication in distributed applications reengineering projects.

The process of code compaction is ensured by source code refactoring. Having a compact and stable code is important because this is minimizing the volume of operations performed and reduces the number of calls of the default method as well. This process has great importance in simplifying the class graph of the distributed application. Hence a much clearer picture of the class type entities and interactions between them is developed.

Because changes made in the code by refactoring process are reflected in the architecture and system design, and vice versa, it is desirable to always maintain the link between architecture and actual implementation.

The indicator of code duplication reflects the number of duplicated source code entities divided by the total number of entities from the source code and it is defined as:

$$Idc = \frac{\sum_{i=1}^{n} ClassDup_i}{\sum_{i=1}^{k} Class_i} = \frac{\sum_{i=1}^{n}\sum_{j=1}^{m} MetDup_{ij} + \sum_{i=1}^{n}\sum_{j=1}^{m} AttrDup_{ij}}{\sum_{i=1}^{k}\sum_{j=1}^{p} Met_{ij} + \sum_{i=1}^{k}\sum_{j=1}^{p} Attr_{ij}} \quad (3)$$

where:

- I_{dc} is the indicator of code duplication
- $ClassDup_i$ represents classes are duplicated in the distributed computing application;
- $Class_i$ represent classes of objects within the distributed computing application

- $MetDup_{ij}$ is the duplicated method *j* from the class *i;*
- $AttrDup_{ij}$ is the duplicated attribute *j* from the class *i;*
- *n* is the number of duplicated classes of objects in distributed application;
- *m* is the number of class methods and attributes of objects duplicated;
- *k* represents the total number of classes in the distributed application;
- *t* is the number of duplicate methods within the classes.

This indicator has been taken into account in the process of reengineering the two-stage least squares distributed econometric application for regression analysis. In consequence, the number of code lines has been reduced and several methods were correctly parameterized by refactoring. However, in econometric applications development the correctness of econometric algorithms comes on the first place, and just after the obtaining of correct coefficients of linear models developers have to pass through the source code optimization by refactoring.

The transition of the econometric application from the initial phase to a distributed environment is described in (4), concerned being on the evolution in objectives and modules.

$$Dev\left(\bigcup_{i=1}^{n} Mo_{i1}\right)=\sum_{i=1}^{n} Obj_1^i = Obj^1 \xrightarrow{[\text{Re engineering}]} Dev\left(\bigcup_{i=1}^{n} Mo_{i1}+\bigcup_{i=1}^{m} Mo_{i2}\right)=\sum_{i=1}^{n+m} Obj^i{}_2 = Obj^2 \quad (4)$$

where:

- Mo_{i1} are the distributed application modules after the first iteration of process reengineering
- *Dev* is the development function of the spiral model with agile elements;
- *n* is the number of modules of the application after the first iteration of reengineering;
- *m* is the number of application modules, introduced during the second iteration of the reengineering process;
- Mo_{i2} application modules are distributed result after the second iteration of the reengineering process;
- $Obj^i{}_2$ targets are operational, distributed as a result of the application process reengineering software that are integrated into the ultimate objective of the application;
- Obj^2 is the ultimate aim of application in stage 2 as an arithmetic sum of other objectives.

Quality assurance strategies of distributed applications are very important reengineering. Each one of the updates are being inspected and certified through testing. In the next section, accordingly, the W testing model for reengineering will be defined and described.

3. The W Testing Model for Reengineering

If the process of reengineering starts in a mostly theoretical way, by the determination of requirements and demands, suddenly aspects regarding the study and testing of the existing software application are brought into the play. Initial predictive test are made, for the team to efficiently understand the behaviour and the structure of the

application. In addition to this, behavioural and structural tests are also being defined by the reengineering team.

The initial tests are carried out by the team of specialists, while analyzing the existing information system or software application for the determination of the systems behaviour based on the established factors from requirements.

It is also necessary that in the steps of reengineering discussions and interviews take place between the reengineering team and the target group of users. The ideas and objectives determined through the interviews and the preliminary discussions are the basis of the black box testing phase.

Black-box testing consists of a collection of predictive methods, techniques and procedures used in the analysis of existing software, which is to be subjected to the reengineering process in order to determine the behaviour and utilization patterns. These tests provide an objective view on the IT application.

In [7] there is mentioned that black-box tests identify the applications behaviour, and black – box tests are used in order to determine bugs in the high-level operations as well as the overall functionality of the tested software.

Testing the behaviour of the software application requires an understanding of the domain, and how software contributes and models the activities within the organization. The higher level of design is understood by the team of IT project and black-box test cases are identified. Every test case is placed in correspondence with the activities of the target group of users.

In the case of distributed econometric applications for two-stage least squares regression analysis, it is shown that the development team as well as the teams of maintenance and reengineering must have solid knowledge of statistics and econometric methods and the way to implement them in programming languages. Later in the project, aspects about how to integrate the modules in distributed applications are to be carried out, by means of reengineering.

For distributed econometric applications discussions and interviews are carried out as in the general case of software reengineering. There are group discussions and interviews with the users in order to determine the essential elements of their interaction with the software. These include the following tasks to be achieved by the reengineering team:

- the interviewing of users about the types of problems they solve with the help of the existing econometric application; they describe the elements of statistics and econometrics consisting of the defining of problems which have to be solved and the way in which the econometric problems are integrated into the existing application;
- to get the users description of the types of data sets, here the test team checks the general types of data sets, the maximum number of data series, the maximum number of exogenous variables included in the regression model, the validation of the data sets;
- the way in which the target group of user are dealing with the functionalities of the existing application; the reengineering team follows the human – application interactions, and the way in which each member of the target group reaches his econometric or statistical objectives;
- what the users opinions about the application which is subjected to the analysis are ; if they are pleased regarding the duration of the operations, and how the users perceive the ways of improving of the existing application;

- the unusual aspects determined in the applications history; the target group of users tell to the reengineering team about the problems had in the past, in the use of the software application, and also about the ways and durations of solving of the identified problems;
- get the users opinions about the quality of the application; the target group is formed of specialists in statistics and econometrics, and they have the knowledge to share with the development team, regarding which other statistical or econometric algorithms are needed to be implemented in the application;

In figure 2 there are presented the stages of the distributed econometric application testing during the process of reengineering, integrated in the *W* testing model based on the V model presented in [7].

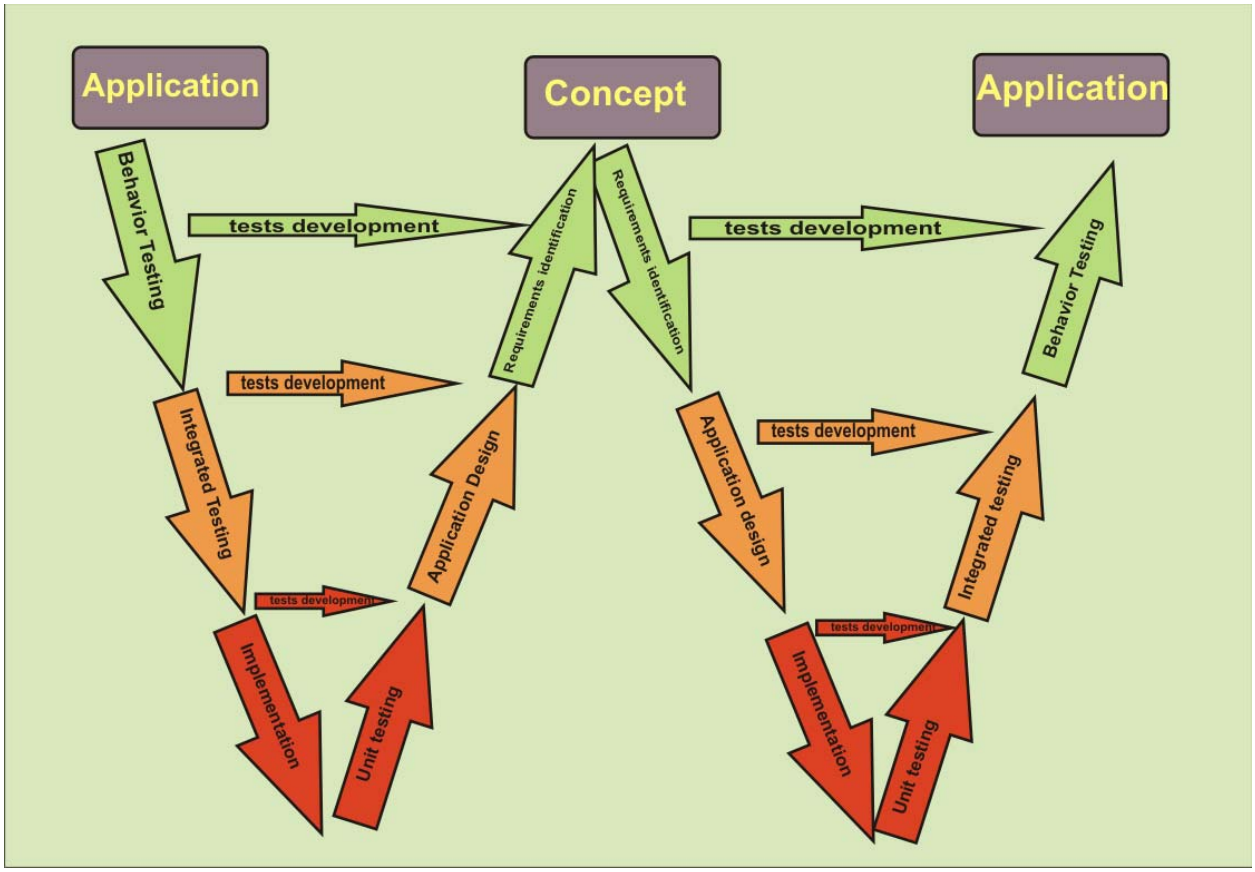

Figure 2. W testing model for software reengineering

In the distributed econometric application for two-stage least squares regression analysis, there are some important aspects, both for black-box, beravior, testing and for the white-box, structural testing.

First of all, the testers have to define the econometric problem, that has to be solved through the software. The defining of the problem presumes the description of the data entered in the regression model, the number of exogenous variables, the number of data series. They have the possibility to enter the data by hand, by completing the tables appeared on the web page or by reading it from binary or XML files. Sometimes, generators linear models can also be used for defining the series of data more rapidly.

Secondly, the testing of correctness of the coefficients determined from the model is prepared, by using the two-stage least squares method, and consequently the two-stage least squares algorithm. The testers are to determine whether the entered data is correctly instantiated in large scale matrices and if the calculations are made correctly. If there are any errors of reading the data from the files, they are recognized and exemplified by the testers.

Another important aspect is the determination of the exact code sequences that generated the results of the calculation of coefficients. The testers introduce several series of data repetitively in order to see whether the application is stable and whether it reflects the modifications made in the series of data entered again.

The computation of the error [11], [12] from the regression model and the analysis of the error are tested, in order to determine whether the error is set between the acceptable limits. In (5) and (6) the formulae for the computing of the error and its limits are presented.

$$Err_i = y_i - \hat{y}_i \qquad (5)$$

where:

- Err_i represents the error term from the series *i* of data from the regression model;
- y_i represents the endogenous, dependent variable of the series *i* of data from the regression model;
- $\hat{y}_i$ represents the estimated endogenous variable;

$$LimInf <= Err_i <= LimSup \qquad (6)$$

where:

- $LimInf$ represents the lower limit of the error;
- $LimSup$ the upper limit of the error;

The testing procedure continues with the computing of the residual sum of squares [11], from (7) which represents the unexplained variance of the model;

$$SSR = \sum_{i=1}^{n} (y_i - \hat{y}_i)^2 \qquad (7)$$

where:

- SSR represents the residual sum of squares;
- $\hat{y}_i$ represents the fitted value for each observation;
- *n* represents the number of data series from the model;

After the computation of the residual sum of squares, the testing procedure goes on to the computing of the total sum of squares, as total variance of the dependent variable, presented in (8), [11] and (9).

$$\bar{y} = n^{-1} \sum_{i=1}^{n} y_i \qquad (8)$$

$$SST = \sum_{i=1}^{n} \left(y_i - \bar{y}\right)^2 \qquad (9)$$

where:

- SST is the total sum of squares;
- $\overline{y}$ is the average of the dependent variable;

The explained sum of squares is defined as the explained variance of the model and reflects the sum of the differences between the fitted values $\hat{y}_i$ and the average of the dependent variable and is presented in (10)

$$SSE = \sum_{i=1}^{n} \left(\hat{y}_i - \overline{y} \right)^2 \qquad (10)$$

The test case will continue by checking whether the total sum of squares is equal to the sum of the explained sum of squares and the residual sum of squares, shown in the relation (11);

$$SST = SSE + SSR; \qquad (11)$$

The next step consists of the computing of the coefficient of determination R^2 presented in (12) and whether it belongs to the interval [0,1].

$$R^2 = SSE / SST = 1 - SSR / SST \qquad (12)$$

Additional aspects related to how the results are saved in binary files, XML files or in databases are also tested, in order that the data should be used again in the future. The testing team checks if the data is correctly saved and whether there are any conversion errors generated by the software during the serialization and deserialization procedures.

All of the relevant aspects determined in the testing stage are taken into account for the transformation process. The recognition and solving of computing issues ensures that the process of reengineering will gain in efficiency and will offer a higher level of quality to the software application.

The test cases are also reflecting upon the security aspects of the application. However, in the following section, several security issues in distributed applications development will be described.

4. Security assurance in distributed econometric applications development

In distributed applications reengineering the security assurance is a very important element, which has always been seriously considered. The work in distributed environments such as computer networks and the sharing of information through the Internet has to notify the presence of threats and dangers.

In our case, due to the technology implemented in the two-stage least squares distributed application for econometrics, it is compulsory to assure that the data and the software are protected in an appropriate manner.

When users want to access the websites of the distributed econometric application they have to pass through the authentication procedure. They have the possibility to create a user account, and after that to login for being redirected the main page.

Asp.NET forms authentication is used for reaching the authentication process, with all the elements provided by .NET Framework [9] and Windows Server 2008. Before the

reengineering process, the application did not have any authentication procedures defined, since it hadn't been projected for the distributed environment. The process of reengineering transformed it radically into a distributed application with special needs, such as concurrent access, authentication, authorization and cryptography. Consequently, custom methods for defining the process of forms authentication have been initialized, due to the target groups' requirements.

The encryption of configuration files has also been achieved for the distributed econometric application, and it was straightforwardly done by means of the .NET Framework, just through the addition of special directives for security.

Before the encryption, the connection strings section from the configuration files looked like in figure 3. The evolution of requirements brought an evolution in the applications configuration security, so as the configuration files and the password table to become encrypted.

```
<connectionStrings>
   <add name="conectionutiliz" connectionString="Data Source=.\SQLEXPRESS;Initial
Catalog=phdresearch2;Integrated Security=True;Pooling=False" />
   <add name="phdresearch2ConnectionString" connectionString="Data
Source=PROGRAMARE03-PC\SQLEXPRESS;Initial Catalog=phdresearch3;Integrated
Security=True"
     providerName="System.Data.SqlClient" />
  </connectionStrings>
```

Figure 3. Web.config connection strings section

After the writing of the encryption method presented in figure 4 and [8], transformations are suddenly made for obtaining the results shown in figure 5. The connection strings section from the web configuration file specifies that there are two databases integrated in the application. The reasons for the integration of two databases are the fact that the econometric application uses a database distributed by replication.

```
    private void EncryptConnectionString()
    {
        System.Configuration.Configuration config =
WebConfigurationManager.OpenWebConfiguration("~");
        ConfigurationSection ConnectConfigSection = config.GetSection("connectionStrings");

        if (ConnectConfigSection != null
            && !ConnectConfigSection.IsReadOnly()
            && !ConnectConfigSection.SectionInformation.IsProtected
            && !ConnectConfigSection.SectionInformation.IsLocked
            )
                {
ConnectConfigSection.SectionInformation.ProtectSection("DataProtectionConfigurationProvid
er");
                    ConnectConfigSection.SectionInformation.ForceSave = true;
                    config.Save(ConfigurationSaveMode.Full);
                }
        else
                {
                    ConnectConfigSection.SectionInformation.UnprotectSection();
                    ConnectConfigSection.SectionInformation.ForceSave = true;
                    config.Save(ConfigurationSaveMode.Full);
                }
    }
```

Figure 4. Asp.Net C# encryption method

The method form figure 4 uses a configuration object defined in the ***System.Configuration*** namespace and in the ***System.Configuration.Configuration*** class. In the method, there is also specified that the section from the web configuration file which will be encrypted is the connection strings section. The security provider for doing the encryption is ***DataProtectionConfigurationProvider*** and it implements Windows Data Protection Api. The key idea is that [8] the Windows Data Protection Api does not allow the exporting of encryption keys, and consequently the application has to run on just a single server, which is good for our case.

If it is necessary to work on multiple application servers the ***DataProtectionConfigurationProvider*** has to be replaced by ***RSAProtectedConfigurationProvider*** which use a RSA publik key cryptography algorithm.

```
<connectionStrings configProtectionProvider="DataProtectionConfigurationProvider">
  <EncryptedData>
   <CipherData>
<CipherValue>AQAAANCMnd8BFdERjHoAwE/Cl+sBAAAAWqz2nwxtwUucSibHUAfMTwQA
AAACAAAAAAAQZgAAAAEAACAAAACU+WAl43JVod9aEOcmhjHJ6DOKgX6vlsQTzj1dF+Vr
nwAAAAAOgAAAAAIAACAAAABInEtiJ4PXYzffxzzi4FzJoRIJnJhsoe5XvOgEmM57QiAFAACygLU
+4nki+6k7WjtQe7Q2FzEXon5Or8A0s7LMQpHxQg1Nh/r0EVDHu4etudMBkGNgrwbC7nkLu
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FrzWRHnUAMx/Xj3YpK3bRIqmuw8+6/ixXvxngNgNeTQVdiusUj6PksHqbFv4hdcPSdFPuCG6li
Fq9+IkkmCkYMvZ+ODg3GtcEtbr4W4EHz2kHRP2CDmqoNChntYq5FnrxlgXfXuB44X4+6PBes
wsgwrN0dl9wFAFrrnNbnBzqRUcweZqE/MUfvX4x5JOiqJ6dQrAvVSBBAcCFyjBhvKYi0qp0MTE7
DiaQtWFKaIjqiT3H45I56t58NNLC2HDSR9QcZYxLncOyBR/MOAmQQqQPIGkvGkM2nsnFeY
32+5s4WlJrGimw8e/dB+fBGw6R0rcBBw9vNNmyYJJFoUMXh+QLOei6U4ZlWvWml8h02RIQ
1ofpxpkcF+Y/DZ2ZnYXYeViaUYwxupjCrKdIf99vDGqTixv6CP4N7W0nAX1UAqnes4es/TSOSl
DZA5HAHcDKrDcD2LTU/XEOGjtHgiYgcGkUMLdrC5dn7DxE/a2bjcIVY9shyjd8I+4Dm4raiPQ
CtjCb5IdLml3fxEjGnnQBJRYEi7l2EN+Zz3mVTFEGBVbDeHjgSSAtfSg+JMzxj6A5UbUWmqXy7
K5UV1TeQThQu+McpwElJrKafkP41LQtkOeqXzpQBjqehgZByf1lkpqkS5BGi1eYqzH1K/urfB0G
KQE7iY4jraakBMNpJKOrLTnLjnNNEaLeu9GbVmZBhUHLboUVZvGJhWX7OievT3oQD+cDsl5
uMxW+uQvTc+rs5lLlzadHtmhVuEopa12CoygedvsKc2OQB6HKeXPjX0sxwXr2YbuGnmoBI6jJ
6lgZBzhKObCBtW9ypBwOBovVIpLZ8WZjGiWuXHxIqPW4IlTP2QWT1iBxJxn9x0SUvN/zsr6ejWf
0Ow1ZlMvP+9xTHVmQSBfwDOjSLjrAmypx9ajMhR60VcvgDhTWbwHoHgWwq4QNx2eB+Bw
+U3n31asYnQxFGi8l9L+uoinNc46OZpn5ASUHFgli1fL+kvCGdgIhwUdj8eRX/D2qGljLYAEE5
wXlIQ2uEXwaN56IcT+ycWicXAxSx1S4II1VlVSWniboe+cY0Z/abfs/UXwuM4B8uBy4FzrrAsVxyij
jO/TUAcVi58ecTLq+VowYOTEY/mwT+bYg/a34DuqJX8cilHnSYjm+UCNYaYXAIR5bHvaoIecL
66HtSqENLiTXjD3eWQuDHbUFErgCYwg0fiIs93OtzPtA2MLS4yzR8l8jaBJhdCuhgf8gdsDvLdYZ
VfbEJKhP6VRZel0g4IF5rkwsq/SelQ+AaEzoJhWVCB/t/FHLoCzIGamI7cZxB7VY+yXmBXgMKU
ZdnP8e5fCAFDdotVPhgacJOP91Q3iWiuyJ5ihMz8EIJYNz22pK6q9hSoQgMhqSQAAAAP4FsZ
NdxtrdnAZUjvCX5ve49csGV1XuYHBLOO+MJKE/3J9aGVQnqkhYhT/SQtQLS6qECtD69BUjaJr
Z44LGSes=</CipherValue>
   </CipherData>
  </EncryptedData>
 </connectionStrings>
```

Figure 5. Web.config with encrypted connection strings section

In figure 5 the encrypted section of connection strings from the configuration file is presented. Potential hackers cannot connect to the databases and access the data, because of the encryption of the connection strings. The only machine which can decrypt the above code is the server on which the application runs on. Attackers may want to break in the server, but it is very difficult, because Windows Server 2008 is one of the most secure servers ever built.

Another very important thing in distributed applications development is the implementing of parameterized SQL Commands and stored procedures. In distributed

econometric applications, the work with the SQL commands has to be done with maximum of care, because hackers may want to forge identities and delete the data from tables. Another important danger which has to be prevented is the SQL Injection Attack. Both of the dangers are prevented by solid authentication and authorization procedures and using correct parameters in SQL commands.

The next iteration of reengineering supposes moving to Windows Communication Foundation and to integrate the existing modules of the application in WCF Services. When talking about Windows Communication Foundation security aspects we have to take into account the transport level security and message level security.

Each one of the above mentioned security directions are important for the development of reliable econometric software as distributed applications. In this case data sent by messages between services in distributed environments is as well encrypted.

To conclude, we may say that security reengineering integrates itself in the IT reengineering project and offers a higher level of confidence in the use and administration of the distributed econometric application.

5. Conclusions

To sum up, this paper has described the objectives achieved by the authors in the field of distributed applications development for econometrics. This desideratum of the reengineering presumed the defining of new strategies of testing, which are different from the ones mentioned in the usual testing model, due to the starting point of the project, which consists of the active application, being subjected to reengineering.

We defined our own indicators and metrics so as to determine the general image of the existing software application, which has been subjected to reengineering. Consequently, the quality assessment became more efficient and the reengineering team had the opportunity to get a more accurate image about the work need to be done in the following stages of the IT project.

Security reengineering implies the study and optimization of the entire software entity at all levels. Furthermore, security reengineering does offer new security strategies concerning the software product, such as architecture, design, source code and database tier. Migrating to new technologies, such as WCF supposes that important changes are made in the security policies, on the basis of the integration of human readable applications into machine to machine communication over distributed systems.

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JOURNAL OF APPLIED QUANTITATIVE METHODS

A MODEL FOR THE EX-ANTE U.K. STOCK MARKET RISK PREMIUM

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Abstract: We propose a model for the aggregate stock market together with its dividend yield and earnings yield so that the ex-ante risk premium could be extracted in an unobserved component modelling framework. We posit the model as a linked stochastic differential equation system and the linking variable is the ex-ante risk premium. By hypothesising a realistic dynamic structure for the ex-ante risk premium, we demonstrate how such a system could be estimated as a filtering problem. As a practical demonstration of the methodology we apply the model to the U.K. stock market data.
Key Words: Ex-Ante Risk Premium, Dividend Yield, Earnings Yield, Kalman Filter

1. Introduction:

Finance research has traditionally focussed on the relationship between stock price, dividends and earnings in order to find an acceptable explanatory model for the observed stock prices. The asset pricing theory predicts that these are related by a quantity that is essentially unobserved and it is referred to as the ex-ante risk premium. The estimation problem of this ex-ante risk premium has spawned a vast empirical literature.

In this letter we approach the problem of estimating the ex-ante risk premium by modelling the relationship between asset price, dividend yield, earnings yield and the ex-ante risk premium as a linked system of continuous time diffusion processes. In particular we assume that the dividend yield mean-reverts to some fraction of the earnings yield, and that the earnings yield itself mean reverts to a long run constant level. These (or related) assumptions can be found in earlier literature such as Davidson, Okunev and Tahir (1996), Campbell and Shiller (1988a, b), Campbell and Kyle (1993).

For the ex-ante risk premium there is less guidance in the literature as to an appropriate dynamic model. The simplest assumption (and that we employ here) is that it follows a mean-reverting process. This assumption was found to give good results in Bhar, Chiarella and Runggaldier (2004) that developed an approach to extract information about the index equity risk premium from index derivatives data. Here we assume that the volatility of the ex-ante risk premium is constant over the sample period. Later we would point out how this assumption could be relaxed and in fact, we have already started investigating other avenues.

The main contribution of this letter is to explain how such a model could be implemented in practice and we demonstrate the methodology using aggregate market data from the U.K. We also highlight the computational issues at the appropriate places in later sections.

In section 2 we discuss the stochastic dynamics for the index, the dividend yield, the earnings yield and the ex-ante risk premium. In section 3 we describe the filtering setup. Section 4 describes the data and the empirical results for the constant volatility case; Section 5 summarises the analysis and points out extensions to the model that are currently being pursued.

2. The Proposed Model:

Let us use $S(t),\ r(t), q(t)$ and $\pi(t)$ to denote respectively the index, the risk-free rate, the dividend yield rate and the ex-ante equity market risk premium at time t. We propose for the movements of the index the geometric Brownian motion process, (actual derivation of this process from the basic principle is described in a working paper available on request),

$$\frac{dS}{S} = \left[r(t) + \pi(t) - q(t)\right]dt + \sigma_S dZ_S \qquad (1)$$

where Z_S is a Wiener process and σ_S is the instantaneous volatility of the index return. In this study we treats σ_S as constant, though we acknowledge that future research may need to consider the dynamics of σ_S also as a diffusion process, thus leading to a stochastic variance model. The intuition expressed by equation (1) is that the expected capital gain on the index equals the risk free rate plus the ex-ante equity market risk premium minus the continuous dividend yield.

Inspired by the approach of Chiang, Davidson and Okunev (1996), who model earnings and dividends as a linked diffusion system, we model earnings yield (e) and dividend yield according to,

$$dq = \beta_q\left(\gamma e - q\right)dt + \sigma_q dZ_q\,, \qquad (2)$$

$$de = \beta_e\left(\bar{e} - e\right)dt + \sigma_e dZ_e\,. \qquad (3)$$

Equation (2) states that the dividend yield is mean-reverting with speed β_q to some fraction of the earnings yield and expresses in yield form the original idea of Lintner (1956) that firms have in mind a target dividend that is some fixed proportion of earnings. When dealing with index returns it seems appropriate to express this relation in yield form.

Equation (3) expresses the notion that the earnings yield is mean-reverting to some long run value $\bar{e}$ with speed β_e. For both processes (2) and (3) we assume independent Wiener processes Z_q and Z_e and the associated volatilities σ_q and σ_e. It seems unlikely that the Wiener processes Z_S, Z_q, and Z_e would be completely independent, so we allow for correlation amongst all of them i.e. we assume the instantaneous correlations between the pairs of variables defined by, ρ_{Sq}, ρ_{Se}, and ρ_{qe}.

Finally, we model the ex-ante risk premium as a mean reverting stochastic system with its own Wiener process. In other words, we specify,

$$d\pi = \beta_\pi\left(\bar{\pi} - \pi\right)dt + \sigma_\pi dZ_\pi . \qquad (4)$$

Also, in this version we allow the Wiener process driving the risk premium to be independent of other Wiener processes in the model. Equations (1), (2), (3) and (4) form a linked stochastic dynamic system. In the next section we show how this linked system could be expressed in the state space framework and the Kalman filter may be applied to estimate the unknown parameters of the system. This estimation process would also allow us to infer the conditional mean and the variance of the ex-ante equity risk premium.

3. State Space Setup for the Proposed Model:

It will be convenient to express (1) in terms of $s = \ln(S)$, i.e.

$$ds = \left(r + \pi - q - 0.5\sigma_S^2\right)dt + \sigma_S dZ_S \qquad (5)$$

With this change of variable equations (2), (3), (4) and (5) form a system of linear stochastic differential equations, to which it is appropriate to apply the Kalman filter. We treat s, q and e as observed quantities and the ex-ante risk premium as the unobserved state variable of the system. For the Kalman filtering application it is convenient to discretise the system (2), (3), (4) and (5) using the Euler-Maruyama scheme. The discretisation of the state equation (4) yields,

$$\pi_t = \beta_\pi\bar{\pi}\Delta t + \left(1 - \beta_\pi\Delta t\right)\pi_{t-1} + \sigma_\pi\varepsilon_{\pi,t}\sqrt{\Delta t} \qquad (6)$$

where, $\varepsilon_{\pi,t} \sim N(0,1)$.

Next, we discretise the measurement equations (2), (3) and (5) and write these in vector notation as,

$$\begin{bmatrix} \Delta s_t \\ \Delta q_t \\ \Delta e_t \end{bmatrix} = \begin{bmatrix} r_{t-1} - q_{t-1} - 0.5\sigma_s^2 \\ \beta_q \gamma e_{t-1} - \beta_q q_{t-1} \\ \beta_e \bar{e} - \beta_e e_{t-1} \end{bmatrix} \Delta t + \begin{bmatrix} \Delta t \\ 0 \\ 0 \end{bmatrix} \pi_t + \begin{bmatrix} \varepsilon_{s,t} \\ \varepsilon_{q,t} \\ \varepsilon_{e,t} \end{bmatrix} \quad (7)$$

where, $\varepsilon_S, \varepsilon_q,$ and ε_e are standard normal variates. The variance-covariance (H) structure of the noise terms in the observation equation (7) implied by equations (2), (3), and (5) is given by,

$$H \equiv \begin{bmatrix} \sigma_s^2 & \rho_{s,q}\sigma_s\sigma_q & \rho_{s,e}\sigma_s\sigma_e \\ \rho_{s,q}\sigma_s\sigma_q & \sigma_q^2 & \rho_{q,e}\sigma_q\sigma_e \\ \rho_{s,e}\sigma_s\sigma_e & \rho_{q,e}\sigma_q\sigma_e & \sigma_e^2 \end{bmatrix} \Delta t. \quad (8)$$

The model parameter vector is, therefore, $\Theta \equiv \left(\sigma_s, \beta_\pi, \bar{\pi}, \sigma_\pi, \beta_q, \gamma, \sigma_q, \beta_e, \bar{e}, \sigma_e, \rho_{s,q}, \rho_{s,e}, \rho_{q,e}\right)$. These parameters are to be estimated by maximising the prediction error form of the likelihood function. The important observation to be made is that the measurement equation (7) is linear in the state variable (π). The details of the algorithm are available from the author on request. This is also discussed in standard books e.g. Bhar and Hamori (2004, page 11).

4. U.K. Market Application:

We have taken the monthly earnings and dividend yields and index price data for the FTSI for the period February 1973 to February 2003, from Data Stream. For the risk-free rate we the UK 3-month Treasury bill rates.

The parameter estimates are displayed in Table 1. The results of various model diagnostic tests are displayed in Tables 2. The filtered equity risk premium is displayed in Figures 1. We see from Table 1 that most estimates are significant. However, β_π, the speed of mean reversion of the risk-premium seems an important exception and the estimate for β_e also has relatively large standard error. Table 2 indicates a reasonably good model fit using a number of diagnostics. As for the risk-premium, Figure 1 tends to indicate that for the U.K. market index there is a structural break, the first around mid 1979 and the second around mid 1998. Over all periods the two standard deviations band is around ±1.5%.

Figure 1
Ex-Ante Equity Risk Premium: U.K. (Filtered Estimate)

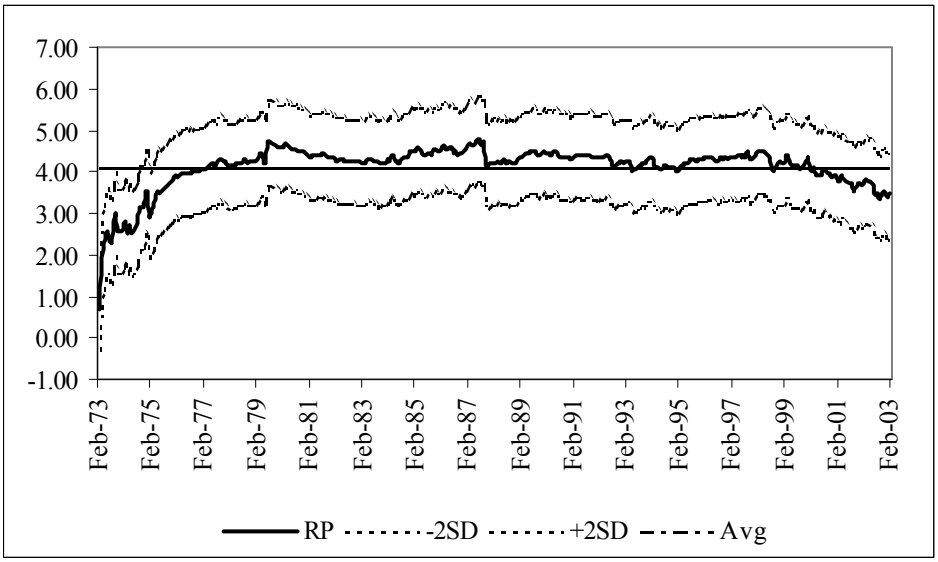

Table 1
Ex-Ante Equity Risk Premium Model for the U.K. Stock Market

Parameters	U.K.
σ_S	2.45369
	(0.08353)
β_π	0.55231
	(0.33519)
$\overline{\pi}$	4.23528
	(0.45011)
σ_π	0.59899
	(0.27487)
β_q	0.14295
	(0.07284)
γ	0.43442
	(0.12988)
σ_q	0.01279
	(0.00043)
β_e	0.02240
	(0.06499)
$\overline{e}$	0.00005
	(0.00140)
σ_e	0.03484
	(0.00116)
ρ_{Sq}	-0.91965
	(0.00735)
ρ_{Se}	-0.82044
	(0.01541)
ρ_{qe}	0.92970
	(0.00649)

Standard errors are in parentheses below the parameter estimates.

Table 2
Residual Diagnostics and Model Adequacy Tests (U.K.)

Equations	Portmanteau	ARCH	KS Test	MNR
ΔS	0.176	0.682	0.176	0.980
Δ Div Yield	0.020	0.068	0.141	0.996
Δ Earn Yield	0.001	0.035	0.193	0.999

Entries are p-values for the respective statistics except for the KS statistic. These diagnostics are computed from the recursive residual of the measurement equation, which corresponds to the spot index process. The null hypothesis in portmanteau test is that the residuals are serially uncorrelated. The ARCH test checks for no serial correlations in the squared residual up to lag 26. Both these test are applicable to recursive residuals as explained in Wells (1996, page 27). MNR is the modified Von Neumann ratio test using recursive residual for model adequacy (see Harvey (1990, chapter 5). KS statistic represents the Kolmogorov-Smirnov test statistic for normality. 95% significance level in this test is 0.072. When KS statistic is less than 0.072 the null hypothesis of normality cannot be rejected at the indicated level of significance.

5. Summary and Concluding Remarks:

We have set up the relationship between the stock market index level, the dividend yield, the earnings yield and the ex-ante risk premium as a system of stochastic differential equations. We have used unobserved component modelling approach and Kalman filtering methodology to estimate the model and obtain filtered estimates of the ex-ante risk premium. The long run levels for the risk premium are consistent with the point estimates obtained from various ex-post regression based studies. The empirical results also suggest that there are at least two different regimes that classify the behaviour of the ex-ante risk premium in the U.K over the sample period.

The methodology developed here shows promise and may be extended in different directions further. First, the indication of the regime changes in the unobserved component could be captured in a hidden Markov framework. In fact we have already started exploring this avenue. Second, some practical application of the one-step ahead prediction available from the filter may be explored. For example, the predicted risk premium may be used to restructure stock portfolio to take advantage of possible excess return.

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RATING SCALE OPTIMIZATION IN SURVEY RESEARCH: AN APPLICATION OF THE RASCH RATING SCALE MODEL

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Abstract: Linacre (1997) describes rating scale optimization as "fine-tuning" to try to squeeze the last ounce of performance out of a test [or survey]". In the survey research arena, rating scale optimization often involves collapsing rating scale categories and performing additional iterative analyses of the data to ensure appropriate fit to the Rasch model. The purpose of this research is to 1) explore the literature as it pertains to rating scales in survey research, 2) discuss Rasch measurement and its applications in survey research, 3) conduct an iterative Rasch analysis of a sample survey dataset that demonstrates how collapsing rating scale categories can sometimes improve construct, communicative and structural validity and increase the reliability of the measures, and 4) discuss the implications of this technique.

Quality rating scales are essential for meaningful measurement in survey research. Because rating scales are the communication medium between the researcher and survey respondents, it is important that "communication validity" is evident in all survey research (Lopez, 1996). Communication validity is the extent to which the survey was developed in a manner that is unambiguous in language, terminology, and meaning for respondents. Further, it is also the extent to which respondents were able to clearly identify the ordered nature of the rating scale response options and accurately distinguish the difference between each category. However, establishing communication validity can be a bit tricky as survey research comes in many shapes and sizes. For example, rating scales may solicit degrees of frequency, agreement, importance, quality, likelihood, and a host of other measures. Selecting a response option is not so uniform either. This may involve selecting a single

response from a dichotomous scale (e.g., yes/no), a trichotomous scale (e.g, yes/maybe/no), or scales with varying ranges and response options (e.g., Strongly Agree, Agree, Disagree, Strongly Disagree). Regardless of the scale used there is the risk of using too few categories which can result in inaccurate findings due to "lumpy" data, or too many categories which can result in better accuracy but also more confusion for the respondent. The sample-dependent nature of the survey also makes choosing the best scale increasingly problematic. It is not uncommon to pilot test a survey on a group of individuals only to find the rating scale did not function the same way for the larger sample. Similarly, this may also happen when an existing instrument and rating scale is administered to a sample from a different population. In any instance, it would be irresponsible and/or naïve to say a one-size-fits-all solution is available for choosing the ideal rating scale given research purposes and respondent samples are so different. Despite this inevitability, Rasch measurement models can optimize rating scale functioning and provide researchers with more meaningful results.

Linacre (1997) describes rating scale optimization as "'fine-tuning'" to try to squeeze the last ounce of performance out of a test [or survey]". Consider the following example. A survey developer envisioned respondents would utilize all the response options along a 7-point continuum to respond to various items, but in actuality, respondents only utilized 5 categories. As Ben Wright, the most notable proponent of Rasch measurement in the world would say, to analyze the scale as though the respondents conceptualized more levels than were actually conceptualized is to deceive ourselves. Rating scales that utilize more response options than survey respondents actually use are ideal candidates for collapsing. However, survey researchers should be warned that this is not always the case. Wright and Linacre (1992) offer guidelines for collapsing rating scales. The authors suggest that any collapsing of categories should above all else, make sense. However, they warn that it is possible that collapsing some qualitative categories may create an artificial category which can have negative effects on validity. To help avoid these pitfalls, survey developers are advised to create a histogram that displays the frequency for which each rating scale category was utilized. From there, one can visually inspect the extent to which the rating scale was utilized and begin to envision which categories would make the most sense to collapse without creating an artificial category. This process is one component of a larger quality control process that evaluates the structural validity of the rating scale. More discussion of these processes as well as a demonstration will be provided in the methodology.

Although rating scale optimization techniques are often implemented by psychometricians and others who are expert in Rasch measurement analyses, few survey researchers in arenas outside the immediate Rasch measurement circles employ these techniques. The authors argue that perhaps survey researchers should consider Rasch measurement, as there can be a great deal of utility in this practice. The purpose of this research is to 1) explore the literature as it pertains to rating scales in survey research, 2) discuss Rasch measurement and its applications in survey research, 3) conduct an iterative Rasch analysis of survey data that demonstrates how collapsing rating scale categories can sometimes improve construct, structural and communicative validity and increase the reliability of the measures, and 4) discuss the implications of this technique.

Literature Regarding Rating Scales

Survey research is perhaps the most popular data collection technique in the social and behavioral sciences. Questionnaires can be conducted verbally, using paper and pencil, or by computer. Questionnaires can be open-ended in which respondents reply with their own words to questions, or they may be closed form in which individuals respond to questions or statements using a specific type of scale. Open-ended questionnaires provide less standardized responses, and researcher bias may influence how the responses are interpreted (Converse & Presser, 1986). The less definitive answers and lengthy responses that often result from open-ended surveys make for more complicated data analysis. Closed forms allow for more specific answers, call for less interpretation from researchers, and improve the ease of data collection. Closed forms include ranked items, check lists, and response scales (McMillan & Schumacher, 2010).

Response scales imply the researcher chooses questions or statements followed by a scale of potential responses which measure intensity of respondents' opinions or beliefs (Nardi, 2006). Rating scales include various types such as Thurstone scales (1928) which are used to measure attitude toward a particular construct by having respondents agree or disagree with statements equating with a predetermined level of favorability for that construct. Guttman scales (1944) also use a dichotomous response format but have statements arranged from least extreme to most extreme so that respondents will have a point of transition from affirmative to negative answers. Semantic differential scales (Osgood, Suci & Tannenbaum, 1957) use bipolar adjectives and offer respondents a range to indicate how their preference toward one or the other descriptor as it relates to a particular construct.

However, the most commonly used scale was created by Rensis Likert in 1932. When responding to an item on a Likert scale, respondents are asked to specify their level of agreement to a given statement (McMillan & Schumacher, 2010). The creation of questions or stems for a Likert scale is both an art and a science. To ensure that the statements get to the heart of the question and remain objective, non-leading, unambiguous, and relatively concise may be quite challenging. In addition to the stems, the response options need careful consideration in order to avoid certain pitfalls and increase the likelihood that the scale will function as intended.

Respondents rely on the labels of a response scale to create meaning for the scale points (Klockars & Yamagishi, 1988). Based upon the purpose of the survey, a response scale may include numerical labels, verbal labels, or both. Ultimately, when scales are verbally labeled for each point, the measurement of validity improves (Krosnick & Fabrigar, 1997). However, while verbal labels have been shown to be more reliable and valid than numerical labels, terms such as "often" and "sometimes" may be ambiguous and result in inaccurate responses (Jamieson, 2004). As the data collection tool is developed, it is essential that the appropriate use of verbal labels remain a focal point for designing a survey that will yield accurate data (Klockars & Yamagishi, 1988).

Stylistic elements, the visual attributes such as background colors, font, and spacing, are features of a response scale that are not necessarily essential, but help to give a survey or questionnaire its "look and feel" (Tourangeau, Mick, Couper, & Conrad, 2004). Respondents will use purely visual cues to aid them in their interpretation of response scale items. Examples include: respondents tend to assume a middle position means typical, something positioned left and top means first, things placed near one another imply they are

related, items placed in the upper portion of the scale are viewed as good or positive, and similar appearance is interpreted as close in meaning (Tourangeau, Couper, & Conrad, 2004). In addition, when the extreme end points of the scale are shaded in different hues, responses tend to shift to the higher end of the response scale than when both extreme ends are shaded in the same hue (Tourangeau, Couper, & Conrad, 2007).

Two characteristics demonstrated by survey respondents, *acquiescence* and *extreme responses,* may have an effect on how answers are provided (Billiet & McClendon, 2000; Cheung & Rensvold, 2000; Moors, 2003). The idea of *extreme response* refers to a respondent's tendency to choose items at the extreme ends of a response scale (Moors, 2008). Those who have the option of a mid-point do not necessarily answer the question or item in the same way that they would if they were forced to "choose a side" about the issue being explored (Bishop, 1987; Kalton, Roberts, & Holt, 1980). When deciding whether to include a mid-point in a response scale, it is also imperative to consider how the mid-point option may be interpreted by respondents. Respondents may use this option when the middle category accurately describes their neutral position regarding an item on a response scale. Another interpretation is that a mid-point may equate to "no opinion" (Maitland, 2009). This response may be an "easy out" for respondents who are unwilling or unable to express their opinion due to the cognitive encumbrance of a particular response scale item (Krosnick, 1991).

Researchers usually desire their respondents to make a definite choice rather than to choose a neutral or middle position. Therefore, it may be said that a response scale without a mid-point or neutral point would be preferred as long as it did not affect the validity or the reliability of the responses (Garland, 1991). It has been suggested that the inclusion of a mid-point leads to lower reliability for shorter response scales that have fewer items (Alwin, 2007).

Response options should allow respondents to both sufficiently and accurately discriminate between scale options. In other words, a range of choices allows for better classification, but too many choices makes precision problematic (DeVellis, 1991). The cognitive processes needed for respondents to generate answers could be a factor in whether or not the respondent is optimizing or satisficing when giving their response (Krosnick, 1999). Satisficing implies that respondents are not putting forth full effort to provide their most thought-out response. A large number of response items offer no empirical advantage over a small number, and experiments suggest that four to seven categories be used to optimize validity and to provide consistent and reliable participant responses (McKelvie, 1978; Weng, 2004; Lozano, Garicai-Cueto, and Muniz, 2008).

Rasch Measurement

Rasch modeling is already a popular method of choice in the survey research arena particularly in the health sciences, business and psychology, but it is also quickly becoming the norm for establishing quality measurement and valid instruments in all the social sciences. Rasch models are logistic, latent trait models of probability for monotonically increasing functions. Unlike statistical models that are developed based on data, Rasch measurement models are static models that are imposed upon data. Rasch models are invariant and assume the probability of a respondent agreeing with a particular item is a logistic function of the relative distance between the person and item location on a linear

continuum. Rasch models require unidimensional data and may be utilized in both dichotomous and polytomous scenarios.

With survey research, polytomous models are often employed. When a survey utilizes a rating scale that is consistent with regard to the number of response options (i.e., a 5-point rating scale for all items), the Rating Scale Model (Andrich, 1978) would be the appropriate model to apply. The formulae for the Rating Scale Model are presented below:

$$\ln (P_{nik}/P_{ni(k-1)}) = B_n - D_i - F_k$$

where,
P_{nik} is the probability that person *n* encountering item $_i$ is observed in category $_k$,
$P_{ni(k-1)}$ is the probability that the observation (or response) would be in category $_{k-1}$,
B_n is the "ability" (attitude, etc.) measure of person $_n$,
D_i is the "difficulty" measure of item $_i$,
F_k is the impediment to being observed in category $_k$ relative to category $_{k-1}$.

In situations where the rating scale varies from item to item (i.e., some items utilize a 5-point rating scale, others use a different 4-point scale), the Partial Credit Model (Masters, 1982) would be the appropriate model to apply. The formulae for the Partial Credit Model are presented below:

$$\ln (P_{nik}/P_{ni(k-1)}) = B_n - D_{ik}$$

Although the process of Rasch analysis is well documented in the literature (see Wright and Stone, 1979; Wright and Stone, 1999; Smith, Jr. & Smith, 2004; and Bond & Fox, 2007), it would be suffice to say that the analysis is largely concerned with the extent to which observed data match what is expected by the model.

Method

Instrument and Data

The data utilized in this study is from an academic misconduct study of 262 undergraduate business and economics students from a southern university. A 20 item instrument asked students to rate the extent to which they believed each item would affect the frequency of academic misconduct. The rating scale consisted of five categories: 1-Definitely would reduce academic misconduct; 2-Probably would reduce academic misconduct; 3-Would not affect misconduct; 4-Probably would increase academic misconduct; and, 5-Definitely would increase academic misconduct.

Rating Scale Diagnostics

Investigating rating scale diagnostics is useful as it demonstrates the extent to which respondents utilized each rating scale option (see Table 1). Here, counts and percents are provided to illustrate these points. Infit and outfit mean square statistics provide information about how well each category fits the Rating Scale Model. Based on these data, it is apparent that most respondents utilized ratings 1-3, with rating 4 utilized some (7% of the time), and rating 5 seldom utilized (3% of the time). Based on this information, one could establish a case that ratings 4 and 5 should be collapsed and re-analyzed. Also, because

the scale is balanced and contains a midpoint (response category 3), one might wish to make the scale a trichotomy by collapsing 1 and 2 into a single category, maintaining 3 as a midpoint, and collapsing 4 and 5 into a single category as well. Because it would make sense, at least on the surface, to consider these scenarios, an iterative analysis will be performed to determine which, if any, scenario provides the most meaningful information and improves the quality of measurement taking place with these data.

Table 1

Rating Scale Diagnostics

Rating Scale Category	Count	Percent	Infit Mnsq	Outfit Mnsq
1=Definitely would reduce academic misconduct	943	19	1.03	1.01
2=Probably would reduce academic misconduct	1637	33	.86	.89
3=Would not affect misconduct	1884	38	.91	.89
4=Probably would increase misconduct	326	7	1.00	1.01
5=Definitely would increase misconduct	140	3	1.27	1.34

Iterative Analyses

Three separate analyses were performed using Winsteps (Linacre, 2010) measurement software based on the rationale mentioned above. The first analysis investigated the quality of measurement and rating scale functioning based on the 12345 rating scale schema provided to survey participants. The second analysis investigated the same criteria for a rating scale which collapsed categories 4 and 5 as they were rarely utilized by survey respondents. The third analysis collapsed categories 1 and 2 as they were both categories that referred to reducing academic misconduct, collapsed categories 4 and 5 as they were both categories that referred to increasing academic misconduct, and category 3 remained unaltered as it provided the neutral category in the scale.

Probability Curves

Probability curves provide an excellent tool to visually view how well the rating scale is functioning. With a rating scale that is functioning well, a series of distinguishable hills should be present. Each hill should somewhat stand alone, as hills that tend to blend in with other hills indicate categories which raters may have a found difficult to endorse. Below are the probability curves for the three analyses performed in this study.

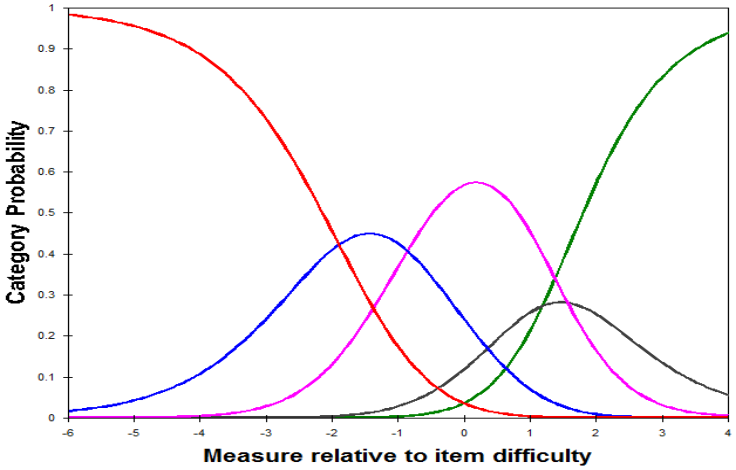

Figure 1. Rating Scale "12345"

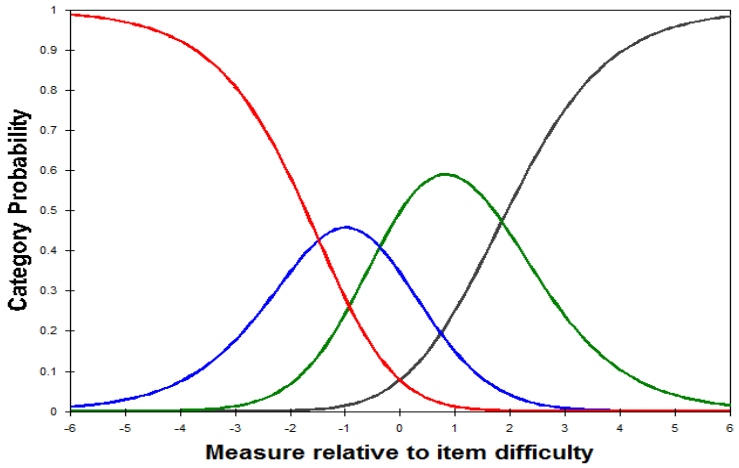

Figure 2. Rating Scale "Collapse 4,5"

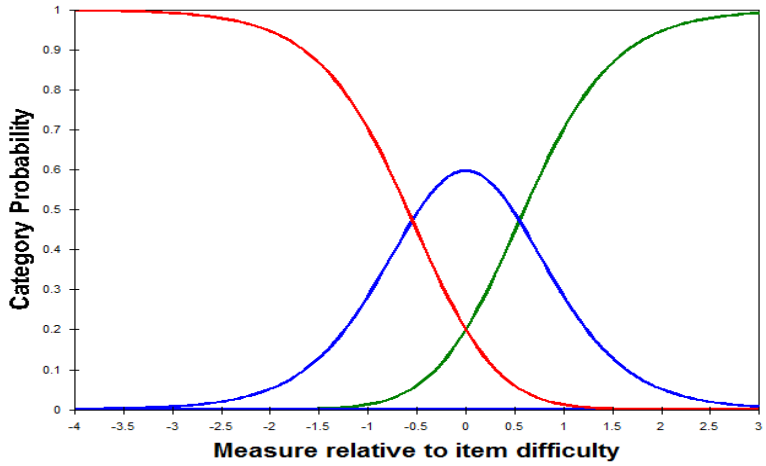

Figure 3. Rating Scale "Collapse 1,2; 4,5"

Figure 1 contains five hills, each indicating a rating scale response option (12345). Figure 2 illustrates four hills representing four rating scale categories (11244). Figure 3 illustrates three response categories (11355). Often probability curves will quickly indicate

rating scale problems as it relates to functioning, but here, all three figures illustrate hills that would be considered acceptable.

Results

Results of the three analyses are provided in Table 2. It appears collapsing categories 4 and 5 best optimized the use of the rating scale, as it improved separation and reliability measures and provided better data to model fit (improved validity) than the other two analyses. Leaving the scale unaltered by no means provided poor measurement, as the statistical indicators suggest the data fit quite well and the measures were sound. However, when the goal is maximize meaning, it is evident that collapsing categories 4 and 5 provided the most meaningful information.

Table 2

Reliability and Validity Measures

Rating	Separation		Reliability		Infit Mnsq		Outfit Mnsq	
Scale	Person	Item	Person	Item	Person	Item	Person	Item
12345	1.81	7.36	.77	.98	1.02	.98	1.00	1.00
Collapse 4,5	1.94	7.42	.79	.98	.99	1.00	1.01	1.00
Collapse 1,2; 4,5	1.50	7.17	.69	.98	1.03	1.00	.99	.98

Discussion and Conclusions

Initially, rating scale diagnostics indicated categories 4 and 5 of the rating scale were seldom utilized by survey respondents. For this reason, categories 4 and 5 were collapsed and the data were re-analyzed. Because categories 1 and 2 at the opposite end of the scale measure a related response "decreasing academic misconduct", it is within reason to test whether or not collapsing these categories would improve measurement as well. Data were re-analyzed on the trichotomous scale as well. Results indicate collapsing categories 4 and 5 improved measurement quality in this particular study. However, further collapsing categories 1 and 2 in addition to categories 4 and 5 negatively impacted the quality of measurement. In this particular instance data to model fit was not grossly affected by the additional collapsing, as fit indices suggested a negligible decrease in fit. However, reliability (one aspect of generalizability) dramatically decreased by about .10. An investigation of separation measures indicate the additional collapsing decreased the spread of the person measures, thus resulting in weaker reliability.

From the three analyses, results that indicate the most valid and reliable measures should be reported. In this case, the most meaningful measurement came from a rating scale that collapses categories 4 and 5. What does this mean for practice? Does it mean the researcher should collapse the rating scale to a 4-point scale for future administrations of the survey? Not necessarily. It would be perfectly acceptable to continue administering the survey in its present form. After all, there is no theoretical reason not to. Further, results indicate data fit the Rating Scale Model very well and the validity and reliability measures that were produced with the default 5-point scale were quite good. However, when the goal

is to "squeeze every ounce of performance out of a survey", as Mike Linacre aptly stated, one should use the strongest measures available to present results (2002).

Although rating scale optimization offers a number of potential benefits, not all survey researchers will embrace the practice. Many survey researchers are taught that rating scales should always be balanced, both in the data collection and reporting phases of research. Some researchers might contend balanced scale reporting is more aesthetically pleasing, or perhaps more true to form. Although the authors of the present study agree that balanced scales are generally well-advised, we contend that survey researchers should place a premium on obtaining meaningful results. That is, obtaining high-quality measures of validity and reliability are of the utmost concern. In some instances, following the "best practice" of balanced scales will impede our search for the most valid results and reliable measures possible. When this is the case, best practice reporting or conventions of aesthetics should be reconsidered.

Numerous studies have successfully optimized rating scales via collapsing categories. Although the present study demonstrates only a minor improvement of what is possible, several studies have shown significant advantages of this useful technique. Smith, Wakely, de Kruif, and Swartz (2003) collapsed a 10-point scale into a more meaningful 4-point scale, then re-administered the 4-point scale successfully in later administrations. Mark Stone (1998) was able to successfully collapse a 4-point Beck Depression Inventory into a dichotomy, as well as a 5-point survey focusing on fear. With regard to the fear dichotomy he points out, "Simple identification of fear is sufficient. Attempts to discriminate further are not useful" (p. 65). This is an excellent point, as sometimes the most useful and meaningful information resulting from survey analyses is simply whether or not a trait or phenomena is present or absent. Any attempts to dig further are futile in practice.

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FINANCIAL BEHAVIOR OF ROMANIANS - PRELIMINARY ISSUES OF THE HOUSEHOLD BUDGET SURVEY WITH AN EXTENSION OF THE QUESTIONNAIRE

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Abstract: In the context of an unprecedented acceleration of the demographic ageing process the objective of financial stability at different levels of the economy needs economic and social measures that are based on scientific grounds regarding the identification, analysis and forecasting of the changes in the financial behavior of both economic agents and the population. Pertinent data are necessary for the analysis, and since they did not exist to the necessary extent, we came up with the **original idea** of using the existent infrastructure for projection and implementation of the Household Budget Survey in the territory, to which a **pilot section** was added. The present approach aims at presenting the preliminary results of the pilot questionnaire, dedicated to financial behavior of the households.

Key words: demographic ageing, financial behavior, saving behavior, life insurance, private pensions

1. Introduction

During the past two decades, the economic, social and financial systems of the developed countries, especially those of the European Union, have been suffering from numerous disequilibria generated by the deepening of the demographic ageing process.

In Romania, the coercive pronatalist policy from the years 1966-1989 caused an artificial Romanian baby-boom, which peaked in 1967 – 1968. After the fall of Ceausescu's communist regime at the end of 1989, the draconic legislation regarding abortion was revoked.

The decrease of natality that followed was a predictable reaction of the reproductive behavior of the population towards the old abusive pronatalist policy. However, the steepness of the decrease took the specialists by surprise. The total fertility rate plunged from 3.7 children per woman (for the whole duration of her fertile life) in 1967 to 1.8 in 1990 and to 1.3 in 2008. This level is much lower than the threshold for replacing the generations, which in Romania would be of 2.1 children per woman.

After 1990, the evolutions of natality and mortality corroborated with net emigration led to the decline of the population, but this is not the process that raises the most concerns from the point of view of the multiple implications for the economy and the society.

The divergent evolutions of natality in the two periods (communist and transition to a social market economy) caused important deformations in the age structure of the population in the sense of an unprecedented acceleration of the demographic ageing process. The weight of the elderly (65 years and more) in the total population grew from 8.3% in 1968 to 10.3% in 1990 and to almost 15% in 2008 and it is expected to reach 20% in 2032.

The effects of these structural mutations are already felt nowadays, but they will grow even stronger after 2032, when the generations of baby-boomers retire.

The implications of these demographic evolutions are complex and they can be felt both at macroeconomic and at microeconomic levels, especially at household level.

For **the economy as a whole**, it implies effects in the spheres of economic growth and inflation, of equilibrium and function of the pension and health systems, as well as on economies, prices, property and stock assets and so forth.

At household level, the individuals become aware of the fact that they will live longer (or at least they realize that the ones around them do) and, as a consequence, they adapt their behavior according to this perception, as well as according to the public policies and the general economic environment.

According to the **theory of life cycle (Modigliani and Brumberg, 1954)**, the financial behavior is different for both the youth and the elderly compared to maturity. Furthermore, the **theory of permanent income (M. Friedman, 1975)** states that, for certain conjunctures, the active population may be stimulated to increase their caution savings in order to compensate for a possible relative decrease of the future benefits after retirement. One of those conjunctures is the present world financial crisis, whose effects have started to be felt in the second semester of 2008 in Romania as well, through the erosion of the national currency, increase of unemployment, inflation, external payments balance and so forth.

In this context, the objective of financial stability at different levels of the economy needs economic and social measures that are based scientific grounds regarding the identification, analysis and forecasting of the changes in the financial behavior of both economic agents and the population.

Identification of the particularities of the population's financial behavior means to analyze the **saving, indebtedness and accumulation** components of the population, according to age, income, education level, patrimony, socio-professional category or other socio-demo-economic or cultural variables.

These characteristics are determinant for knowing and orienting **consumption, placements, intergeneration transfers, financial or non-financial patrimony accumulation and so forth.,** at **microeconomic** level (households or marketing policy at company level), **sectorial, institutional** (banks), as well as **macroeconomic.**

Building up answers firstly requires the characterization of behaviors according to age, generation and observation date. **This actually means grasping those particularities of the behaviors that emerge from combining the generation effects with present ones**. In reality, there are great difficulties in observing these effects due to

lack of longitudinal data. These are the only source for generation analysis, all other available sources observing only momentary effects.

The problem of the lack of appropriate informational sources is stringent in most EU countries, specific researches being relatively new. During the last decade, the Romanian informational statistic system has made actual progresses with regard to social-economic surveys, but it does not have yet a high level of organization and refining, so as to offer data regarding the financial behavior by all demographic and socio-economical variables mentioned above.

Solving some of these informational problems constituted the purpose of the research project entitled **"Modeling the financial behavior of the population under the impact of demographic ageing. System of specific indicators and measures for controlling the financial disequilibria"**, financed by the state budget through the contract number 91-016/2007 CNMP (National Centre for Program Management), in the competition Partnerships PNDII2007[1] Romania.

2. Methodology

In Romania, the **Household Budget Survey** (HBS) is a survey with representative sample at national level realized by the National Institute of Statistics. Starting with 2001, it was organized according to a methodology harmonized with EUROSTAT recommendations, as transversal record, instead of panel. However, the published results of the survey are not sufficient for reaching the aims of the project mentioned before. This is because the survey questionnaire includes questions regarding the financial behavior only to a small extent and in a synthetic way (population savings and loan rates) and the following processing of data stops only at general results and does not continue with demo-economic and social structures of the households.

Due to the limited financial resources of the project, the research team looked for solutions that ***avoided the very high costs*** implied by the *projection and organization of a* ***new survey.*** Thus, we came up with the **original idea** of using the existent infrastructure for projection and implementation of the Household Budget Survey in the territory, to which a **pilot section** was added.

This section had 6 basic fundamental questions, with multiple vertical and horizontal questions, taking into account two aspects:

a) Avoiding to overload the HBS questionnaire, which was already very complex, with more than one sheet (front and back);

b) Avoiding non-responses and inadequate responses

The six questions regarded:

- The type of financial placement (in lei or in foreign currency)
- Financial patrimony
- Incomes from rents, sub-rents, inheritance, insurances, different state allowances and so forth
- Solutions taken into account within the household for supplementation of incomes after retirement

[1] website: www.idcfp.ase.ro

- Household attitude towards risk, by four main chapters: health, professional career, income management and financial and non-financial patrimony administration

The first wave of field records was made during April-June 2008, together with the Household Budget Survey from the second trimester of 2008. The sampling and results estimation methodology was the same as for normal HBS. The sample comprised 9360 permanent households, distributed in sub samples of 3120 permanent households per month. The total answer rate was 85.9% (80.3% in urban area and 92.5% in rural area).

In the first stage, a specific IT solution was created for the database generation of the pilot section. In the second stage, the database was calibrated through statistic procedures and then developed through multiple crossings of the variables from the pilot section with variables from the regular HBS questionnaire, using specialized software. The database was saved under more utility programs, in order to make it as accessible as possible to the members of the research team.

The present approach aims at presenting the preliminary results of the pilot questionnaire, dedicated to financial behavior of the households. The authors intend to develop, finish and refine the results, respectively to model the financial behavior of the population after the development of the second HBS wave in May 2010.

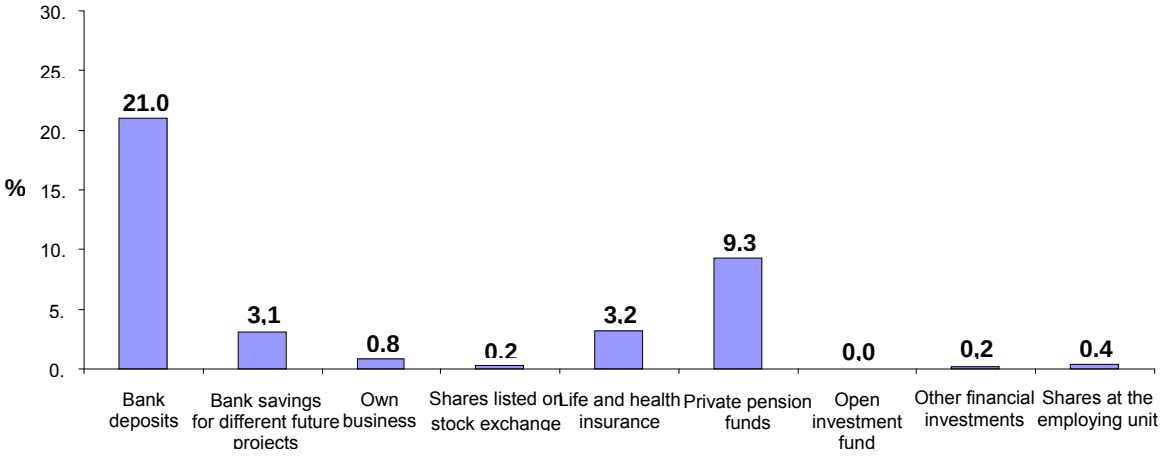
3. Preliminary Results of HBS

The first important result: **67.4% of the Romanian households reported that they had no financial investment at the time of the survey (second quarter of 2008).**

Among the **32.6%** households that had at least one financial investment, most had savings in **bank deposits** (21%), which shows a high level of confidence in banking products, compared to other methods of financial investments (Figure 1).

Figure 1

Percentage of households having financial investment in total households



On the second place in the top of preferences, but at great distance from the first place, were **private pension funds** - 9.8% of investment preferences, followed by **life or health insurance**, as well as **savings in banks for different future plans** (house, holidays, children's education and so forth). The "appetite" for large investments in private pension funds is explained by the entrance into force of the legislation on privately managed

mandatory pensions (second pillar), on the 1st of January 2008. According to it, all persons younger than or exactly 35 years old on the 31st of December 2007 were forced to opt for a private pension fund towards which to direct a certain percentage of individual contribution to CAS (Contributions for social insurances). This decision also referred to those who had less than or exactly 45 years old on the 31st of December 2007, but it was optional.

3.1. Specific results

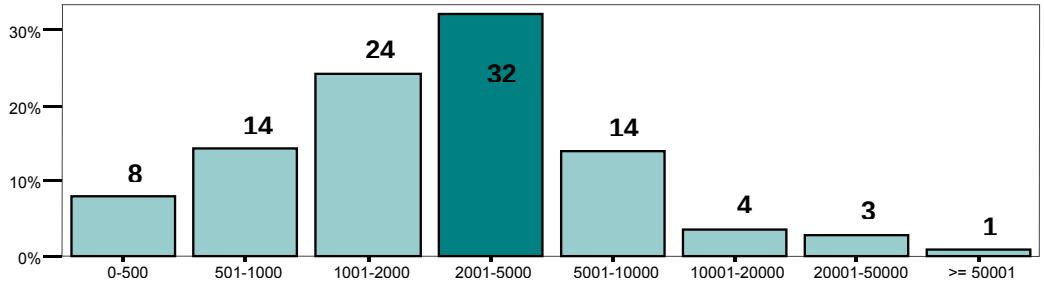
Further on, the analysis of the financial behavior of the population will focus exclusively and righteously on **the segment of those who reported at least one financial investment at the time of the interview** at HBS (Household Budget Survey). The replies of the heads of these households will be studied using advanced statistical methods and techniques so that we can grasp the specifics of their financial behavior by demographic, socio-economic and cultural characteristics.

Focusing on the households that had savings in bank deposits, we extended the analysis on the value of the installments where they fit.

The result: a highly asymmetric distribution of households on the value interval, because most declared small value savings (Figure 2). Approximately 78% of households with financial placements have savings less than 5000 lei (approximately 1180 Euros)[2] in bank deposits. Strong concentration to the left of the histogram shows both the low financial resources of Romanian households, and low propensity to save in the financial system. Undoubtedly, there is a part of the population's savings that remains outside the financial system, banking and non-banking, the so-called "money from the mattress".

Figure 2

Bank deposits (accounts, certificates of deposits etc.) according to the installment value declared (lei)



Continuously following the objectives of this phase of our project, we have deepened the analysis of the feature contained in each question in the experimental section with demographic, socio-economic and cultural variables.

3.1.1. Demographic and socio-economic profile of the households that have savings in bank deposits

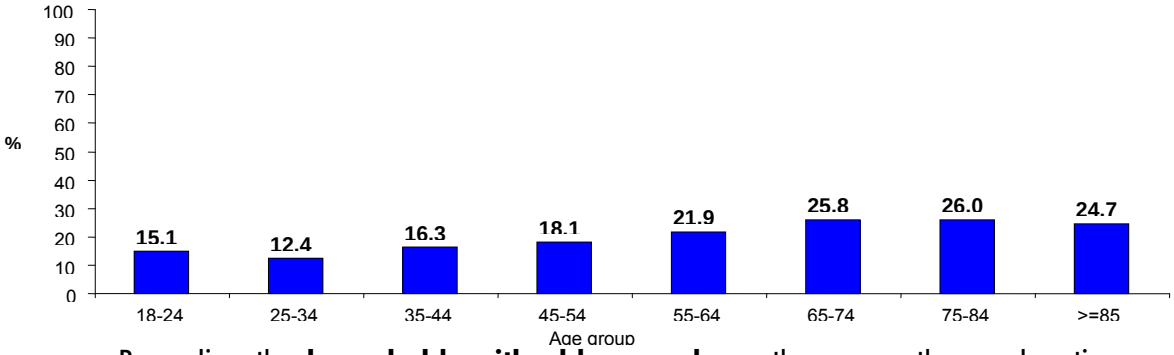
Out of processing the data, we derived that there is a direct link between the frequency of savings ownership in bank deposits and the age of the head of the household. As **age** increases, the share of households who reported savings deposits in banks also

[2] 1 euro=4,2372 lei, official exchange rate of the National Bank of Romania, 18.06.2010

increases (Figure 3). This conclusion is not true for the relationship between age and the amount saved.

In case of young households, the relatively large weights have several explanations. In general, young people are more open and more eager to use electronic means of payment, credits and so forth. These are the 'Internet generations', who receive a series of grants and state allowances until they turn 18 and scholarships up to 25 years (in the case of continuing education) on bank cards. On the same cards or on other separate ones they can make various savings.

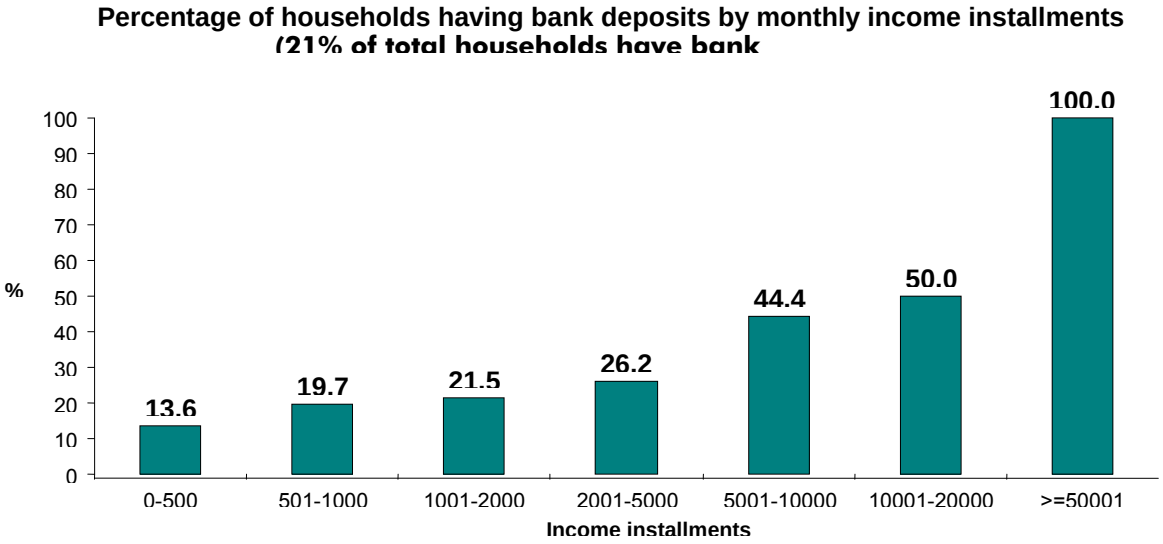
Figure 3
Percentage of households having bank deposits by age groups (21% of all households have bank accounts)



Regarding the **households with elder members**, there are other explanations. They predominantly include cultural factors, since most Romanians do not have a financial education in the true sense of the word. Until 1990, savings were almost entirely concentrated in the state-owned CEC Bank (Savings Bank), and loans were rare and on short-term. On a relatively large scale, the current financial behavior, as it manifests itself at the elder generations, is marked by inertia of former behavior. Despite the fact that, in the meantime, CEC turned into a commercial bank and it competes with all the other banks, these generations firstly grant their trust mainly to CEC.

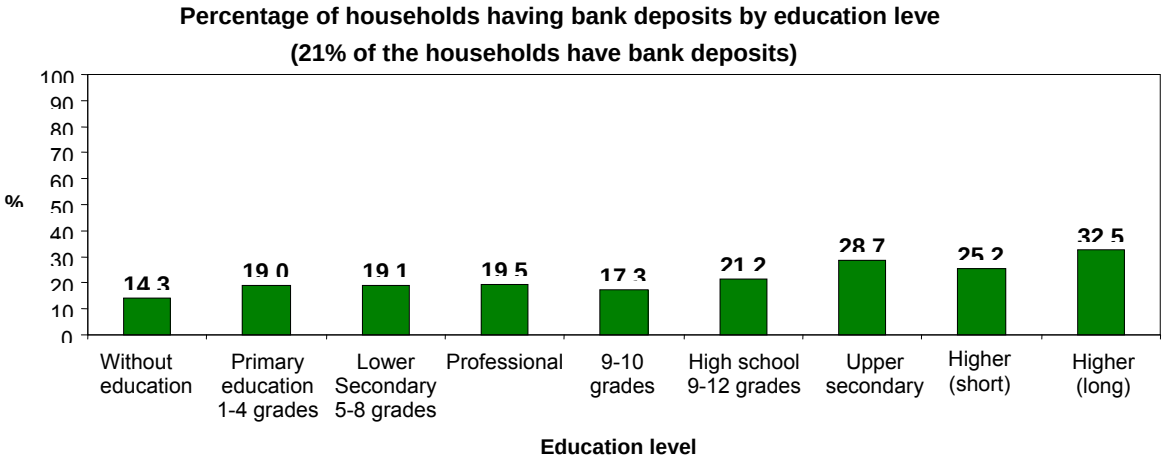
Also, the higher propensity to save at an advanced age, though often with small amounts (the concomitant relationship between age and the residence environment), can be explained by the Orthodox tradition for funerals and all other rituals after death, much more expensive than in other religions or rites. Thus, no later than 60 years, most people save money for the funeral and all the things related to it, so as not to be a burden for the followers.

Figure 4



There is a strong connection between **the level of monthly income** and the frequency of households having savings in a bank deposit (Figure 4). Among households that have declared a monthly income of less than 500 lei (118 Euros), only 13.6% had savings in banks. On the other hand, among households in which income exceeded 10001 lei per month (2360 Euros), more than half have savings in bank deposits.

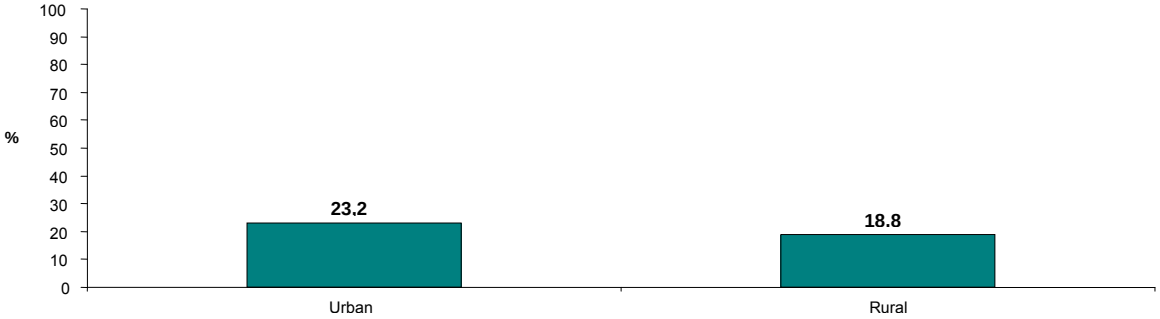
Figure 5



One of the important features in our analysis is **the level of education** of the household head. The frequency distribution obtained by this variable confirms the assertion according to which the share of households that have savings in bank deposits increases along with the increase of the education level. At the same time, it should not be forgotten that in households with high level of training, there are also other types of financial investments such as private pension funds, life insurance, health insurance and so forth.

Figure 6

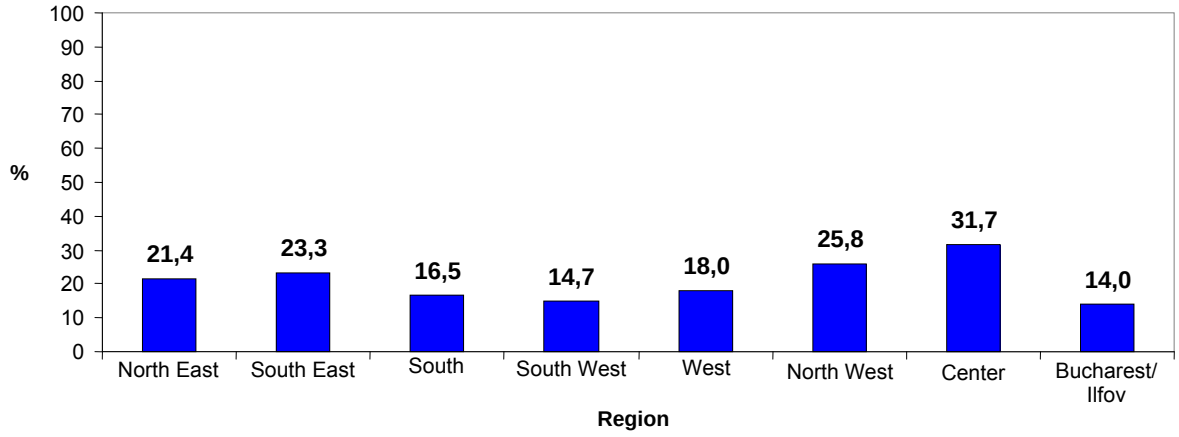
Percentage of households having bank deposits by residence environment
(21% of the households have bank deposits)



A predictable result: **the rural households** have savings in deposits at banks in a much smaller extent than **urban households** (Figure 6). The explanatory factors for this difference are the ones that make the difference in living standards of households in rural areas compared to those from urban areas: income, level of education, access to financial and banking information, banking facilities, digital division and so forth.

Figure 7

Percentage of households having bank deposits by development regions
(21% of the households have bank deposits)

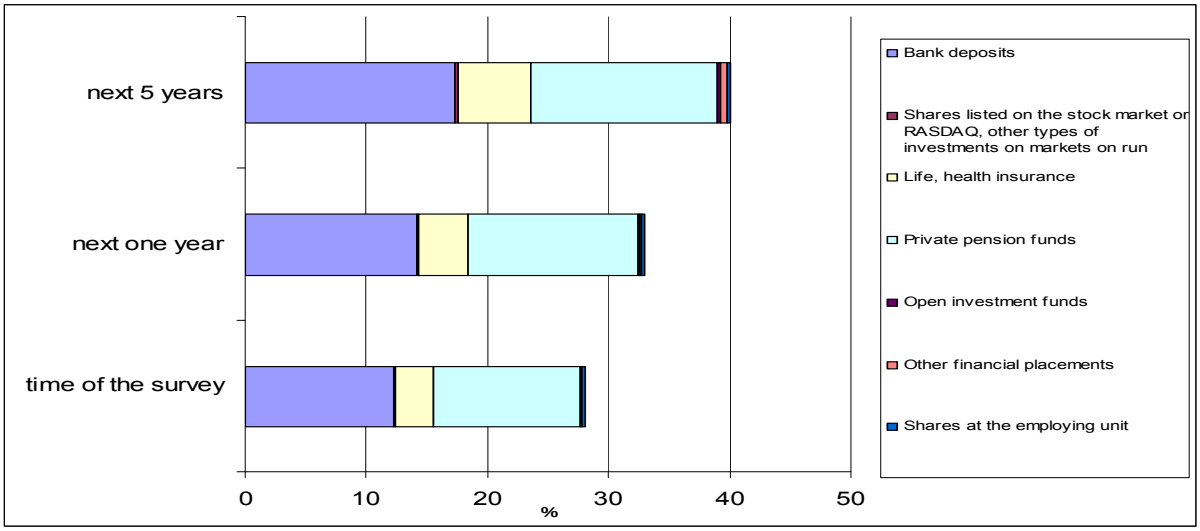


Another variable that brings additional knowledge is the **development region** where the household is (Figure 7). It is interesting to note that households in the most developed country regions – Bucharest/Ilfov and West declared fewer savings deposits in banks than most regions. It is very likely that in the households of the "richer" regions behavior is more diversified, financial resources are bigger, and may be oriented towards modern financial investment like shares listed on the stock market or RASDAQ, private pension, health or life insurance or investments in businesses of their own and so forth.

3.1.2 Demographic and socio-economic profile of households with financial manifest or intentional behavior meant to supplement income after retirement

After this overview of households that declared they have savings in bank deposits, the analysis has been developed on **households that manifest financial behavior for the present and the future** (Figure 8).

Figure 8. Percentage of total respondents who have ensured an extra income for themselves after retiring or intend to do so



The perception of increasing the individual longevity and the need to preserve the living standard achieved before retirement determines people to act, or at least to imagine measures to undertake in the near future, with the view of increasing savings and financial accumulation in different ways.

For the society as a whole, the sum of the relatively similar financial behavior generates financial consequences of the most complex and manifest, as the demographic ageing process deepens, corroborated with the effects of the financial crisis.

Although the share of population who undertook such actions is very low, further we will refer to them as the ones with financial behavior. Thus, we aim to analyze the characteristics of the group having a financial behavior and to highlight the statistically significant differences compared to the group having no financial behavior. The analyzed features are the following:

1. Demo-economic characteristics regarding the household head (gender, age, level of education)
2. Household size (number of people in household);
3. The total income and income per household member
4. Residence environment (urban, rural)

A. Who are the ones that saved money in order to have extra income at an old age?

Table 1 presents the descriptive statistics computed for the numeric characteristics analyzed, calculated both for the group with saving behavior and for the rest of the households.

Table 1

Group Statistics

	Extra income after retirement	N	Mean	Std. Deviation	Std. Error Mean
Age	NO	6941	57.7372	16.06411	.19282
	YES	969	57.5872	15.12793	.48598
Income per Household member	NO	6941	624.2312	465.35929	5.58570
	YES	969	939.1213	1877.05592	60.29972
Household size	NO	6941	2.39	1.386	.017
	YES	969	2.55	1.283	.041
Total incomes	NO	6941	1386.187	1173.4655	14.0851
	YES	969	2206.839	3846.6564	123.5724

For verifying the hypotheses regarding the equality of means of the two groups we computed several tests.

Age

The calculated value of the z test is 0.287, which leads to accepting the assumption of equality of variances. We cannot say that there are differences regarding the age of those who have and those who don't have a saving behavior in order to ensure themselves an extra income after retirement.

Average income per household member and total income

Based on the results obtained, we may say that the group of those who have savings for ensuring themselves a higher income after retirement is part of households with higher income. Also, the households that have saving behavior have a higher total income.

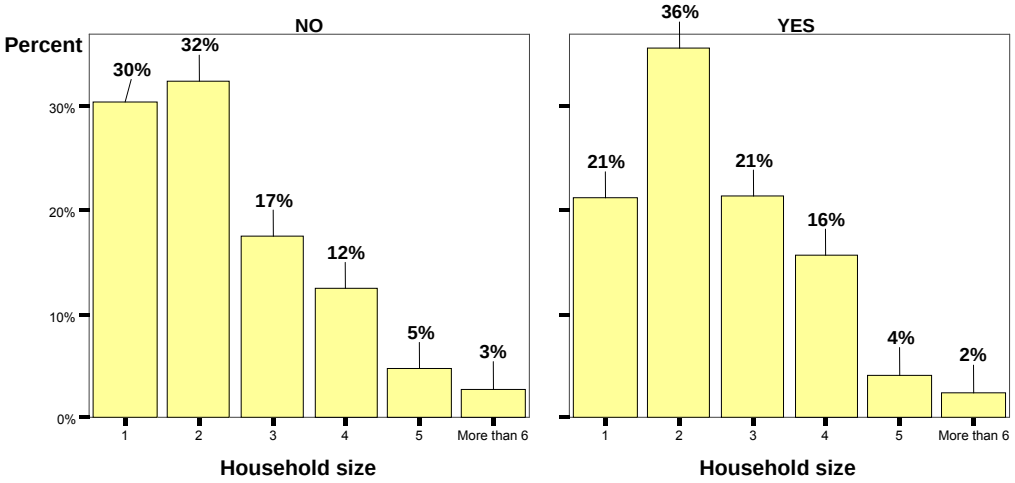
Household size

Persons having saving behavior are mostly from two member households. We find that for households of one person it is more difficult to save. For this reason the average household size for households having saving behavior is statistically significant higher than of a household without saving behavior.

Figure 9. Household distribution by household size and by groups

NO – they **do not** have bank deposits for extra income after retirement

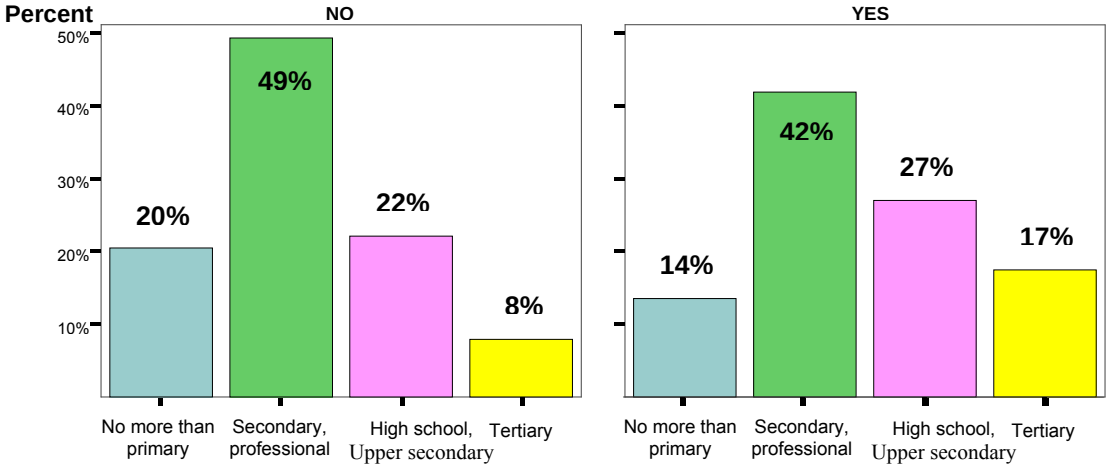
YES – they have bank deposits for extra income after retirement



Education level

The results indicate the existence of feeble a link between the variable "Education level" and "Ensuring extra incomes after retirement through saving".

Figure 10. Household distribution by education level and by groups

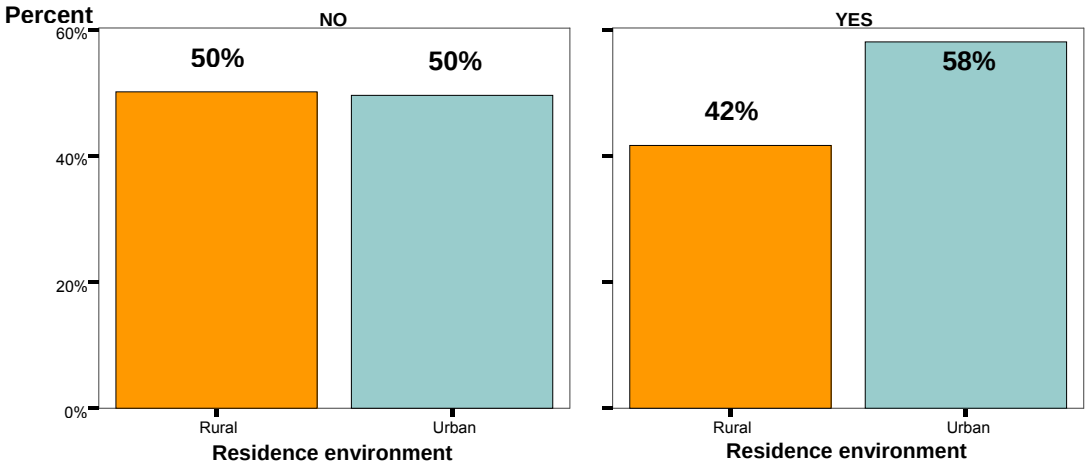


As the Figure shows, the households where the head of the household has a higher education level resorted to a higher extent to savings for ensuring extra income after retirement.

Residence environment

This characteristic has an even more reduced influence than the previous one. We notice that 58% of the households that have such savings are from urban areas, while the households without savings are equally distributed by residence environment. The difference between the percentages is statistically significant, but the association intensity is very feeble (V=0.056).

Figure 11. Household distribution by residence environment and by the two groups: with and without savings



The other demo-economic characteristics regarding the head of the household (gender, marital status, occupational status) do not significantly influence the households' behavior regarding savings as bank deposits for ensuring an extra income after retirement.

B. Who are those who have life or health insurance in order to have an extra income at an old age?

Table 2 presents the descriptive statistics indicators calculated for the numeric characteristics analyzed, both for the group constituted from those who have life or health insurance and for those who do not have.

Table 2

Group Statistics

	Extra income after retirement	N	Mean	Std. Deviation	Std. Error Mean
Household size	NO	7662	2.38	1.302	.015
	YES	248	2.89	1.131	.072
Age	NO	7662	58.0719	15.93779	.18208
	YES	248	46.8105	12.07200	.76657
Income per household member	NO	7662	647.2775	786.13496	8.98103
	YES	248	1142.5685	909.54047	57.75588
Total income	NO	7662	1438.663	1725.0726	19.7077
	YES	248	2971.415	2100.6027	133.3884

Age

The results show that the average age of those having life or health insurances is significantly statistic lower than for those who don't.

Average income per household member and total income

We may say that the group of those who have life or health insurance in order to ensure extra income after retirement is part of the households with higher income per

household member. Also, the households that have life or health insurance have a higher total income.

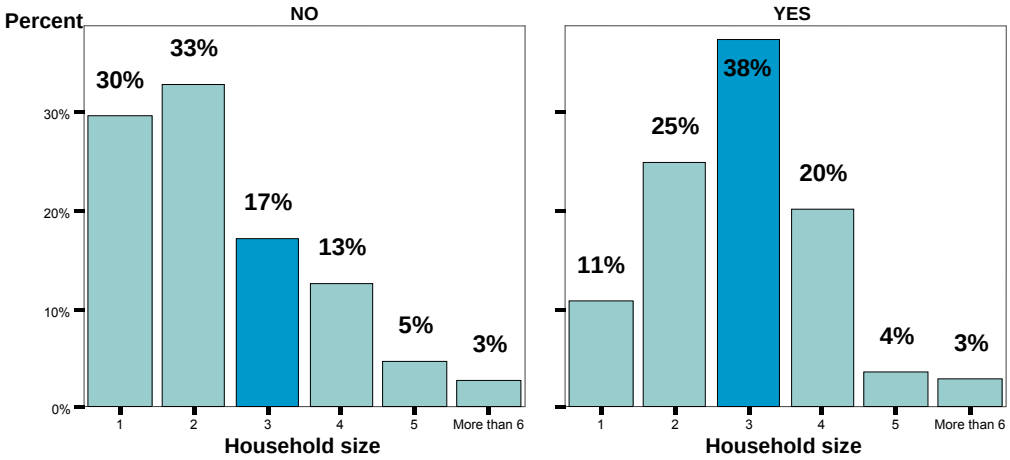
Household size

The persons that have life or health insurance are mainly part of families with 3 members. We see that only 11% of the households constituted by a single person have life or health insurance.

Figure 12. Household distribution by household size and by groups

NO – they **do not** have life or health insurance for extra income after retirement

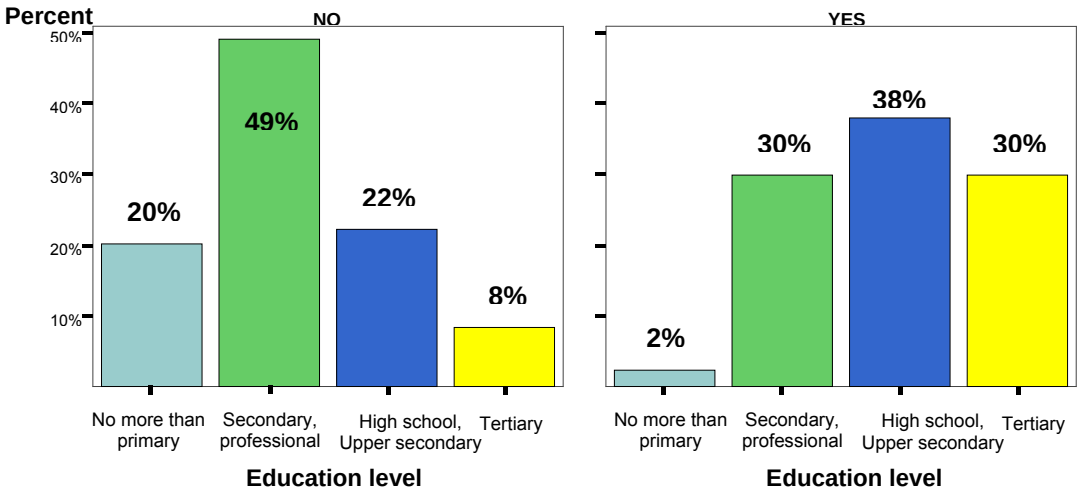
YES – they have life or health insurance for extra income after retirement



Education level

The computed value of the χ^2 test (201.85) indicated the existence of a feeble link between the variable "Education level" and "Life or health insurance settlement". We notice that households whose heads have a high education level (at least secondary level education) resorted to a greater extent to life or health insurances.

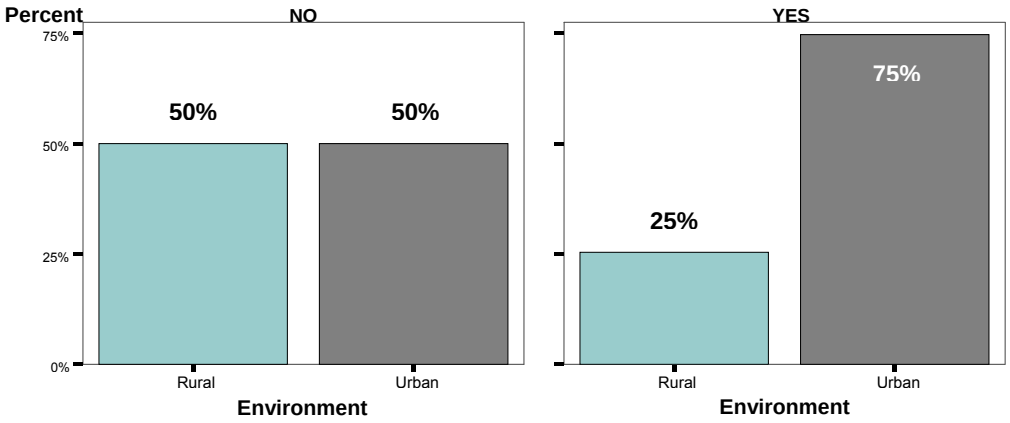
Figure 13. Household distribution by education level and by groups



Residence environment of the household

An even smaller influence is that of the characteristic residence environment. We notice that 75% of the households that have life or health insurance are from the urban area, compared to the equal repartition by environment for the households that do not have life or health insurances. The difference between the percentages is statistically significant, but the intensity of the association is very low (V=0.086).

Figure 14. Household distribution by residence environment and by groups



The other demo-economic characteristics regarding the head of the household (gender, marital status, occupational status) do not significantly influence the households' behavior regarding the settlement of life or health insurance.

C. Who are those who contributed to private pension funds in order to have an extra income at old age?

Table 3 presents the descriptive statistics indicators computed for the numeric characteristics analyzed, calculated both for the group of those who contributed to private pension funds and for the rest of the households

Table 3

Group Statistics

	Extra income after retirement	N	Mean	Std. Deviation	Std. Error Mean
Household size	NO	6956	2.30	1.281	.015
	YES	954	3.05	1.251	.040
Age	NO	6956	59.6100	15.38340	.18445
	YES	954	43.9298	12.96918	.41989
Income per household member	NO	6956	622.6314	798.81694	9.57784
	YES	954	955.7367	699.79173	22.65659
Total income	NO	6956	1341.312	1728.9684	20.7304
	YES	954	2546.941	1600.8287	51.8287

Age

There is a statistically significant difference in the case of those who contributed to private pension funds, thus age has an influence on the contribution to private pension funds. This is a predictable results, taking into account that the private pension became compulsory for people aged up to 35 years and optional for those aged up to 45 years.

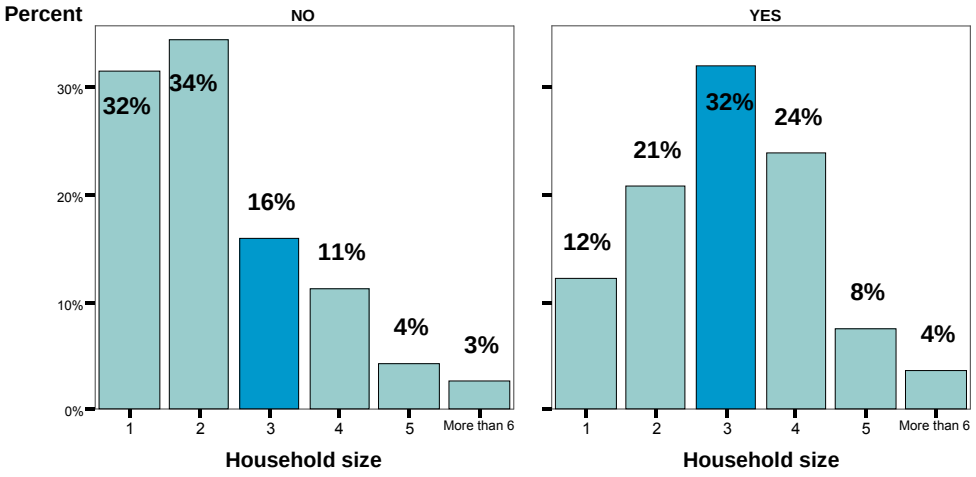
Average income per household member and total income

We may say that the group of those who contributed to private pension funds is part of the households with higher income per household member. Also, households that contributed to private pension funds have a higher total income.

Household size

The persons that contributed to private pension funds are mainly part of households with 3 members. We see that only 12% of the households of a single person contribute to private pension funds.

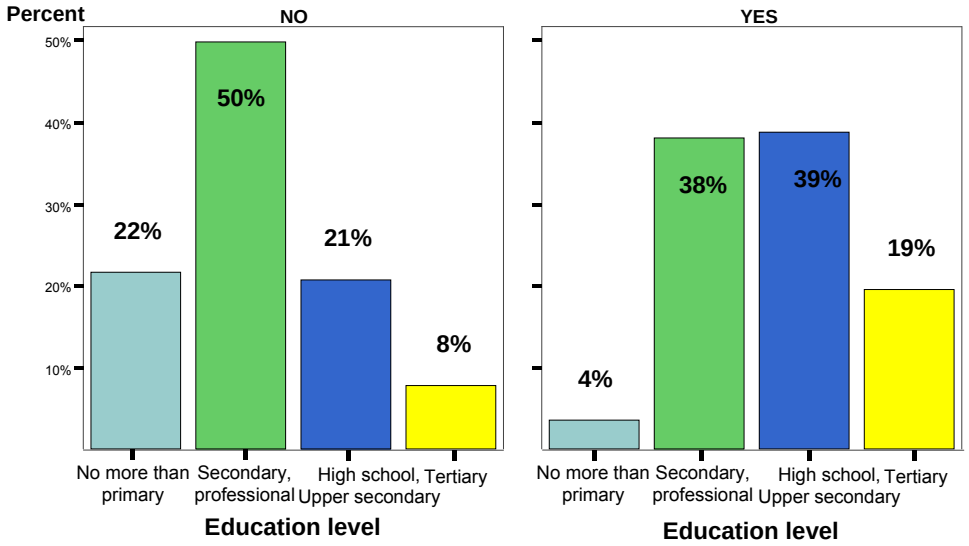
Figure 15. Household distribution by household size and by groups
NO – they **do not** private pension funds for extra income after retirement
YES – they have private pension funds for extra income after retirement



Education level

The computed value of the χ^2 test (415.223) indicates the existence of a feeble link between the variables "Education level" and "With contribution to private pension funds". We notice that households whose "heads" have a high education level (at least secondary level education) contributed to a greater extent to private pension funds (table 11).

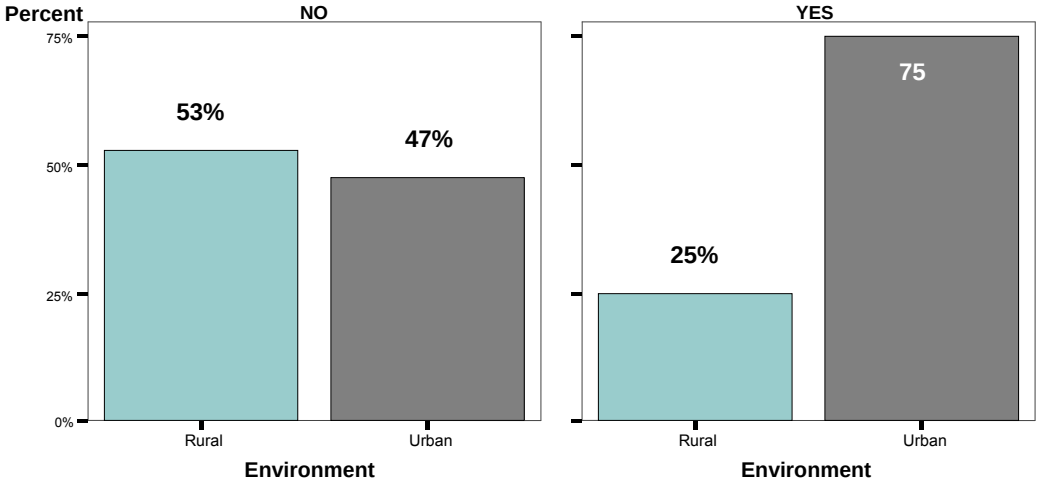
Figure 16. Household distribution by education level and by groups



Residence environment

A smaller influence is that of the characteristic residence environment. We notice that 75% of the households that contribute to private pension funds are from the urban area. The difference between the percentages is statistically significant, but the intensity of the association is very low (V=0.212)

Figure 17. Household distribution by residence environment and by groups

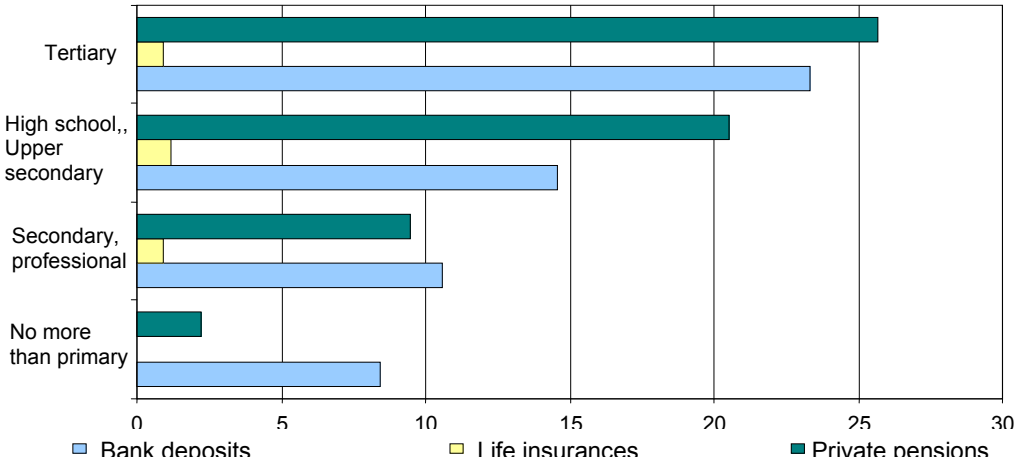


The other demo-economic characteristics regarding the head of the household (gender, marital status, occupational status) do not significantly influence the households' behavior regarding the contribution to private pension funds.

Figure 18 represents a synthesis of the influence of education level on the financial behavior of the households. We may notice that those households represented by a head of

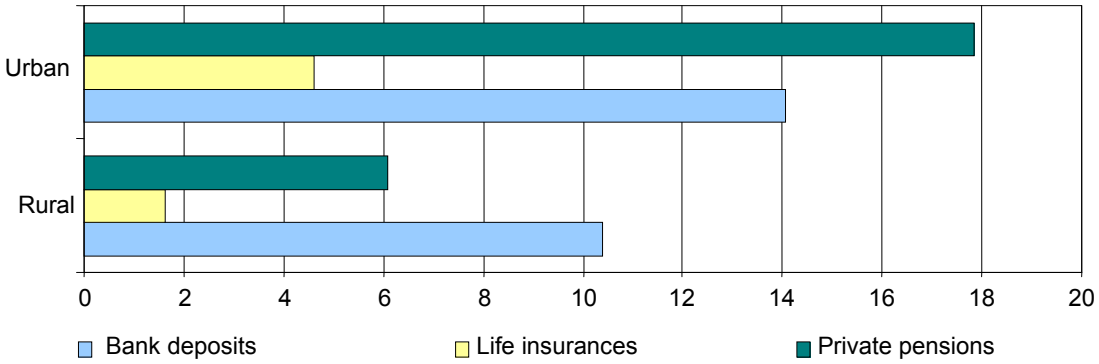
household with a high level of education have a greater openness towards the three ways to ensure themselves an extra income after retirement.

Figure 18 The influence of education level on the financial behavior of the households



In a similar way, Figure 19 represents a synthesis of the influence that the environment has on the three components of financial behavior that we analyzed.

Figure 19 The influence of the environment on the financial behavior of the households



4. Conclusion

The extension of the HBS questionnaire with the Financial Placements section allows for a deeper study of the financial behavior of the households in Romania, as it was observed during the field recordings from the second trimester of 2008.

The preliminary processing indicates that most Romanian households (67.4% of total households) *do not have any financial placement*. The rest of 32.6% of total households, who reported at least one financial placement, oriented their preferences mainly towards *bank deposits*, but with relatively low values. It is, on the one hand the confirmation of the lack of financial education of the population, and on the other, that of low financial

resources of the Romanian households, as well as the low propensity for savings within the financial system. Undoubtedly, there is a part of the population's savings that remains outside the financial system, banking and non-banking, the so-called "money from the mattress".

After processing the database, direct and strong relationships emerged between the *frequency of having savings in bank deposits* and:

- the *age* of the household head; as age increases, the weight of households having economies in bank deposits increases as well;
- *monthly income level*;
- *education level* of the household head; in the households with a high (at least secondary) education level, there are also other types of financial placements, such as private pension funds, life insurances, health insurances;
- urban residence environment;
- development level of the region where the household is.

Using statistical tests for significance and correlation, the relationships between the households that we identified as having financial behavior and different demographic and socio-economic characteristics were verified. We considered those households that, either in the present or in the next 5 years, are preoccupied to gain extra incomes after the retirement of its members, through different financial products: bank savings, life and health insurance and private pensions.

The present approach is the first to present, outside the borders of Romania, the preliminary results of the HBS with the pilot questionnaire, dedicated to the financial behavior of households. In the near future, the research team intends to fully exploit the HBS database with the "Financial Behavior" section from the two waves, through crossings with characteristics from the regular sections of HBS and using advanced data analysis methods. In this way we will be able to identify more relationships between different variables, the intensity of their relationships and we will be able to model the different types of financial behavior of the households. Thereby, the solutions necessary for ensuring a certain financial equilibrium will be easier to conceive and apply.

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JOURNAL OF APPLIED QUANTITATIVE METHODS

THE PARTICULARITIES AND SPECIFICS OF CIVIL SERVANTS: OPINIONS ON SOME CHARACTERISTIC OF PUBLIC ADMINISTRATION SEGMENTED BY RELIGION

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Abstract: In order to collect the statistical data necessary in performing this analysis we used a sample of employees from the public administration. Then, we projected a statistical survey to obtain the statistical information. For the elaboration of the survey, we identified major themes in the field of public administration, such as: institution management, public function, system transparency, decentralization process, corruption at the level of the system as well as the society, the quality of the public administration reformation. The statistical sample, for which we gathered statistical values based on the survey, has a dimension of 560 units. It is representative for the national level, and the error interval is ± 3%.

Key words: civil servants; public administration; quantitative methods; religion

1. INTRODUCTION

Based on the survey, primary and secondary variables have been defined. They will ensure the evaluation of important aspects within the public administration. The data base formed through the SPSS survey contains data series defined based on primary variables (each primary variable corresponds to a simple question in the survey) and derived variables (they are usually defined by applying the average operator on two or more primary variables). The analysis is performed at the level of the entire data base as well as on three categories of persons segmented by the person's religion: Orthodox, Catholics and Protestants.

In the followings, we present a series of results regarding institution management, budgetary performance, human resources management, the quality of the institution's relationship with the beneficiaries, public function, and the quality of the reformation process and transparency of public institutions' decisions. For each particular case, primary and aggregate variables are defined, and for each variable, a series of statistics are computed at the level of the entire population, as well as for the three categories of persons defined based on religion.

2. THE MANAGEMENT OF INSTITUTIONS IN PUBLIC ADMINISTRATION

In order to assess the opinions of the employees in the public administration regarding the quality of management in the institution they work, the survey contains questions meant to highlight certain aspects concerning evaluation system, budgetary performance, human resources management, the quality of relation between the institution and its beneficiaries.

Based on the information provided by the answers to the four questions, we defined four primary variables: A_{11} – the content of the system of indicators for the institution performance evaluation; A_{12} – the application of system of indicators for the institution performance evaluation; A_{13} – the annual assessment grating for the employees in the institution and its implementation methodology; A_{14} – the actual implementation of the assessment grating on the employees in the public institution.

After processing the data series registered for the two variables, we obtained the following results at the level of the sample:

Variable	**A_{11}**	**A_{12}**	**A_{13}**	**A_{14}**
	The distribution of answers (%)			
Unsatisfactory	5	5.8	8.2	10
Satisfactory	21.2	23.2	17.4	19.5
Well	45.3	40.1	43.8	43.2
Very well	17.6	19.5	24.7	20.2
I don't know	10.6	10.8	5.4	6.7
Non-responses	0.4	0.7	0.4	0.4
	Variables' average			
Average - Orthodox	2.55	2.53	2.77	2.62
Average – Catholics	2.50	2.25	2.50	2.13
Average – Protestants	2.13	2.13	2.13	2.00

Table 1. *The appreciation of the evaluation system in public institutions relative to the four elements*

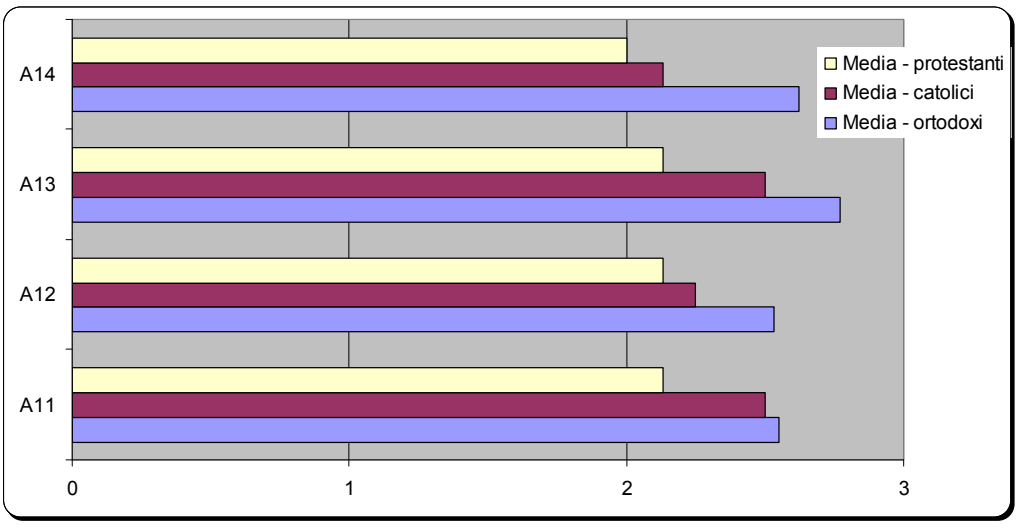

Figure 2. The *averages of primary variables used in characterizing the assessment system*

For the overall appreciation of the employees' opinion in public administrative institutions on the evaluation system in such institutions, we define the aggregate variable SEI based on the below application:

$$SEI : N \to [1,4], \quad SEI = \frac{1}{4}[A_{11} + A_{12} + A_{13} + A_{14}]$$

The values which characterize this variable are in the table below, for all three categories of religions (orthodox, catholic, protestant).

	Average	Standard deviation	Skewness	Kurtosis
Orthodox	2.62	0.965	0.918	0.46
Catholic	2.34	0.944	-1.15	-0.25
Protestant	2.09	1.552	-0.512	-1.73

Table 2. *Indicators for characterizing the aggregated variables SEI and SEIP*

3. BUDGETARY PERFORMACE OF INSTITUTIONS

In order to assess the budgetary performance of the institutions in public administration, we defined five variables: A_{21} – the volume of finance resources; A_{22} – the quality of the institution's Program of development and budget; A_{23} – the content of the strategic planning documents (multiannual) at the level of the institution; A_{24} – the action plan for implementing the development strategy; A_{25} – the monitoring system for implementing the action plan. After processing the information at the level of the sample, we obtained the results presented in table 2.

Variable	**A_{21}**	**A_{22}**	**A_{23}**	**A_{24}**	**A_{25}**
	Answer distribution (%)				
Unsatisfactory	12.4	7.4	5.4	5	6.7
Satisfactory	21.9	18.6	18	13.9	13.9
Well	42.3	47.5	39.9	30.2	34.9
Very well	17.8	17.3	24.7	28.5	21.1
I don't know	5.6	8.9	12.1	21.9	23
NR(99)	0	0.2	0	0.4	0.4
	Variables' averages				
Average – Orthodox	2.57	2.61	2.62	2.40	2.25
Average – Catholics	1.88	2.25	2.63	2.38	2.38
Average - Protestants	1.86	2.14	2.57	1.71	1.86

Table 3. Evaluating the budgetary performance of institutions relative to five elements

Based on the five primary variables, we define the aggregated variable PBI, in order to assess the global opinions of employees on the budgetary performances of the institutions they work in. this variable is defined as an average of the primary variables:

$$PBI : N \to [1,4], \quad PBI = \frac{1}{5}[A_{21} + A_{22} + A_{23} + A_{24} + A_{25}]$$

For this variable, we obtained the results in table 4, at the level of the three subcategories.

	Average	Standard deviation	Skewness	Kurtosis
Orthodox	2.49	1.051	-0.60	-0.38
Catholics	2.3	1.181	-1.39	0.93
Protestants	2.03	1.055	-1.172	2.046

Tabel 4. Indicators for characterizing the PBI and PBIP aggregated variables

4. HUMAN RESOURCES MANAGEMENT

In order to characterize this aspect, we defined five variables: A_{31} – the orientation of the institution towards resolving the problems of the employees; A_{32} – the strategy regarding continuous training; c A_{33} – implementation of the strategy of continuous training; A_{34} – the number of employees relative to the work load; A_{35} – the quality of employees relative to the requests of the institution.

After processing the five data series, we obtained the results presented in Table 5.

Variable	**A_{31}**	**A_{32}**	**A_{33}**	**A_{34}**	**A_{35}**
	Answers distribution (%)				
Unsatisfactory	12.4	7.4	5.4	5	6.7
Satisfactory	21.9	18.6	18	13.9	13.9
Well	42.3	47.5	39.9	30.2	34.9
Very well	17.8	17.3	24.7	28.5	21.1
I don't know	5.6	8.9	12.1	21.9	23
NR(99)	0	0.2	0	0.4	0.4
	Variables' averages				
Average I	2.93	2.78	2.64	2.43	2.83
Average II	2.87	2.64	2.44	2.37	2.80
Average – Orthodox	2.88	2.64	2.44	2.37	2.81
Average – Catholics	3.14	2.43	1.71	2.00	3.29
Average - Protestants	2.63	3.00	2.88	2.25	2.00

Table 5. *Assessing the human resources management quality relative to five elements*

Based on the five primary variables, we define the aggregated variable MRU to make a global assessment of the employees' opinion regarding the quality of human resources management at the level of the institution they work in. this variable is defined as an average of the primary variables based on the application:

$$MRU : N \to [1,4], \quad MRU = \frac{1}{5}[A_{31} + A_{32} + A_{33} + A_{34} + A_{35}]$$

The median and position indicators are presented din table 6 for the three categories of persons.

	Average	Standard deviation	Skewness	Kurtosis
Orthodox	2.63	0.781	-0.278	-0.429
Catholics	2.51	0.652	0.414	0.327
Protestants	2.55	1.380	-0.934	0.170

Table 6. *Indicators for characterizing the aggregated variables MRU and MRUP*

5. THE RELATION BETWEEN THE INSTITUTION AND ITS BENEFICIARIES

In order to characterize the relation of the institution and its beneficiaries, we define three variables: A_{41} – Informing the employees on the beneficiaries' needs and expectations; A_{42} – periodically consult the beneficiaries; A_{43} – integrating the beneficiaries' points of view.

For the three primary variables, we compute the averages in two ways: we don't take into consideration for each variable the respone "i don't know"; we consider all valid observations. The results are presented in table 7.

Unsatisfactory	**A_{41}**	**A_{42}**	**A_{43}**
Satisfactory	Answers distribution (%)		
Well	2.2	3.2	3.2
Very well	9.3	10.9	12.4
I don't know	30.4	30.1	25.8
NR(99)	42.5	43	40.1
	15.4	12.6	18.4
Average I	0.2	0.2	0.2
Average II	Variables' averages		
Average – Orthodox	3.29	3.21	3.24
Average – Catholics	3.33	3.33	3.17
Average - Protestants	3.17	3.00	2.83

Table 7. *Assessing the relation between the institution and its beneficiaries*

Based on the three variables we compute a first degree aggregated variable symbolized RIB. It is used to make a global appreciation of the employees' opinion regarding the quality of the relation between the institution and the beneficiaries of its services. This variable is defined as an average of the primary variables according to the application below:

$$RIB : N \to [1,4], \quad RIB = \frac{1}{3}[A_{41} + A_{42} + A_{43}]$$

For this variable we compute the average, standard deviation, and indicators which characterize asymmetry and skewness. The results are presented in table 8.

Variables	Average	Standard deviation	Skewness	Kurtosis
Orthodox	3.24	0.730	-0.913	0.352
Catholics	3.28	0.712	-0.232	-2.150
Protestants	3.00	1.116	-0.720	-1.317

Table 8. *Indicators to characterize PBI*

6. PUBLIC FUNCTION

An important component of the reformation process within the public administration system is represented by the reformation of the public function. In order to analyze public functions through the survey we included a series of questions to measure the employees' opinions regarding:

- The degree of satisfaction of the employees in public administration relative to aspects related to income, respect, work conditions, and political pressure;
- The correctness of professional competitions in hiring and promoting in the public function;
- The characteristics of the reformation process of the public function.

Based on the information received by the responses to the four questions, we defined nine primary variables: B_{11} – the degree of satisfaction relative to monthly income; B_{12} – degree of satisfaction relative to the respect received from work colleagues; B_{13} – degree of satisfaction relative to the respect received from citizens; B_{14} – degree of satisfaction relative to the respect received from the superior; B_{15} – degree of satisfaction relative to the respect received from the management of the institution; B_{16} – degree of satisfaction relative to the respect received from the office of work; B_{17} – degree of satisfaction relative to office endowment ; B_{18} – degree of satisfaction relative to the Internet connection; B_{19} – degree of satisfaction relative to the political pressures.

In defining the nine characteristics we used a measure scale defined based on the following values: 1- total dissatisfaction, 2- low satisfaction; 3- moderate satisfaction; 4- high satisfaction; 5- total satisfaction.

After processing the registered data series for the nine variables at the level of the sample, we obtained the results in table 9. The answers distribution for these primary variables, as well as their averages is presented in table 9.

	B_{11}	B_{12}	B_{13}	B_{14}	B_{15}	B_{16}	B_{17}	B_{18}	B_{19}
	Answers distribution (%)								
1	17.8	2.0	6.5	3.3	2.8	2.2	5.0	7.2	20.6
2	27.6	6.1	10.9	5.8	8.7	9.6	11.1	10.8	24.5
3	45.1	35.8	40.1	24.5	29.3	26.7	29.5	21.0	24.5
4	8.2	41.4	34.0	39.9	34.9	37.3	32.7	35.3	17.6
5	1.3	14.5	7.8	26.5	24.3	23.9	21.2	25.4	11.9
NR	0.0	0.2	0.7	0.0	0.0	0.2	0.6	0.4	0.9
	Variables averages								
Average	2.48	3.60	3.25	3.80	3.68	3.70	3.54	3.61	2.75
Orthodox	2.49	3.60	3.25	3.81	3.69	3.71	3.54	3.62	2.75
Catholics	2.71	3.57	3.00	3.86	3.86	3.57	3.29	3.43	2.42
Protestants	2.13	3.50	3.38	3.38	3.63	3.60	3.54	3.65	3.60

Table 9. *Characteristics of the satisfaction degree*

Using the primary variables above, we defined two level one aggregated variables, as follows:

- The RES variable for evaluating the respect that employees in public administration institutions enjoy. It's a variable which is computed as an arithmetic average of the primary variables B_{12}, B_{13}, B_{14} and B_{15};
- The COL variable characterizes the satisfaction degree of employees in public administration relative to work conditions (office, computer, Internet connection).

The two level one aggregated variables, as well as the primary variables B_{11} and B_{19} are defined in the interval $[1,5]$. For the global evaluation of the satisfaction degree of public administration institutions, we define the level two aggregated variables GSA based on the application below:

$$GSA : N \to [1,5], \quad GSA = \frac{1}{4}[B_{11} + RES + COL + A_{19}]$$

For the two variable categories, we compute the average, standard deviation, and indicators which characterize skewness and asymmetry. The results are presented in table 10.

	Number of valid cases	Average	Standard deviation	Skewness	Kurtosis
B_{11}	525	2.48	0.922	-0.057	-0.386
B_{19}	525	2.75	1.297	0.222	-0.1.036
RES	525	3.58	0.751	-0.489	0.454
COL	525	3.61	0.867	-0.399	-0.210
GSA	525	3.11	0.675	0.182	0.005

Table 10. *Indicators used to characterize the aggregated variables SEI and SEIP*

In order to evaluate the correctness of occupancy or promotion tests, we define the following primary variables: B_{21} – professional competitions encourage memorization; B_{22} – professional competitions encourage analysis; B_{23} – professional competitions

encourage synthesis; B_{24} – professional competitions encourage determining the truthfulness of the information; B_{25} – professional competitions encourage applying theories.

The measurement scale used in defining the five variables has the following five values: 1- not at all, 2- in an insignificant measure, 3 – moderately, 4 – significantly high, 5 – high.

After processing the information at the level of the sample, we obtained the results presented in table 11.

Variable	**B_{21}**	**B_{22}**	**B_{23}**	**B_{24}**	**B_{25}**
	Answers distribution (%)				
1	8.9	3.5	3.7	4.8	6.1
2	11.1	15.6	10.8	13.2	12.4
3	30.6	37.1	36.4	39.1	38.4
4	28.4	28.9	29.1	26.7	25.4
5	20.6	14.5	19.3	15.6	17.3
NR(99)	0.4	0.4	0.7	0.6	0.4
	Variables averages				
Average	2.59	2.64	2.50	2.65	2.64
Orthodox	2.41	2.51	2.38	2.55	2.53
Catholics	3.00	2.75	2.38	2.25	2.25
Protestants	1.80	2.20	2.20	2.20	2.40

Table 11. *Evaluating budgetary performance of the institution relative to five elements*

7. TRANSPARENCY IN DECISION MAKING AT THE LEVEL OF INSTITUTIONS

In order to characterize the transparency of decisions in public institutions, we define the following variables: C_{11}-Evaluating transparency relative to obeying rules in decision making with respect to human resources management issues; C_{12}-evaluating transparency relative to obeying rules in decision making relative to the institution's budget management issues; C_{13}-evaluating transparency relative to the communication between employees and institution management; C_{14}- evaluating transparency relative to access to information.

The four variables are defined as follows:

$$C_{1i} : N \to \{0,1,2,3,4\}, i = 1,...,4$$

The measurement scale used for the four variables is defined as: 0 – I don't know; 1 – dissatisfactory; 2 – satisfactory; 3 – well; 4 – very well. We attributed the null value to the answer "I don't know", to penalize the lack of attitude among employees towards important issues of the institution.

Variable	C_{11}	C_{12}	C_{13}	C_{14}
	Answers distribution (%)			
1	9.5	6.5	8.3	8.7
2	17.6	15.4	22.1	21.5
3	37.5	36.5	43.8	41.7
4	26.3	29.3	23.4	26.0
I don't know	8.7	12.1	2.4	2.0
NR	0.4	0.2	0.0	0.0
	Averages and standard deviations			
Average I	2.89	3.01	2.84	2.87
Average II	2.63	2.65	2.78	2.81
Orthodox	2.64	2.65	2.78	2.81
Catholics	3.00	2.63	2.75	2.88
Protestants	2.50	2.63	2.63	2.88

Table 12. *Evaluating budget performance of institutions relative to five elements*

We computed averages for the four primary variables in two ways:

- We take into consideration all valid answers (including those with "I don't know" option). In this case, we obtain results in table 4, line Average II.
- We take into consideration all observations which for the four variables have an answer among the four. In this case, we exclude observations with the answer "I don't know". We obtain the four averages in table 12, line Average I.

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JOURNAL OF APPLIED QUANTITATIVE METHODS

ORDINAL REGRESSION TO ANALYZE EMPLOYEES' ATTITUDES TOWARDS THE APPLICATION OF TOTAL QUALITY MANAGEMENT

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Abstract: The ordinal regression method was used to model the relationship between the ordinal outcome variable, e.g. different levels of employees' attitude regarding the overall working experience in the application of Total Quality Management (TQM) in University of Bahrain (UOB), and the explanatory variables concerning demographics and employees working environment in UOB. The outcome variable for employees' attitudes was measured on an ordered, categorical five-point Likert scale. The major decisions involved in the model building for ordinal regression were deciding which explanatory variables should be included in the model and choosing the link function (e.g. logit link, probit link, negative log-log link and complementary log-log link) that demonstrated the model appropriateness. In addition, the model fitting statistics, the accuracy of the classification results and the validity of the model assumptions, e.g., parallel lines, were essentially assessed for selecting the best model. One of our main finding is that suitable environment for development of staff capabilities and opportunities to train on the skills of solving routine and non-routine problems are highly significant with the employee's attitude toward the application of TQM.

Key words: Generalized linear model; regression; quality management.

Introduction

Total Quality Management, TQM, is a management philosophy that seeks to integrate all organizational functions to focus on meeting customer needs and organizational objectives. The management and employees become involved in the

continuous improvement of the production of goods and services. Although originally applied to manufacturing operations, and for a number of years only used in that area, TQM is now becoming recognized as a generic management tool, just as applicable in service and public sector organizations. TQM can be a powerful technique for unleashing employee creativity and potential, reducing bureaucracy and costs, and improving service to clients and the community; see, Evans and Lindsay (2008). Unfortunately, in practice, employees' attitudes are usually not evaluated unless their performance is unsatisfactory. So long as employees' performance is going well, attitudes in themselves may not be closely examined on the assumption that interest and cooperation are probably at acceptable levels. It is when the performance of the employees fall short of that expected by the top manager that the latter is apt to start looking into attitudinal factors that may underlie the poor showing that can eventually affect other people performance; see; Martin (1993).

In this study, the ordinal regression method was used to model the relationship between the ordinal outcome variable, e.g. different levels of employees' attitude regarding the overall working experience in the application of Total Quality Management at University of Bahrain (UOB), and the explanatory variables concerning demographics and employees working environment at UOB. The outcome variable for employees' attitudes was measured on an ordered, categorical, and five-point Likert scale- 'strongly disagree', 'disagree', 'neural', 'agree' and 'strongly agree'. It is implausible to assume the normality and homogeneity of variance for ordered categorical outcome. Thus, the ordinal regression model becomes a preferable modeling tool that does not assume the normality and constant variance, but require the assumption of parallel lines across all levels of the categorical outcome. Explanatory variables included four demographic levels, e.g., gender, age, experience and education level and 21 questionnaire items related to the awareness of the concepts of TQM, support of top management for TQM, team work policy, and training programs at UOB, see Figure 1. Regression methods such as linear, logistic, and ordinal regression are useful tools to analyze the relationship between multiple explanatory variables and clients' attitude.

The ordinal regression method is capable of allowing researcher to identify explanatory variables related to training programs, team work policy and support services that contribute to overall employees' attitude toward the application of TQM. The ordinal regression also permit researcher to estimate the magnitude of the effect of the explanatory variables on the outcome variable. The major decisions involved in the model building for ordinal regression were deciding which explanatory variables should be included in the model and choosing the link function (e.g. logit link, probit link and complementary log-log link) that demonstrated the model appropriateness. The study results could lead to a better understanding of the college programs and services from employees' perspectives; see, Staus (2008) and Hales and Chakavorty (2006).

The primary focus of the study was the formulation of the ordinal regression model, the application of ordinal regression analysis, and the interpretation of study results. The employees' attitude questionnaire was analyzed by the ordinal regression method to achieve the four study objectives:

1. To identify significant explanatory variables that influenced the overall employees' attitude;
2. To estimate thresholds (i.e. constants) and regression coefficients;

3. To describe the direction of the relationship between the explanatory variables and the overall employees' attitude based on the sign (+ and -) of regression coefficients; and

4. To perform classifications for all attitude levels of the overall employees experience, and subsequently evaluate the accuracy of the classification results.

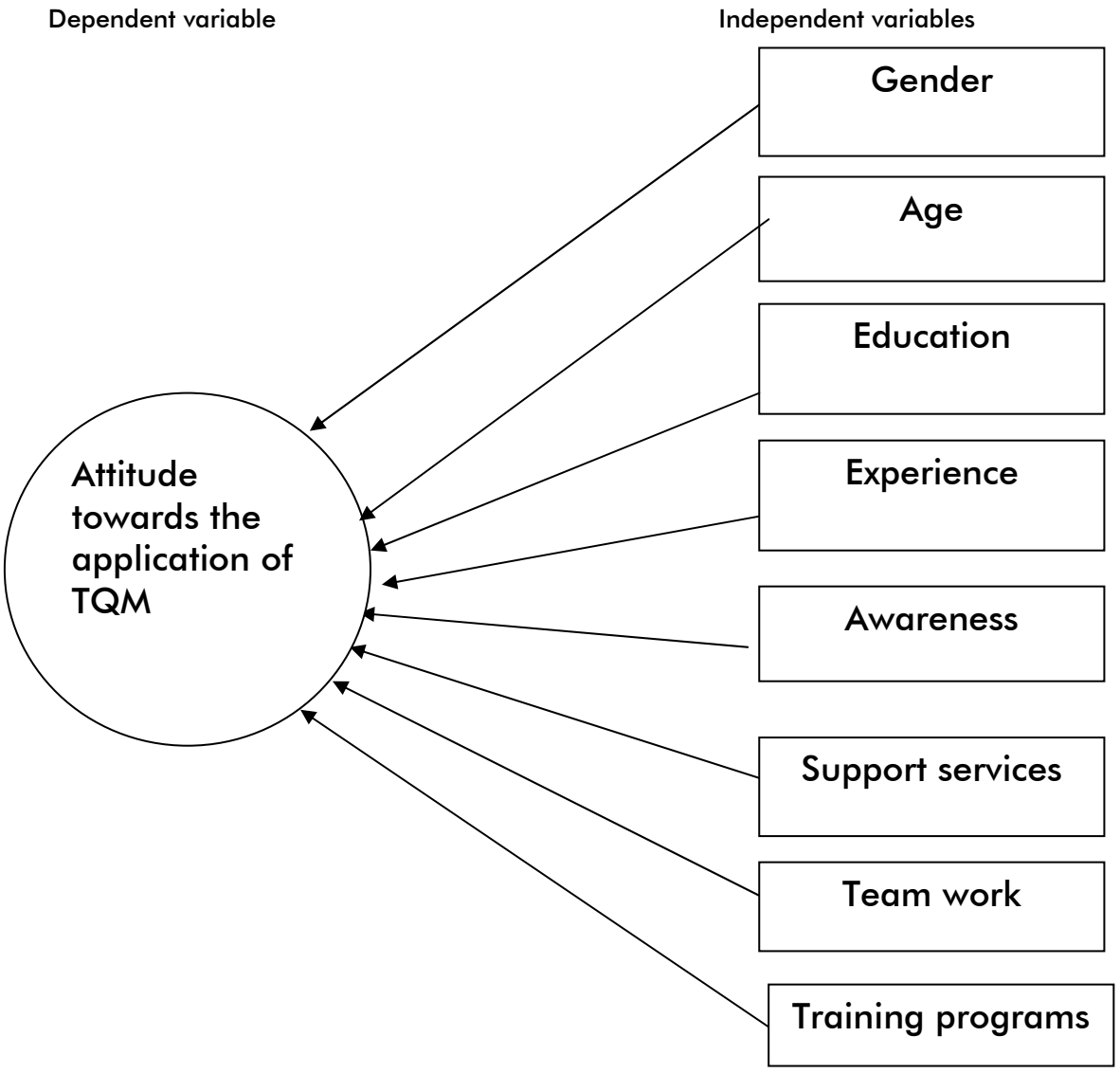

Figure 1: The model for employee's attitude towards the application of TQM

The ultimate goal of the study was to make recommendations to enhance the awareness of the concepts, support services, team work policy, and training programs as appropriate in the light of research findings.

To understand the principle of the class of generalized linear model; see, McCullagh and Nelder (1989) and Bender and Benner (2000) let us first consider a binary

response variable Y. For simplicity, we consider only one explanatory factor X (binary or continuous). The question of an investigator may then be whether X has an effect on Y. As Y itself has only two values ($y = 1$=yes or $y = 0$=no) we analyze whether the probability of an event $\pi(x) = P(Y = 1|X = x)$ is associated with X by means of an appropriate model; see, Cox and Snell (1989). The class of generalized linear models in this case is given by

$$f[\pi(x)] = \alpha + \beta x$$

Where f is an appropriate function (called link function), α is the intercept, and β is the regression coefficient of X. In the case of $m \geq 2$ explanatory factors $X_1, \ldots, X_m$ is replaced by linear combination, $\beta_1 x_1 + \cdots + \beta_m x_m$. For the analysis of binary and ordinal response data the following two link functions have been widely used

1. The logit link: $f(\pi) = \log[\pi(1 - \pi)]$
2. The complementary log-log link: $f(\pi) = \log[-\log(1 - \pi)]$

Grouped continuous model

Let Y be a categorical response variable with $k + 1$ ordered categories where

$$\pi_j(x) = P(Y = j|X)$$

be the probability for the realization of $Y = j$, $j = 0, 1, \ldots, k$ and the cumulative probabilities

$$\gamma_j(x) = P(Y \geq j|X)$$

The class of grouped continuous model is obtained by the generalized linear model in which the cumulative probabilities are used instead of π

$$f[\gamma_j(x)] = \alpha_j + \beta x, \qquad j = 1, \ldots, k$$

Note that it is assumed that for the considering link function f the corresponding regression coefficients are equal for each cut-off point j. The adequacy of this equal slopes assumption has to be evaluated carefully before this model can be applied.

In ordinal regression analysis, there are link functions, e.g., logit and cloglog links, are used to build specific models. There is no clear cut method to distinguish the preference of using different link functions. However, the logit link is generally suitable for analyzing the ordered categorical data evenly distributed among all categories. The cloglog link may be used to analyze the ordered categorical data when higher categories are more probable; see, Bender and Benner (2000).

The ordinal regression model may be written in the form as follows if the logit link is applied

$$f[\gamma_j(X)] = \log\left\{\frac{\gamma_j(x)}{1-\gamma_j(x)}\right\} = \log\left\{\frac{P(Y \leq j|x)}{P(Y > j|x)}\right\} = \alpha + \beta X, \; j = 1, 2, \ldots, k-1$$

and

$$\gamma_j(X) = \frac{e^{\alpha+\beta x}}{1+e^{\alpha+\beta x}},$$

where j indexes the cut-off points for all categories (k) of the outcome variable. If multiple explanatory variables are applied to the ordinal regression model, βX is replaced by the linear combination of $\beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_p X_p$. The function $f[\gamma_j(X)]$ is called the link

function that connects the systematic components (i.e. $\alpha_j + BX$) of the linear model. The alpha α_j represents a separate intercept or threshold for each cumulative probability. The threshold and regression coefficients are unknown parameters to be estimated by means of the maximum likelihood method, see, Winship (1984), Bender and Benner (2000) and Long (2003).

Methodology

Survey data were collected from a questionnaire which distributed for a random sample of employees at UOB working at different departments. We distributed 201 questionnaires and the return questionnaire was 180. The questionnaire items consisted of the employees' attitude towards the application of TQM, and four demographic such as, gender, age, experience and education levels and 21 questionnaire items concerned the application of TQM.

The 21 items were classified into four predetermined factors- the awareness of the concepts of TQM, support of top management for TQM, team work policy, and training programs at UOB. Factor I- awareness included items such as top manager has awareness of the concept of TQM (R1) and top manager continuously familiarizes the employees with TQM advantages (R2). Factor II- support of top management included items such as the qualification staff to apply TQM (R3), suitable environment for development of staff capabilities (R4), participation of the staff to improve performance quality (R5), analysis organization problems (R6) and set the suitable solutions (R7), concerned with complaints and suggestions (R8), encourage open door policy (R9), encourage staff in participation in decision making process and study on the who affected by decisions (R10). Factor III- team work policy included items such as focus on team work rather than individual performance (R11), performance evaluation is carried out through team work performance rather than individual performance (R12), and group spirit (R13). Factor IV- training programs included items such as high priority for Training (R14), training programs aims to insure the important of quality (R15), the level of efficiency and type of training has direct relationship with improvement of quality of performance (R16), the training programs include the explanation of assigning the duties and tasks of concern individuals (R17), employees are trained on the modern techniques and skills (R18), there is follow up for new recruitments (R19), opportunities to train on the skills of solving routine and non-routine problems (R20), necessary training for the process of improving quality for support an commitment (R21).

The high internal consistency for the survey instrument might be demonstrated based on the alpha reliability, all items combined 0.83 (21 items), factor I 0.79, factor II 0.81, factor III 0.75 and factor IV 0.74.

The major decisions involved in constructing the ordinal regression models where deciding what explanatory variables had more effect on the dependent variable and choosing the link functions that would be good to fit the model.

There are many of the link function which is a transformation of the cumulative probabilities that allows estimation of the model. Five link functions are summarized in Table 1; see, Staus (2008).

Table 1: The link function and its typical application

Function	Form	Typical application
Logit	$\log\left(\frac{x}{1-x}\right)$	Evenly distributed categories
Complementary log-log	$\log(-\log(1-x))$	Higher categories more likely
Negative log-log	$-\log(-\log(x))$	Lower categories more likely
Probit	$F^{-1}(x)$	Variable is normally distributed
Cauchit (inverse Cauchy)	$\tan(\pi(x-0.5))$	Variable has many extreme values

Study Results

Constructing ordinal regression model entails several decisions. First, of course, we need to identify the ordinal outcome variable. Then, we need to decide which predictors to use for the location component of the model. Finally, we need to decide which link function gives good fits for our data. We use SPSS package in our analysis; see Lin (2007) and Chen and Hughes (2004) for details. To choose a link function, it is helpful to examine the distribution of values for the outcome variable. We create the histogram for the dependent variables to show the distribution of catogries of employee attitude towards application of TQM. The bulk of cases are in the lower categories, especially categories 1 (very disagree) and 2 (disagree). For this reason, we will begin with the negative log-log link function, since that function focuses on the lower outcome categories.

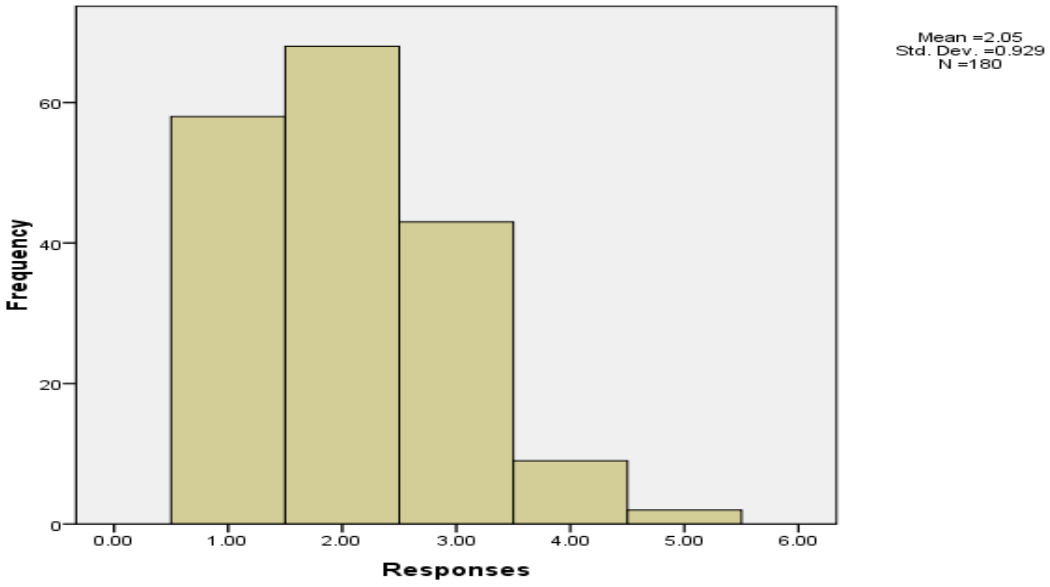

Figure 1: The distribution of employee attitude towards application of TQM

Before we start looking at the individual predictors in the model, we need to find out if the model gives adequate predictions. Therefore, we can examine the model fitting information Table 2.

Table 2: Model fitting information

Model	-2 Log likelihood	Chi-Square	df	Sig.
Intercept only	2152.34			
Final	1432.51	335.63	25	.000

Link function: negative Log-Log

The significant chi-square statistic indicates that the model gives a significant improvement over the baseline intercept-only model. This basically tells us that the model gives better predictions than if we just guessed based on the marginal probabilities for the outcome categories.

The Goodness-of-Fit is given in Table 3. This table contains Pearson's chi-square statistic for the model and another chi-square statistic based on the deviance. These statistics are intended to test whether the observed data are inconsistent with the fitted model. If they are not-the significance values are large-then we would conclude that the data and the model predictions are similar and that you have a good model. The large value for significant shows we have a good model

Table 3: Goodness of fit

	Chi-square	df	Sig.
Pearson	146.15	679	1.000
Deviance	90.08	679	1.000

Link function: Negative Log-Log

In the linear regression model, the coefficient of determination, R^2, summarizes the proportion of variance in the dependent variable associated with the predictor (independent) variables, with larger R^2 values indicating that more of the variation is explained by the model. For regression models with a categorical dependent variable, it is not possible to compute a single R^2 statistic that has all of the characteristics of R^2 in the linear regression model, so these approximations are computed instead. The following methods are used to estimate the coefficient of determination. Cox and Snell (1989) (R^2) is based on the log likelihood for the model compared to the log likelihood for a baseline model. However, with categorical outcomes, it has a theoretical maximum value of less than 1, even for a "perfect"

model. Nagelkerke (1991) (R^2) is an adjusted version of the Cox & Snell that adjusts the scale of the statistic to cover the full range from 0 to 1. McFadden (1974) (R^2) is another version, based on the log-likelihood kernels for the intercept-only model and the full estimated model. The model with the largest R^2 statistic is "best" according to this measure.

Table 4 shows these values which indicate the fitting model is good according to these measures.

Table 4: pseudo R^2

Cox and Snell	0.722
Negelkerke	0.83
McFadden	0.83

The next step is to examine the predictions generated by the model. However, what we are probably most interested in is how often the model can produce correct predicted categories based on the values of the predictor variables. We construct a classification table-also called a confusion matrix-by cross-tabulating the predicted categories with the actual categories. From Table 5 the model seems to be doing good of predicting outcome categories, for categories-category 1 (strongly disagree) the models correctly classifies 91.4%, category 2 (disagree) classifies 88.85%, the category 3 (neural) classifies 79%, the category 4 (agree) classifies 89% and the category 5 (strongly agree) classifies 100%.

Table 5: Responses against predicted responses

Responses		Predicted responses catogries strongly disagree	Disagree	Neural	agree	Strongly agree	Total
Strongly	Count	53	5	0	0	0	58
disagree	%within	91.4%	8.6%	0%	0%	0%	100%
Disagree	Count	7	59	1	1	0	68
	%within	8.7%	88.8%	1.5%	1.5%	0%	100%
Neural	Count	2	6	34	1	0	43
	%within	4.6%	14%	79%	2.3%	0%	100%
Agree	Count	0	0	1	8	0	9
	%within	0%	0%	11%	89%	0%	100%
Strongly agree	Count	0	0	0	0	2	2
	%within	0%	0%	0%	0%	100%	100%
Total	Count	62	70	36	10	2	180
	%within	34%	39%	20%	5.5%	1%	100%

For our models, the test of parallel lines can help you assess whether the assumption that the parameters are the same for all categories is reasonable. This test compares the estimated model with one set of coefficients for all categories to a model with a separate set of coefficients for each category. We see from Table 6 that the assumption is plausible for this problem where the observed significant level is large.

Table 6: Test of parallel line

Model	-2Log Lik.	Chi-Square	df	Sig.
Null Hypothesis	3.793			
General	2.90	1.887	75	0.89

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

The parameter estimates are given in Table 7. Also, Table 7 summarizes the effect of each predictor. The sign of the coefficients for covariates and relative values of the coefficients for factor levels can give important insights into the effects of the predictors in the model. For covariates, positive (negative) coefficients indicate positive (inverse) relationships between predictors and outcome. An increasing value of a covariate with a positive coefficient corresponds to an increasing probability of being in one of the "higher" cumulative outcome categories. For factors, a factor level with a greater coefficient indicates a greater probability of being in one of the "higher" cumulative outcome categories. The sign of a coefficient for a factor level is dependent upon that factor level's effect relative to the reference categories.

Table 7: Explanatory variables associated with the attitude towards the application of TQM based on the ordinal regression model with negative log-log link

Item name	Regression coefficient	p-value	Item name	Regression coefficient	p-value
Const1	20.11	0	R8	0.917	0.001
Const2	27.46	0	R9	0.083	0.793
Const3	39.37	0	R10	0.667	0.021
Const4	51.30	0	R11	0.467	0.067
Gender	-0.48	0.231	R12	0.323	0.113
Age	0.057	0.045	R13	0.662	0.015
Education	-0.424	0.349	R14	0.253	0.203
Experience	-0.131	0.012	R15	0.005	0.985
R1	-.036	0.877	R16	0.609	0.051
R2	0.938	0.003	R17	0.674	0.033
R3	0.633	0.006	R18	0.483	0.081
R4	1.738	0	R19	0.745	0.014
R5	-0.696	0.021	R20	1.129	0
R6	0.898	0.005	R21	-0.136	0.555
R7	0.668	0.027			

The significance of the test for Age is less than 0.05, suggesting that its observed effect is not due to chance. Since its coefficient is positive, as age increases, so does the probability of being in one of the attitude of account status. Also, experience has opposite effect where it estimates by negative. By contrast, Gender and education adds little to the model.

For factor I- awareness we find that the awareness of the concepts (R1) is not significant while familiarize the employees with TQM advantages (R2) is significant.

For factor II- support of top management we find that qualification staff to apply TQM (R3), suitable environment for development of staff capabilities (R4), participation of the staff to improve performance quality (R5), analysis organization problems (R6) and set the suitable solutions (R7), concerned with complaints and suggestions (R8) and encourage staff in participation in decision making process and study on the who affected by decisions (R10) are significant while encouraging open door policy is not significant (R9).

Factor III- team work policy we find that focusing on team work rather than individual performance (R11) is not slightly significant. It is worth keeping such a variable in the model, since the small effects of each category accumulate and provide useful information to the model. But the performance evaluation is carried out through team work

performance rather than individual performance (R12) is not significant, while group spirit (R13) is significant.

Factor IV- training programs we find that high priority for Training (R14), training programs aims to insure the important of quality (R15) and necessary training for the process of improving quality for support an commitment (R21) are not significant while the level of efficiency and type of training has direct relationship with improvement of quality of performance (R16), the training programs include the explanation of assigning the duties and tasks of concern individuals (R17), employees are trained on the modern techniques and skills (R18), there is follow up for new recruitments (R19) and opportunities to train on the skills of solving routine and non-routine problems (R20) are significant.

Note that the participation of the staff to improve performance quality (R5) is the only variable which is significant and had a negative coefficient (effect). Also, suitable environment for development of staff capabilities (R4) and opportunities to train on the skills of solving routine and non-routine problems (R20) are highly significant.

Recommendations

From above results we recommend the following:

- The establishment of an independent administration of TQM.
- Building suitable environment for development of staff capabilities.
- Giving opportunities to train on the skills of solving routine and non-routine problems.
- Focus on the importance of employee's participation and their effective role.
- Forming the work team (consideration should be given to careful selection of those individuals who are highly concerned and interested in the process of performance improvement).
- Working for facilitating some of the obstacles of applying TQM.
- Giving more concern for the development of complains and suggestion boxes.

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MONTE CARLO ANALYSIS OF CHANGE POINT ESTIMATORS

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Abstract: *We consider several estimators for the change point in a sequence of independent observations. These are defined as the maximizing points of usually used statistics for nonparametric change point detection problems. Our investigations focus on the non asymptotic behaviour of the proposed estimators for sample sizes commonly observed in practice. We conducted a broad Monte Carlo study to compare these change point estimators, also investigating their properties and potential* **practical applications.**

Key words: *change point estimation; nonparametric tests; stochastically ordered alternatives*; Mann-Whitney statistic

1. Introduction

Since the middle of the twentieth century, the retrospective change point problem has been extensively addressed in statistics and engineering literature (e.g., Chernoff and Zacks, 1964; James et al., 1987; Csorgo and Horvath, 1988; Gombay and Horvath, 1994, Gurevich and Vexler, 2005, 2010; Gurevich, 2006, 2007, 2009). This problem is directly connected to process capability and is important in biostatistics, education, economics and other fields (e.g., see Page, 1954, 1955; Sen and Srivastava, 1975). Formally, the problem is that of hypothesis testing:

$$H_0\text{, the null: } X_1, X_2, ..., X_n \sim F_1 \text{ versus} \quad (1)$$
$$H_1\text{, the alternative: } X_i \sim F_1,\ X_j \sim F_2,\ i = 1,...,\nu-1,\ j = \nu,...,n,$$

where $X_1, X_2, ..., X_n$ is a sample of independent observations, F_1 and F_2 are distribution functions with corresponding density functions f_1 and f_2, respectively. The

distribution functions F_1 and F_2 are not necessary known. The unknown parameter ν, $2 \le \nu \le n$ is called a change point. In accordance with the statistical literature, the problem (1) has been investigated in parametric and nonparametric forms, depending on assumptions made on the distribution functions F_1 and F_2. In the parametric case of (1), it is assumed that the distribution functions F_1 and F_2 have known forms that can contain certain unknown parameters (e.g., James et al., 1987; Gombay and Horvath, 1994; Gurevich, 2007). In the nonparametric case of (1), the functions F_1, F_2 are assumed to be completely unknown (e.g., Wolfe and Schechtman, 1984; Ferger, 1994; Gombay, 2000, 2001; Gurevich, 2006).

The parametric case of testing the change point problem (1) has been dealt with extensively in both the theoretical and applied literature (e.g., Chernoff and Zacks, 1964; Kander and Zacks, 1966; Sen and Srivastava, 1975; James et al., 1987; Gombay and Horvath, 1994; Gurevich and Vexler, 2005; Gurevich, 2007). Chernoff and Zacks (1964) considered the problem (1) based on normally distributed observations with $F_1 = N(\theta_0,1)$, $F_2 = N(\theta,1)$, where θ_0 and $\theta > \theta_0$ are unknown. Kander and Zacks (1966) extended the Chernoff and Zacks's results to a case based on data from the one-parameter exponential family. Sen and Srivastava (1975) used the maximum likelihood technique to present a test-statistic. James et al. (1987) proposed, in the context of (1), decision rules based on likelihood ratios and recursive residuals. This change point literature concluded that there is no a globally (with respect to values of ν, under H_1) preferable test for (1). It turned out that the Chernoff and Zacks' test has a larger power than that of tests based on the likelihood ratio or recursive residuals when ν is around $n/2$, but this property is reversed if the change point ν is close to the edges, i.e., when $\nu \approx n$ or $\nu \approx 2$.

When the problem (1) is stated nonparametrically, the common components of change point detection policies have been proposed to be based on signs and/or ranks and/or U -statistics (e.g., Wolfe and Schechtman, 1984; Ferger, 1994; Gombay, 2000, 2001; Gurevich, 2006). Sen and Srivastava (1975) focused on the problem (1) with the unknown distributions $F_1(x)$, $F_2(x) = F_1(x-\beta)$, $\beta > 0$. The authors suggested to reject H_0, for large values of the statistic

$$D = \max_{2 \le k \le n} \left\{ \left[U_{k-1,n-k+1} - (k-1)(n-k+1)/2 \right] / \left[(k-1)(n-k+1)(n+1)/12 \right]^{\frac{1}{2}} \right\}, \qquad (2)$$

where $U_{k-1,n-k+1} = \sum_{i=1}^{k-1} \sum_{j=k}^{n} I(X_i \le X_j)$, ($I(\cdot)$ is the indicator function), is the Mann-Whitney statistic for two samples of size $k-1$ and $n-k+1$. (Sen and Srivastava (1975) did not study analytical properties of the statistic (2).) Setting the problem (1) in a similar manner to Sen and Srivastava (1975), Pettitt (1979) used the statistic

$$\max_{2 \le k \le n} \left\{ -\sum_{i=1}^{k-1} \sum_{j=k}^{n} Q_{ij} \right\}, \quad Q_{ij} = sign(X_i - X_j) = \begin{cases} 1 & X_i > X_j \\ 0 & X_i = X_j \\ -1 & X_i < X_j \end{cases}$$

to propose a change point detection policy. Wolfe and Schechtman (1984) showed that this statistic can be presented as

$$K = 2\max_{2\le k\le n}\left\{U_{k-1,n-k+1} - (k-1)(n-k+1)/2\right\}. \quad (3)$$

Csorgo and Horvath (1988) have modified very slightly the statistic (2) and evaluated asymptotically $(n\to\infty)$ the type I error of the corresponding test. Ferger (1994) and Gombay (2001,2002) studied the asymptotic behaviour of U-statistics, in particular, the asymptotic properties of the test based on statistic (3). Wolfe and Schechtman (1984), Gurevich (2006, 2009) as well as Gurevich and Vexler (2010) compared the powers of various nonparametric retrospective tests for the problem (1). Their study confirmed that the tests based on statistics (2) and (3) are usually very efficient, especially for stochastically ordered alternatives. Moreover, It turned out that, as in the parametric case, there is no a globally preferable test. For $\nu \approx n/2$ it seems that the test based on the statistic (3) is preferable; and for ν that is close to edges, the test based on the statistic (2) is preferable. Note that, under H_0 the distribution of the statistics (2) and (3) does not depend on the distribution of the observations. That is, the tests based on these statistics are exact and corresponding critical values can be tabulated for fix sample sizes and any desirable significance level. When the two-sided alternative $F_2(x) = F_1(x-\beta)$, $\beta \neq 0$ is assumed, the absolute values under the operator max in the statistics (2) and (3) should be considered (e.g., Gurevich and Vexler, 2010). Thus, the tests for the two-sided alternative are based on the statistics

$$DD = \max_{2\le k\le n}\left|U_{k-1,n-k+1} - (k-1)(n-k+1)/2\right| / \left[(k-1)(n-k+1)(n+1)/12\right]^{\frac{1}{2}}, \quad (4)$$

$$KK = 2\max_{2\le k\le n}\left|U_{k-1,n-k+1} - (k-1)(n-k+1)/2\right|. \quad (5)$$

While the change point literature mainly relates on testing the hypotheses (1), rather scant work has been done on the problem of estimation of the change point ν. Gurevich and Vexler (2005, 2010) showed that, in general, a process of estimation of the change point parameter ν should be started if needed, provided that just the null hypothesis of (1) is rejected. When H_0 is rejected, the issue to estimate the unknown parameter ν can be stated. Borovkov (1999) as well as Gurevich and Vexler (2005) investigated different estimators of the change point parameter ν in a parametric framework. Ferger (2001) studied the behaviour of change point estimators in a nonparametric framework under the null hypothesis. Theoretical investigations of the change point estimators need substantial mathematical details and usually are restricted to the asymptotic analysis when $\nu\to\infty$, $n-\nu\to\infty$ (e.g. Ferger, 2001 and his references).

In this article we propose four nonparametric change point estimators in the context of the problem (1) with stochastically ordered alternatives. That is, we consider the problem (1), where the functions F_1 and F_2 are completely unknown but the observations after the change are assumed to be stochastically larger/smaller than that before the change. We focus on the non asymptotic behaviour of the proposed estimators and present a broad Monte Carlo study investigating their properties and potential ***practical applications.*** The rest of the paper is organized as follows. Section 2 gives a short background in change point estimation and presents four proposed estimators of ν. Section 3 displays a Monte Carlo study. Finally, we state our conclusions in Section 4.

2. The proposed change point estimators

Let $X_1, X_2, ..., X_n$ be independent random observations. We consider the hypotheses (1) where unknown distribution functions F_1 and F_2 such that for all x, $F_2(x) \le F_1(x)$ or $F_2(x) \ge F_1(x)$ (that is, we assume after a possible change the observations are stochastically larger or smaller than before the change). The analysis of change point estimators in a nonparametric framework has been of increasing interest in the last two decades. Commonly, the results for estimators of ν are concerned with the case of an actual change ($2 \le \nu \le n$) and are based on ***theoretical*** studies regarding the ***asymptotic*** ($\nu \to \infty$, $n - \nu \to \infty$) behaviour of their distributions. Since in many actual applications the most commonly used sample sizes are small or average, the practical implementation of such results is not straightforward. Gurevich and Vexler (2005) presented some Monte Carlo experiments regarding the non asymptotic behavior of the maximum likelihood change point estimators in the parametric framework, i.e., when the problem (1) is stated in the parametric form.

Here we propose the following four estimators of ν in a nonparametric framework. These maximum likelihood type estimators are based on the relevant nonparametric statistics D, K, DD, KK that have been suggested for corresponding change point detection problems.

$$\hat{\nu}_D = \arg\max_{2 \le k \le n} \left\{ \left[U_{k-1,n-k+1} - (k-1)(n-k+1)/2 \right] / \left[(k-1)(n-k+1)(n+1)/12 \right]^{\frac{1}{2}} \right\}, \quad (6)$$

$$\hat{\nu}_K = \arg\max_{2 \le k \le n} \left\{ U_{k-1,n-k+1} - (k-1)(n-k+1)/2 \right\}, \quad (7)$$

$$\hat{\nu}_{DD} = \arg\max_{2 \le k \le n} \left| U_{k-1,n-k+1} - (k-1)(n-k+1)/2 \right| / \left[(k-1)(n-k+1)(n+1)/12 \right]^{\frac{1}{2}}, \quad (8)$$

$$\hat{\nu}_{KK} = \arg\max_{2 \le k \le n} \left| U_{k-1,n-k+1} - (k-1)(n-k+1)/2 \right|. \quad (9)$$

Theoretical evaluations of distribution of the proposed estimators ***require complicated computations*** that are beyond the scope of this article. In Section 3 we present Monte Carlo results to illustrate the non asymptotic behaviour of the estimators $\hat{\nu}_D$, $\hat{\nu}_K$, $\hat{\nu}_{DD}$, $\hat{\nu}_{KK}$ as well as their comparisons and the practical suitability.

3. Monte Carlo Study

To study the behavior of the change point estimators (6)-(9), we conducted the following experiments. For each distribution set with different sample sizes, we generated 50,000 times corresponding data. Tables 1;2;3 presents the Monte Carlo means and standard deviations of the estimators $\hat{\nu}_D$, $\hat{\nu}_K$, $\hat{\nu}_{DD}$, $\hat{\nu}_{KK}$, when samples of X's were drown from $F_1 = Norm(\mu, \sigma^2)$, $F_2 = Norm(\mu + \beta\sigma, \sigma^2)$; $F_1 = \text{Unif}(0,1)$, $F_2 = \text{Unif}(\beta, 1+\beta)$; $F_1 = LogNorm(\mu, \sigma^2)$, $F_2 = LogNorm(\mu + \beta\sigma, \sigma^2)$, respectively, for different values of β, sample sizes n and values of the change point parameter ν. To explain the results of these experiments we have also evaluated the simulated powers of the tests RD, RK,

RDD, RKK, based on the statistics (2), (3), (4), (5). That is, the test RD rejects the null hypothesis H_0 if $D > C_D$, the tests RK, RDD, RKK reject H_0 if $K > C_K$, $DD > C_{DD}$, $KK > C_{KK}$, respectively, where C_D, C_K, C_{DD}, C_{KK} are test thresholds. (The tests RD and RK are proposed for the situations where the observations after the possible change are suspected to be stochastically larger than that before the change. For the situations where the observations after the possible change are suspected to be stochastically smaller, the similar tests that reject H_0 for small values of the statistics D and K should be considered.) The Monte Carlo powers of the tests RD, RK, RDD, RKK were evaluated at the level of significance 0.05 that was fixed experimentally by choosing special values of the thresholds C_D, C_K, C_{DD}, C_{KK}. (Under the null hypothesis of (1), the baseline distribution functions of the nonparametric test statistics D, K, DD, KK do not depend on data distributions, only tables of critical values of the tests are required for their implementation.) Note also that distributions of all four considered statistics do not depend on the parameters μ and σ. Therefore, without loss of generality we utilized $\mu = 0$ and $\sigma = 1$. The power functions of the tests RD, RK, RDD, RKK as functions of ν are symmetric around the middle points $\nu - 1 = n/2$. Moreover, the powers of the tests RDD and RKK do not depend on a sign of β, for all fixed ν.

Table1. The Monte Carlo powers (at $\alpha = 0.05$) of the tests RD, RK, RDD, RKK, and the Monte Carlo means and standard deviations (Std) of the estimators $\hat{\nu}_D$, $\hat{\nu}_K$, $\hat{\nu}_{DD}$, $\hat{\nu}_{KK}$, when $F_1 = Norm(0,1)$, $F_2 = Norm(\beta,1)$, for different sample sizes n and values of β and ν. Observations with the subscript $\nu - 1$ are the last observations before the change.

n	β	$\nu-1$	Power of RD	Power of RK	Power of RDD	Power of RKK	Mean (Std) of $\hat{\nu}_D - 1$	Mean (Std) of $\hat{\nu}_K - 1$	Mean (Std) of $\hat{\nu}_{DD} - 1$	Mean (Std) of $\hat{\nu}_{KK} - 1$
	0.8	10	0.388	0.429	0.264	0.311	10.0(4.3)	9.9(3.0)	9.9(4.6)	9.9(3.0)
		5	0.291	0.258	0.177	0.160	7.5(4.9)	7.7(3.9)	8.1(5.3)	7.8(3.9)
		3	0.186	0.135	0.105	0.079	7.0(5.6)	7.6(4.6)	8.2(5.9)	7.6(4.6)
	1	10	0.526	0.574	0.387	0.450	10.0(3.6)	9.9(2.5)	10.0(3.8)	9.9(2.5)
20		5	0.396	0.354	0.262	0.227	7.0(4.4)	7.4(3.4)	7.5(4.8)	7.4(3.4)
		3	0.250	0.160	0.141	0.093	6.4(5.2)	7.1(4.3)	7.4(5.7)	7.1(4.3)
	1.2	10	0.661	0.717	0.524	0.603	10.0(3.0)	9.9(2.0)	10.0(3.2)	9.6(2.0)
		5	0.513	0.458	0.359	0.312	6.6(3.8)	7.1(3.1)	7.0(4.1)	7.1(3.0)
		3	0.326	0.194	0.189	0.111	5.9(4.8)	6.8(4.1)	6.7(5.3)	6.8(4.1)
	0.8	20	0.617	0.689	0.497	0.575	20.0(7.1)	19.9(4.3)	20.0(7.5)	19.9(4.4)
		10	0.485	0.461	0.368	0.325	13.4(8.6)	14.4(6.4)	14.2(9.4)	14.4(6.4)
		5	0.284	0.172	0.181	0.101	11.9(11.1)	14.1(9.0)	14.0(12.1)	14.0(9.0)
	1	20	0.798	0.850	0.704	0.770	20.0(5.4)	20.0(3.3)	20.0(5.6)	20.0(3.3)
40		10	0.660	0.627	0.539	0.491	12.4(6.9)	13.6(5.4)	12.7(7.5)	13.6(5.4)
		5	0.396	0.224	0.265	0.132	10.3(9.7)	13.0(8.3)	11.9(10.9)	13.1(8.3)
	1.2	20	0.916	0.944	0.856	0.902	20.0(4.0)	20.0(2.6)	20.0(4.2)	20.0(2.6)
		10	0.806	0.785	0.708	0.657	11.6(5.4)	13.0(4.6)	11.8(5.8)	13.0(4.6)
		5	0.526	0.281	0.374	0.163	9.1(8.4)	12.2(7.6)	10.2(9.4)	12.1(7.7)
	0.8	35	0.838	0.897	0.753	0.834	35.0(9.3)	35.0(5.4)	35.0(9.7)	35.0(5.4)
		50	0.749	0.778	0.645	0.665	47.2(11.1)	45.4(8.0)	46.9(11.8)	45.3(8.0)
		60	0.507	0.357	0.378	0.225	52.7(15.9)	47.9(13.3)	50.6(17.9)	47.9(13.3)
	1	35	0.956	0.979	0.922	0.956	35.0(6.3)	35.0(3.9)	35.0(6.4)	35.0(3.9)
70		50	0.903	0.924	0.849	0.861	48.4(7.7)	46.4(6.3)	48.2(8.0)	46.4(6.3)
		60	0.689	0.514	0.565	0.346	55.3(12.4)	49.9(11.7)	54.3(14.0)	49.9(11.7)
	1.2	35	0.993	0.997	0.985	0.993	35.0(4.4)	35.0(2.9)	35.0(4.3)	35.0(2.9)
		50	0.978	0.982	0.953	0.960	49.0(5.3)	47.2(5.0)	49.0(5.3)	47.2(5.1)
		60	0.838	0.673	0.741	0.490	57.0(9.3)	51.4(10.4)	56.6(10.4)	51.5(10.4)
	0.8	50	0.939	0.971	0.898	0.944	50.0(10.2)	50.0(6.0)	50.1(10.4)	49.9(6.1)
		70	0.889	0.916	0.825	0.857	67.8(11.9)	65.1(9.1)	67.7(12.4)	65.2(9.0)
		90	0.502	0.270	0.374	0.164	79.1(23.4)	69.5(20.9)	75.6(26.9)	69.3(20.8)
	1	50	0.993	0.998	0.985	0.994	50.0(6.5)	50.0(4.3)	50.0(6.6)	50.0(4.2)
100		70	0.979	0.986	0.960	0.969	68.9(7.5)	66.4(6.8)	68.9(7.7)	66.4(6.8)
		90	0.688	0.386	0.564	0.232	83.3(18.0)	72.3(18.8)	81.5(20.8)	72.3(18.8)
	1.2	50	1.000	1.000	0.999	1.000	50.0(4.2)	50.0(3.1)	50.0(4.3)	50.0(3.1)
		70	0.997	0.999	0.995	0.996	69.3(4.9)	67.2(5.3)	69.3(4.9)	67.3(5.4)
		90	0.842	0.521	0.751	0.338	85.8(13.2)	74.6(17.2)	85.1(15.0)	74.6(17.1)
	0.8	75	0.990	0.997	0.981	0.993	74.9(10.3)	75.0(6.6)	75.0(10.5)	75.0(6.7)
		100	0.980	0.990	0.965	0.987	98.8(11.4)	95.9(9.3)	98.8(11.6)	95.8(9.2)
		125	0.875	0.805	0.812	0.682	120.2(18.9)	109.9(19.5)	119.5(20.4)	110.2(19.5)
	1	75	1.000	1.000	0.999	1.000	75.0(6.2)	75.0(4.5)	75.0(6.2)	75.0(4.5)
150		100	0.999	1.000	0.998	0.999	99.4(6.8)	97.0(6.6)	99.3(6.8)	97.0(6.7)
		125	0.974	0.947	0.954	0.895	122.7(11.0)	113.3(15.9)	122.6(11.6)	113.2(16.0)
	1.2	75	1.000	1.000	1.000	1.000	75.0(4.1)	75.0(3.2)	75.0(4.1)	75.0(3.2)
		100	1.000	1.000	1.000	1.000	99.6(4.3)	97.8(5.0)	99.6(4.2)	97.7(4.9)
		125	0.997	0.992	0.994	0.978	123.8(6.5)	115.6(13.4)	123.7(6.7)	115.7(13.4)

Table2. The Monte Carlo powers (at $\alpha = 0.05$) of the tests RD, RK, RDD, RKK, and the Monte Carlo means and standard deviations (Std) of the estimators $\hat{\nu}_D$, $\hat{\nu}_K$, $\hat{\nu}_{DD}$, $\hat{\nu}_{KK}$, when $F_1 = \text{Unif}(0,1)$, $F_2 = \text{Unif}(\beta, 1+\beta)$, for different sample sizes n and values of β and ν. Observations with the subscript $\nu - 1$ are the last observations before the change.

n	β	$\nu-1$	Power of RD	Power of RK	Power of RDD	Power of RKK	Mean (Std) of $\hat{\nu}_D - 1$	Mean (Std) of $\hat{\nu}_K - 1$	Mean (Std) of $\hat{\nu}_{DD} - 1$	Mean (Std) of $\hat{\nu}_{KK} - 1$
	0.20	10	0.299	0.329	0.191	0.224	10.0(4.8)	9.9(3.4)	10.0(5.0)	9.9(3.4)
		5	0.225	0.201	0.137	0.121	7.9(5.3)	8.1(4.2)	8.7(5.6)	8.1(4.2)
		3	0.156	0.115	0.091	0.069	7.5(5.9)	8.0(4.8)	8.8(6.1)	8.0(4.8)
	0.35	10	0.627	0.682	0.486	0.555	10.0(3.3)	9.9(2.2)	10.0(3.4)	9.9(2.2)
20		5	0.470	0.419	0.319	0.277	6.8(4.0)	7.2(3.2)	7.2(4.4)	7.2(3.2)
		3	0.294	0.184	0.182	0.105	6.1(5.0)	6.9(4.1)	7.0(5.4)	6.9(4.2)
	0.50	10	0.893	0.924	0.809	0.864	10.0(2.0)	10.0(1.3)	10.0(2.0)	10.0(1.3)
		5	0.753	0.691	0.597	0.516	6.0(2.8)	6.6(2.4)	6.1(2.9)	6.6(2.4)
		3	0.489	0.259	0.332	0.147	5.0(3.8)	6.2(3.6)	5.4(4.3)	6.2(3.6)
	0.20	20	0.481	0.546	0.359	0.418	20.0(8.5)	20.0(5.3)	20.0(9.0)	19.9(5.4)
		10	0.368	0.344	0.258	0.228	14.3(9.9)	15.1(7.2)	15.7(10.7)	15.2(7.2)
		5	0.218	0.141	0.138	0.084	13.2(12.0)	15.0(9.5)	15.9(12.7)	15.0(9.4)
	0.35	20	0.890	0.926	0.821	0.874	20.0(4.6)	20.0(2.8)	20.0(4.7)	20.0(2.9)
40		10	0.766	0.742	0.659	0.606	11.9(6.0)	13.2(4.9)	12.2(6.5)	13.2(4.9)
		5	0.468	0.259	0.336	0.150	9.6(8.9)	12.5(7.9)	10.9(10.1)	12.5(7.9)
	0.50	20	0.995	0.998	0.989	0.995	20.0(2.3)	20.0(1.6)	20.0(2.2)	20.0(1.6)
		10	0.972	0.966	0.943	0.921	10.9(3.1)	12.2(3.3)	10.9(3.1)	12.1(3.4)
		5	0.770	0.428	0.630	0.254	7.3(5.7)	10.8(6.6)	7.7(6.4)	10.9(6.6)
	0.20	35	0.693	0.778	0.581	0.671	35.0(12.2)	35.0(7.0)	35.0(12.7)	35.0(7.0)
		50	0.596	0.626	0.469	0.493	45.9(14.1)	44.2(9.6)	44.8(15.1)	44.1(9.5)
		60	0.377	0.268	0.262	0.160	50.1(18.5)	46.2(14.5)	46.8(20.6)	46.2(14.6)
	0.35	35	0.987	0.994	0.974	0.987	35.0(5.0)	35.0(3.2)	35.0(5.0)	35.0(3.2)
70		50	0.964	0.971	0.934	0.938	48.8(6.1)	46.9(5.4)	48.8(6.1)	46.9(5.4)
		60	0.795	0.616	0.684	0.440	56.3(10.4)	50.8(10.9)	55.7(11.6)	50.8(10.8)
	0.50	35	1.000	1.000	1.000	1.000	35.0(2.1)	35.0(1.7)	35.0(2.2)	35.0(1.7)
		50	1.000	1.000	0.999	1.000	49.5(2.6)	48.1(3.4)	49.5(2.5)	48.1(3.4)
		60	0.983	0.922	0.964	0.810	58.6(4.8)	53.4(8.4)	58.6(4.8)	53.5(8.3)
	0.20	50	0.827	0.896	0.743	0.831	50.0(14.4)	50.0(8.0)	49.9(14.6)	50.0(8.0)
		70	0.753	0.793	0.648	0.692	66.4(16.5)	63.8(11.2)	65.6(17.4)	63.7(11.1)
		90	0.366	0.206	0.258	0.127	75.0(27.5)	66.7(22.2)	69.6(31.0)	66.8(22.4)
	0.35	50	0.999	1.000	0.998	0.999	50.0(4.9)	50.0(3.4)	50.0(4.9)	50.0(3.4)
100		70	0.996	0.997	0.990	0.993	69.1(5.8)	66.9(5.8)	69.1(5.9)	67.0(5.8)
		90	0.795	0.471	0.689	0.303	85.0(14.9)	73.9(17.6)	84.1(16.8)	73.8(17.6)
	0.50	50	1.000	1.000	1.000	1.000	50.0(2.1)	50.0(1.7)	50.0(2.1)	50.0(1.7)
		70	1.000	1.000	1.000	1.000	69.6(2.3)	68.2(3.4)	69.6(2.3)	68.2(3.4)
		90	0.986	0.808	0.968	0.607	88.3(6.5)	77.9(14.2)	88.2(6.5)	77.9(14.1)
	0.20	75	0.943	0.974	0.905	0.951	74.9(15.6)	75.0(8.9)	75.0(16.0)	75.0(9.0)
		100	0.915	0.947	0.862	0.903	97.6(17.3)	94.3(12.0)	97.4(17.8)	94.3(12.2)
		125	0.729	0.637	0.624	0.490	116.6(26.6)	106.5(22.8)	114.4(29.8)	106.6(22.9)
	0.35	75	1.000	1.000	1.000	1.000	75.0(4.6)	75.0(3.6)	75.0(4.7)	75.0(3.6)
150		100	1.000	1.000	1.000	1.000	99.5(4.9)	97.5(5.4)	99.5(4.9)	97.5(5.4)
		125	0.995	0.987	0.989	0.964	123.4(7.7)	114.8(14.1)	123.4(8.0)	114.9(14.2)
	0.50	75	1.000	1.000	1.000	1.000	75.0(2.0)	75.0(1.8)	75.0(2.0)	75.0(1.8)
		100	1.000	1.000	1.000	1.000	99.7(2.1)	98.6(3.0)	99.7(2.1)	98.6(3.0)
		125	1.000	1.000	1.000	1.000	124.3(2.9)	118.4(9.7)	124.3(2.8)	118.4(9.7)

Table3. The Monte Carlo powers (at $\alpha = 0.05$) of the tests RD, RK, RDD, RKK, and the Monte Carlo means and standard deviations (Std) of the estimators $\hat{\nu}_D$, $\hat{\nu}_K$, $\hat{\nu}_{DD}$, $\hat{\nu}_{KK}$, when $F_1 = LogNorm(0,1)$, $F_2 = LogNorm(\beta,1)$, for different sample sizes n and values of β and ν. Observations with the subscript $\nu - 1$ are the last observations before the change.

n	β	$\nu-1$	Power of RD	Power of RK	Power of RDD	Power of RKK	Mean (Std) of $\hat{\nu}_D - 1$	Mean (Std) of $\hat{\nu}_K - 1$	Mean (Std) of $\hat{\nu}_{DD} - 1$	Mean (Std) of $\hat{\nu}_{KK} - 1$
	0.7	10	0.323	0.356	0.210	0.251	10.0(4.6)	9.9(3.3)	9.9(4.9)	9.9(3.3)
		5	0.241	0.217	0.148	0.131	7.8(5.2)	8.0(4.1)	8.5(5.5)	8.0(4.1)
		3	0.163	0.121	0.091	0.076	7.4(5.8)	7.8(4.8)	8.5(6.0)	7.8(4.8)
	1.2	10	0.662	0.720	0.526	0.597	10.0(3.0)	9.9(2.0)	10.0(3.2)	9.9(2.0)
20		5	0.522	0.461	0.360	0.312	6.6(3.8)	7.1(3.1)	7.0(4.1)	7.1(3.0)
		3	0.325	0.195	0.189	0.110	5.8(4.7)	6.8(4.1)	6.7(5.3)	6.8(4.1)
	1.7	10	0.907	0.936	0.831	0.887	10.0(1.8)	10.0(1.2)	10.0(1.8)	10.0(1.2)
		5	0.785	0.724	0.640	0.563	6.0(2.6)	6.5(2.3)	6.0(2.7)	6.5(2.3)
		3	0.546	0.273	0.353	0.154	4.8(3.6)	6.1(3.5)	5.2(4.1)	6.1(3.5)
	0.7	20	0.516	0.584	0.395	0.464	20.0(8.0)	19.9(5.0)	20.0(8.5)	19.9(5.0)
		10	0.399	0.377	0.287	0.256	14.0(9.5)	14.9(6.9)	15.1(10.3)	14.9(7.0)
		5	0.235	0.149	0.147	0.089	12.8(11.6)	14.7(9.3)	15.2(12.6)	14.6(9.3)
	1.2	20	0.915	0.946	0.859	0.904	20.0(4.1)	20.0(2.6)	20.0(4.2)	20.0(2.6)
40		10	0.808	0.782	0.711	0.663	11.6(5.4)	13.0(4.5)	11.8(5.8)	13.0(4.6)
		5	0.520	0.280	0.375	0.162	9.0(8.4)	12.1(7.7)	10.1(9.5)	12.1(7.7)
	1.7	20	0.997	0.999	0.993	0.996	20.0(2.0)	20.0(1.4)	20.0(2.0)	20.0(1.4)
		10	0.979	0.973	0.956	0.936	10.8(2.8)	12.0(3.2)	10.8(2.9)	12.0(3.2)
		5	0.814	0.453	0.687	0.269	7.1(5.4)	10.6(6.4)	7.3(5.9)	10.6(6.4)
	0.7	35	0.734	0.815	0.625	0.722	35.0(11.3)	35.0(6.4)	35.1(11.7)	35.0(6.5)
		50	0.640	0.669	0.517	0.539	46.3(13.0)	44.6(9.1)	45.6(14.3)	44.5(9.1)
		60	0.411	0.292	0.290	0.180	51.0(17.7)	46.8(14.2)	48.2(19.8)	46.8(14.2)
	1.2	35	0.992	0.997	0.984	0.993	35.0(4.3)	35.0(2.9)	35.0(4.4)	35.0(2.9)
70		50	0.976	0.981	0.953	0.960	49.0(5.2)	47.2(5.1)	49.0(5.3)	47.1(5.0)
		60	0.841	0.672	0.747	0.495	57.0(9.4)	51.4(10.3)	56.6(10.2)	51.4(10.4)
	1.7	35	1.000	1.000	1.000	1.000	35.0(2.0)	35.0(1.6)	35.0(1.9)	35.0(1.6)
		50	1.000	1.000	1.000	1.000	49.5(2.3)	48.2(3.2)	49.6(2.3)	48.2(3.2)
		60	0.987	0.938	0.972	0.849	58.8(4.2)	53.7(8.1)	58.8(4.3)	53.8(8.0)
	0.7	50	0.866	0.924	0.795	0.871	50.0(12.8)	49.9(7.3)	50.0(13.2)	50.0(7.3)
		70	0.796	0.835	0.705	0.743	66.9(15.1)	64.3(10.6)	66.4(15.8)	64.2(10.5)
		90	0.403	0.224	0.291	0.136	76.7(26.2)	67.6(21.8)	72.0(29.7)	67.4(21.9)
	1.2	50	1.000	1.000	0.999	1.000	50.0(4.2)	50.0(3.1)	50.0(4.3)	50.0(3.0)
100		70	0.998	0.999	0.994	0.996	69.3(5.0)	67.3(5.3)	69.4(5.0)	67.2(5.2)
		90	0.843	0.520	0.751	0.343	85.8(13.1)	74.6(17.0)	85.2(14.8)	74.6(17.0)
	1.7	50	1.000	1.000	1.000	1.000	50.0(1.9)	50.0(1.6)	50.0(1.9)	50.0(1.6)
		70	1.000	1.000	1.000	1.000	69.6(2.1)	68.3(3.1)	69.6(2.1)	68.4(3.2)
		90	0.989	0.843	0.975	0.660	88.6(5.6)	78.4(13.9)	88.5(5.7)	78.3(13.9)
	0.7	75	0.962	0.985	0.935	0.969	75.0(13.8)	75.0(8.1)	75.0(14.0)	75.0(8.2)
		100	0.940	0.964	0.899	0.931	98.1(15.3)	94.9(11.0)	98.0(15.9)	94.9(11.0)
		125	0.776	0.686	0.684	0.541	117.9(23.8)	107.8(22.0)	116.4(26.7)	107.6(22.0)
	1.2	75	1.000	1.000	1.000	1.000	75.0(4.1)	75.0(3.2)	75.0(4.0)	75.0(3.2)
150		100	1.000	1.000	1.000	1.000	99.6(4.2)	97.7(4.9)	99.6(4.3)	97.8(4.9)
		125	0.997	0.992	0.994	0.978	123.7(6.6)	115.6(13.3)	123.7(6.5)	115.5(13.3)
	1.7	75	1.000	1.000	1.000	1.000	75.0(1.9)	75.0(1.6)	75.0(1.8)	75.0(1.6)
		100	1.000	1.000	1.000	1.000	99.7(1.9)	98.7(2.8)	99.7(2.0)	98.7(2.8)
		125	1.000	1.000	1.000	1.000	124.4(2.5)	118.9(9.3)	124.4(2.5)	118.8(9.3)

Tables 1-3 show that for all considered examples and sample sizes, when an alternative is one-sided, the test RK is preferable to the test RD from the power perspective if a change in the distributions occurs in the middle ($\nu \approx n/2$) and the situation is reversed when the change occurs in the edges ($\nu \approx 2$ or $\nu \approx n$). Thus, our simulation results confirm the conclusions follow from the Monte Carlo experiments presented by Wolfe and Schechtman (1984) and Gurevich (2009) about power comparisons of the nonparametric tests RK and RD. Note also that when an alternative is two-sided, the power's comparison of the tests RKK and RDD seems to be a similar to that of RK and RD. That is the test RKK is preferable to the test RDD if the real change occurs in the middle and the test RDD is preferable to the test RKK when the real change point ν is

close to the edges. As expected, the powers of the test RK, RD are essentially higher than that of the tests RKK, RDD, respectively, for all considered situations. Obviously, it follows from the fact that the tests RK and RD have been constructed utilizing an additional information about possible alternatives. Finally, analyzing the simulated powers of the tests RD, RK, RDD, RKK presented in Tables 1-3, we conclude that all these test are very efficient providing rather high powers even for average and small sample sizes ($n \approx 40$, $n \approx 20$) and insignificant real changes in distributions of the observations.

It ***follows from*** Tables 1-3 that the simulated means and standard deviations of the estimators $\hat{\nu}_K$ are very similar to that of the estimator $\hat{\nu}_{KK}$ for all considered examples and values of the parameter ν. That means that if one decides to use the estimator of a change point ν based on the statistic K, it is not important to define the alternative in (1) as a one-sided (and use the estimator $\hat{\nu}_K$) or as a two-sided (and use the estimator $\hat{\nu}_{KK}$). Comparing the behavior of the estimator $\hat{\nu}_D$ with that of the estimator $\hat{\nu}_{DD}$ shows that the estimator $\hat{\nu}_D$ is more exact than $\hat{\nu}_{DD}$ (i.e., the simulated means of $\hat{\nu}_D$ are closer to the real values of ν and his simulated standard deviations are less than that of $\hat{\nu}_{DD}$), especially for large sample sizes. That is, if one decides to use the statistic D for the testing of the hypotheses (1) and estimating of the change point ν (i.e., the possible change is suspected to be close to edges), the definition of the alternative of (1) as a one-sided not only increases the power of the appropriate test (RD is more powerful than RDD) but also yields more exact estimator ($\hat{\nu}_D$ is more exact than $\hat{\nu}_{DD}$).

In addition, Tables 1-3 demonstrate that for all considered examples and values of ν, for small and average sample sizes ($n = 20,40$) the estimator $\hat{\nu}_D$ is slightly less biased than the estimator $\hat{\nu}_K$ (i.e., the simulated means of the estimator $\hat{\nu}_D$ are slightly closer to the real values of ν than that of the estimator $\hat{\nu}_K$) but has a slightly higher variance than that of $\hat{\nu}_K$. For large sample sizes, the estimator $\hat{\nu}_D$ is essentially less biased than the estimator $\hat{\nu}_K$ (especially if a real changes are close to the edges), and has a higher variance than the estimator $\hat{\nu}_K$ for $\nu \approx n/2$, and a lower variance than $\hat{\nu}_K$ for $\nu \approx 2$ and $\nu \approx n$. Thus, the estimator $\hat{\nu}_D$ seems to be preferable to all the other estimators considered here and can be recommended to be applied in practice for estimation of a change point parameter, even for the situations where the possible change is suspected to be in the middle and tests based on the statistic K are appropriate for the hypotheses (1). Moreover, the simulated results presented in Tables 1-3 demonstrate a good performance of all four proposed estimators from the practical point of view especially for average and large sample sizes.

As aforementioned, the asymptotic analysis of the estimators' behavior is beyond the scope of this article, however, it seems from Tables 1-3 that the estimators $\hat{\nu}_K$, $\hat{\nu}_D$, $\hat{\nu}_{KK}$, $\hat{\nu}_{DD}$ are consistent when $\nu \to \infty$, $n - \nu \to \infty$.

4. Conclusions

In this article we have reviewed the recent change point literature related to the retrospective change point detection and estimation issues. We focused on the problem of nonparametric estimation of the change point parameter and considered four relevant estimators. We conducted a broad Monte Carlo study for judging the accuracy of the proposed change point estimators also comparing them from an implementation point of view. Simulation results confirm the efficiency of these estimators even for small and average sample sizes. Specific practical recommendations for using different estimators in varied situations are given in Section 3. Thus, we believe that the outputs of this manuscript have great potential to be applied in practice.

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STATISTICAL MODELING OF MORTALITY RISK FOR CONGENITAL HEART DEFECTS

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ABSTRACT. This paper, retrieving surgical data recorded in the Pediatric Cardiac Care Consortium between 1985-2004, identifies an inverse relationship between in-hospital mortality and pediatric cardiac surgical volume in small and medium-sized centers. Similar inverse relationship was found for both low and high complexity cases after stratifying the data by risk category using the Risk Adjustment for Congenital Heart Surgery (RACHS). Given the relationship, a threshold on the volume to reach the lowest attainment of surgical mortality is suggested when is attainable.
Key words: Curvature function; Historic data of Pediatric Cardiac Care Consortium; Mortality risk analysis; Optimal surgical volume.

1. INTRODUCTION

Surgical mortality rates are increasingly used by the various stakeholders in the medical care environment to assess hospital performance for high risk procedures such as cardiac surgeries [4]. For adult open heart procedures, a growing body of evidence indicates that certain surgical procedures exhibit a relationship in which higher volume of patients undergoing a particular procedure at a hospital is associated with lower mortality probability [5, 6]. However, the few studies of the volume-outcome relationship for pediatric cardiac surgery have been mixed in their conclusions [7, 8], so that the role of volume load on mortality remains poorly understood [1, 2, 3, 9, 11]. The first study by Jenkins et al., [3], reported outcomes on 2833 cases from 37 centers in the states of California and Massachusetts based on an administrative database of hospital discharge data from these two states for the years 1988 and 1989 respectively. The study suggested that risk-adjusted in-hospital mortality rates are lower in centers with higher than 300 volumes annually of pediatric cardiac surgeries. In [15] bypassing any discretizations of the hospital surgical volume found a significant inverse between surgical volume and mortality probability for all surgical complexity cases besides the lowest one for centers for a database referring to the New York State. Furthermore, analysis from the Nationwide Inpatient Sample (NIS), the

largest administrative inpatient care database in the United States, concluded that volume alone was only marginally better than a coin flip as discriminator of mortality [7]. However, after adjusting for patient and surgical case-mix, large volume hospitals performing more than 200 procedures per year performed more complex operations and achieved superior results.

Based on the above, the relative importance of hospital surgical volume for pediatric cardiac operations is disputed in particular in the most recent reports. This is not surprising, because there are only few hospitals that with the current low operative risk for congenital heart defects (CHD) have sufficient caseloads to reliably identify quality problems based on mortality rates. An additional limitation in approaching the volume-outcome relationship for CHD is the wide variation of diagnoses and surgical procedures that involves different surgical challenges and entails a wide range of risks to patients. Subsequently, the number of reported outcomes for individual procedures per diagnosis is relatively small and even when accumulating data from multiple institutions, individual procedures frequently cannot reach a sufficient volume to sustain complicated multivariate analyses. In this case, the best analysis option is to combine procedures into groups that are as homogeneous as possible with respect to patient severity of illness and to use the groups as risk factors in a risk-adjustment process. Such a data stratification system is the Risk Adjustment for Congenital Heart Surgery (RACHS) [14, 16]. RACHS has a strong association with in-hospital mortality and as complexity increases; discharge mortality also increases [17, 18]. RACHS method takes under consideration a number of factors that have been identified as risk factors for early surgical mortality including patient age, type of surgical procedure, presence of a major non-cardiac anomaly and combination of cardiac procedures [2, 14, 16].

This paper uses risk adjustment data from a large clinical database, the Pediatric Cardiac Care Consortium (PCCC), encompassing approximately 80,000 consecutive surgeries from 47 small and medium size (less or equal to 300 surgeries per year) centers from different areas across the US and Canada for the period 1985-2004. Unlike previous studies, where discretization methods of the surgical volume were chosen, the volume caseload considered naturally a continuous random variable. The historic data have been grouped into four time periods of five years each. Our data for each such period confirm that hospital surgical volume is positively related to better patient outcomes in terms of in-hospital mortality, and these differences persist for both high and low complexity pediatric cardiac procedures. In addition, the results herein suggest a hospital surgical volume threshold as the critical cut off volume to reach the lowest attainment of surgical mortality for CHD reported by larger volume centers. Beyond this threshold, no significant changes in mortality rates were noted.

The paper is organized as follows. Section 2 describes the data, and its stratification according to RACHS. Section 3 gives an outline of the results whose statistical analysis are discussed in Section 4. Section 5 addresses future questions which need to be determined based on the data entries from the PCCC database.

2. DATA SOURSES AND RISK CATEGORY STRATIFICATION

The historic data for the period 1985-2004 are aggregated from the Pediatric cardiac Care Consortium (PCCC). The PCCC registry collects clinical data from centers

perform- ing pediatric cardiac operations [12]. Due to the wide range of diagnoses and surgical procedures, we stratify the data into 6 groups such that conditions with similar expected mortality rates will be in the same group. Such a risk classification system is the Risk Adjusted Classification for Congenital Heart Surgery (RACHS). RACHS is a discrete index taking values from 0 to 6, where RACHS = 1 is assigned to the surgical procedures with the lowest risk of death and RACHS = 6 to the corresponding procedures with the highest risk for death. Conditions which cannot be stratified according to this method and remained unclassified, are assigned RACHS=0.

The outcome data for each five-year period are summarized in Table 1. The use of the database data for research purposes has been approved by the Institutional Review Board of the University of Minnesota.

Period	1985-1989	1990-1994	1995-1999	2000-2004
Number of Participating Centers	21	27	32	47
Number of Surgeries	10,924	15,884	24,495	30,204
Outlier Centers	3	3	4	6
% of surgeries from outlier centers	5%	4.5%	2.8%	2%
% of surgeries with RACHS=0	18.9%	14.5%	9%	12.2%

Table 1: Description for each 5-year period

3. RESULTS

This section outlines the results of this manuscript. Figures 1(a)-1(d) are graphical representations of the relationship between the surgical volume and the mortality probability within each 5-year period after removing any outlier within each period. We observe from Figures 1(a) and 1(b) that during the periods 1985-1989 and 1990-1994, there is a linear decreasing dependency between the mortality risk and the volume. For the two consecutive periods, 1995-1999 and 2000-2004, the decreasing dependency changes to a power law (Figures 1(c) and 1(d)). Figure 3 compares the four different patterns of the relationship volume-outcome. It is clear that the closer to the present year, the lower the mortality risk becomes. On the other hand, one may note that after approximately 1,200 surgeries the mortality probability of the period 1985-1989 is lower than the corresponding mortality probability of the period 1990-1994. An explanation for the fact is on the size of the centers which participated in the study during the early years of 1985-1989. Indeed, only one center recorded more than 1,200 surgeries during that period. If this center is ignored, then the general pattern of higher mortality during the past years is satisfied.

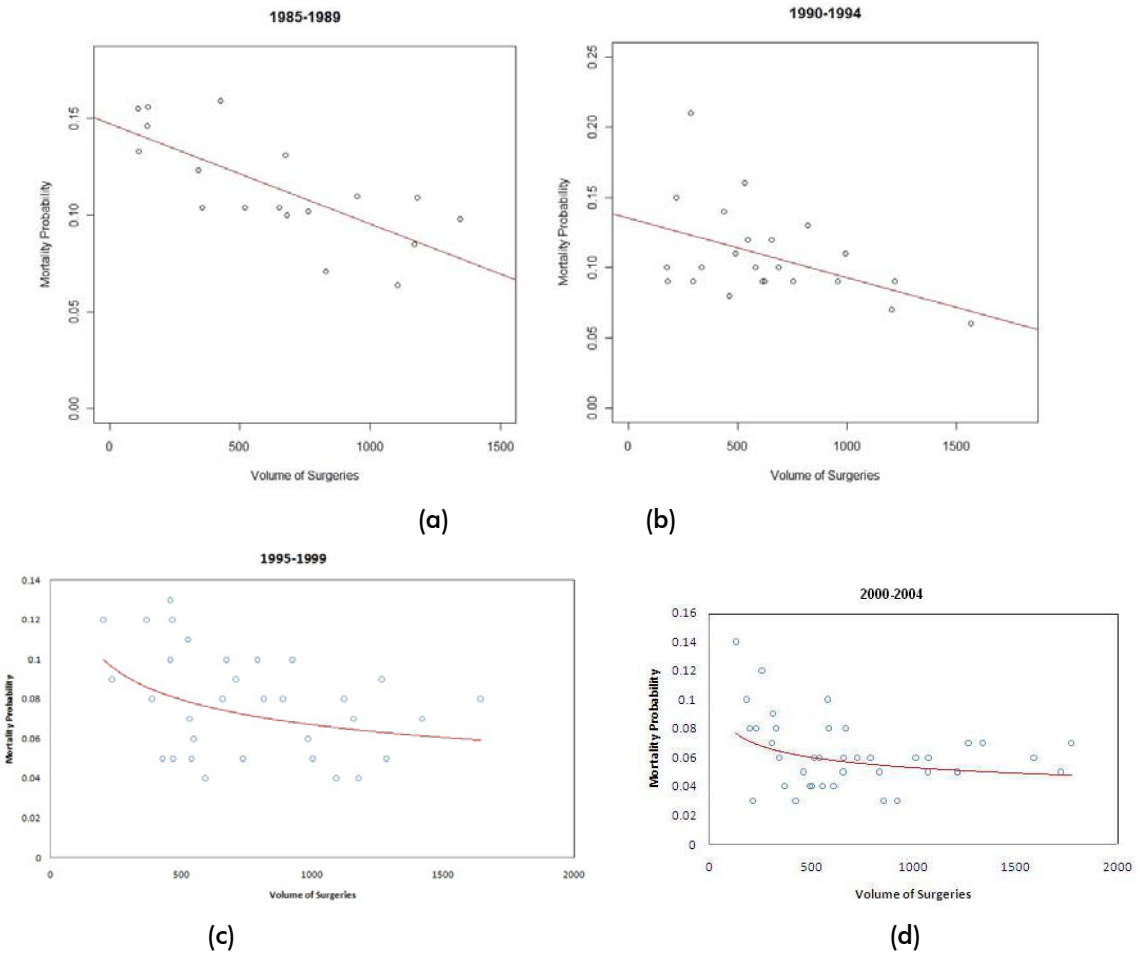


Figure 1. Historic PCCC data between 1985-2004. Each subfigure is the plot of each 5-year period, and the line declares the pattern which is followed within each period.

4. STATISTICAL ANALYSIS

4.1. **All data.** The goal of this paper is to examine whether an increase of the number of surgeries is a real evidence of a change in the probability of surgical mortality for CHD repair. In other words, whether it could be explained merely as a consequence of random variation in the historic data from 1985-2004. The statistical analysis was run via the statistical package R. The reader may refer to [13, 19] for an extensive study of statistical modeling and its application in medicine particularly.

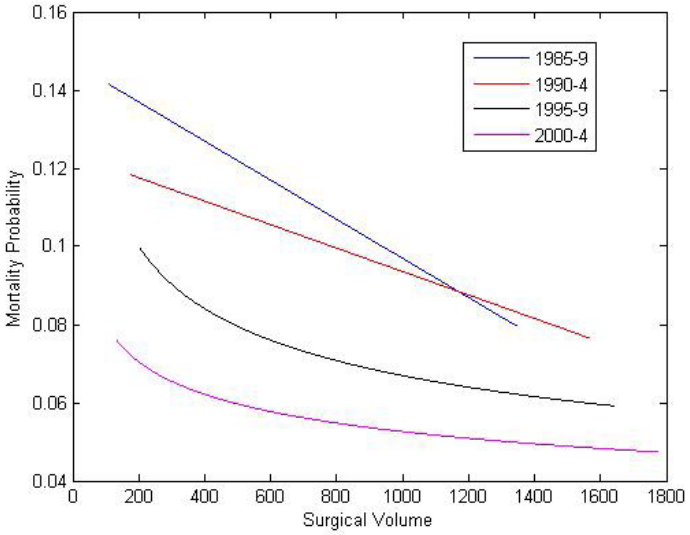


Figure 2. Comparison of the four different patterns within each period.

For the first two periods, 1985-1989 and 1990-1994, and after removing the appropriate outliers, linear regression analysis is used. It is established with p – value = 0.005 and p – value = 0.0156 respectively that the predicted mortality probability with respect to surgical volume is given as:

(1) $\hat{p}_m = \alpha + \beta V$

where $\hat{p}_m$, V are the predicted mortality risk and surgical volume respectively. The different values for α, β for the two different periods, 1 and 2, are in Table 4.1.

Period	Trend	p-value
1	$p_m = -5*10^{-5}V + 0.147$	0.0005
2	$p_m = -5*10^{-5}V + 0.1$	0.0156
3	$p_m = 0.372V^{-0.249}$	0.0426
4	$p_m = 0.186V^{-0.182}$	0.045

Table 2.Models expressing the PCCC data within each period and their corresponding p-value.

Next, observing the scatterplots for the periods 1995-1999 and 2000-2004 as displayed in Figure 1(c) and Figure 1(d) respectively, one may conclude that it is not easily identified a trend between the surgical volume and mortality probability. Proceeding to a natural logarithmic transformation of the data a statistically significant linear relationship between the two transformed data for both 5-year periods is established, and using the inverse transformation, this relationship is given via a power law as below:

(2) $\hat{p}_m = exp(\tilde{\alpha})V^{\tilde{\beta}}$

where $\hat{p}_m$, V are the predicted mortality risk and surgical volume respectively. The different values for $\tilde{\alpha}$, $\tilde{\beta}$ and the corresponding p−values for the two periods 3 and 4, are found in Table 4.1.

4.2. **Stratified data by RACHS.** The Risk Adjusted classification for Congenital Heart Surgery (RACHS) was developed as a tool to compare in-hospital mortality for children undergoing CHD surgery with the purpose of quality improvement. Given the PCCC historic data, there is no much information for the highest RACHS scores, and thus we dichotomize the RACHS score by low, score 1-3, and high, score 4-6. We proceed by analyzing the data the same way as it was explained in Section 4.1. For the first two periods, one may employ linear regression and the relationship is expressed as in (1). After transforming the data of the third and the forth period, a statistically significant association expressed via a power law (see (2)) between the surgical volume and the probability of surgical mortality for CHD repair within each group is revealed. Defining $(V_l, p_{m,l})$, $(V_h, p_{m,h})$ the volume and mortality probability for low RACHS and high RACHS correspondingly, we have the following patterns as explained on Table 3 and Table 4.

Period	Trend	p-value
1	$P_{m,l} = -5*10^{-5}V_l + 0.111$	0.008
2	$P_{m,l} = -5*10^{-5}V_l + 0.1$	-0.0149
3	$P_{m,l} = 0.33V_l^{-0.304}$	0.046
4	$P_{m,l} = 0.179V_l^{-0.26}$	0.046

Table 3. Models expressing the PCCC data with low RACHS within each period and their corresponding p-value.

Period	Trend	p-value
1	$P_{m,l} = -0.002V_h + 0.513$	0.026
2	$P_{m,l} = -5*10^{-4}V_h + 0.4$	0.041
3	$P_{m,l} = 0.877V^{-0.276}$	0.029
4	$P_{m,l} = V_h^{-0.28}$	0.003

Table 4. Models expressing the PCCC data with high RACHS within each period and their corresponding p-value.

4.3. **Establishing the optimal number of surgeries.** This section investigates the optimal number of surgeries after which there is not a drastic change in the decay rate of the probability of surgical mortality. Clearly, there is not such a cut-off value for the first two periods, since the rate is constant and equals to the slope of the regression line, $-5*10^{-5}$.

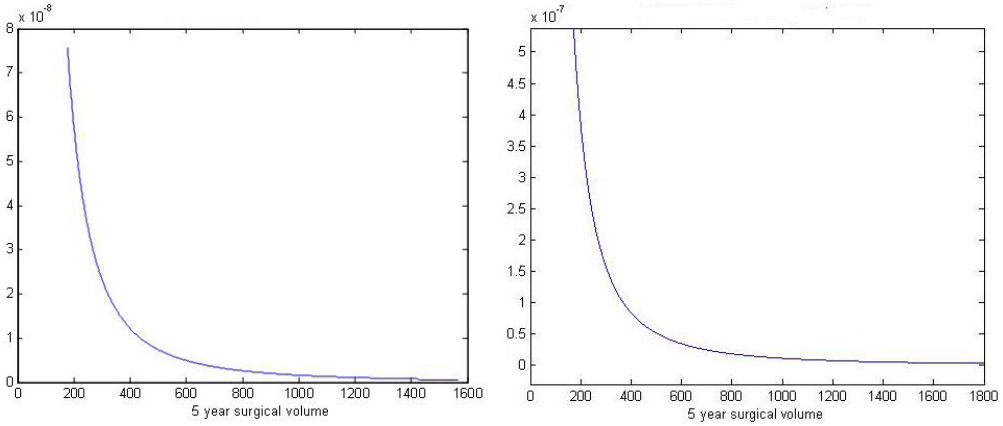
The two consecutive periods 1995-1999, 2000-2004 achieve such an optimal number which will calculated using the curvature function of the two power law expressions which model the relationship between surgical volume and mortality risk. Generally, the curvature, k(x) for a function f(x), is given by the following expression:

$$k(x) = \frac{|f''(x)|}{(1+f'(x)^2)^{3/2}} \quad (3)$$

where f' and f'' are the first and second derivatives of the function f respectively. One mayrefer to [10] and references therein for an extensive study of curvatures. For the special case where f is given as in (2) the curvature is of the following form,

$$k(x) = \frac{|exp(\tilde{\alpha})\tilde{\beta}(\tilde{\beta}-1)x^{\tilde{\beta}-2}|}{(1+exp(2\tilde{\alpha})\tilde{\beta}^2 x^{2(\tilde{\beta}-1)})^{3/2}} \quad (4)$$

Substituting in (4) the exact values for $\tilde{\alpha}$, $\tilde{\beta}$ as they are given in Table 4.1, the curvature functions with respect to 5 year surgical volume for each period (periods 3 and 4) are displayed in Figure 3(a) and Figure 3(b) respectively.



(a) (b)

Figure 3. Curvature function for period 3 and period 4.

Given Figure 3(a) and Figure 3(b), one may conclude that after 1,000-1,200 surgeries for the period 1995-1999 and after 850 to 1,000 surgeries for the period 2000-2004, the decreasing rate does not change drastically.

5. DISCUSSION

Sufficient progress has occurred in surgically repairing physiologically important congenital cardiac defects so that operations for congenital heart defects can now be performed with a relatively low risk of mortality.

However, many studies have demonstrated considerable differences in mortality among institutions performing cardiac surgery in children and young adults. The outcome of surgery is influenced by many factors, including patient-related risk factors, human factors and natural variations.

The primary purpose of this study was to analyze a large database such that any bias is removed and to conclude the impact of cardiac center case load on in-hospital mortality. We reported the outcome events from approximately 80,000 surgeries for congenital heart disease from 47 small and medium size centers across the US participating in the clinical database of the Pediatric Cardiac Care Consortium (PCCC), within the period 1985-2004. The surgical procedures were stratified by the validated Risk Adjustment in Congenital Heart Surgery (RACHS) method. Surgical volume was used as a continuous random variable to avoid the pitfalls of deciding a priori what constitutes small and large volumes within these types of centers. The statistical analysis suggested a decay between mortality probability and surgical volume. Depending on the period this decay was expressed through a linear or a power law expression. Given the large number of outcome events

available in this study a secondary purpose was to identify whether there is a minimum number of surgeries beyond which there is no change in the risk of surgical mortality and in this case to define the threshold demarcating the lowest attainment in terms of surgical mortality. Using the curvature, this threshold was found to be 1,000-1,200 surgeries for the period 1995-1999 and 850 to 1,000 surgeries for the period 2000-2004.

Future analysis is required on the behavior the unclassified data (RACHS=0). Also, more random variables such that the length of hospitalization or several demographics of the patients and their health history, should be incorporated in order to have a more complete picture of the mortality probability.

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ADAPT BUSINESS PROCESSES TO SERVICE ORIENTED ENVIRONMENT TO ACHIEVE BUSINESS AGILITY

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Abstract: In the modern economy, creating agile business processes is one of the conditions to obtain/ maintain competitive advantage on the market. In addition, the agility of business processes, combined with the agility of employees and that of information technology are prerequisites for achieving business agility. Using a service-oriented architecture can provide numerous benefits to the organization, enabling it to reduce complexity and increase flexibility of business processes. This paper presents an approach on adaptation to the service-oriented architecture of tools and methodologies for modeling and management of business processes. Thus, in the paper ❶ is analyzed the aligning of BPM with SOA to achieve business agility, ❷ is provided a perspective view on the management of service-oriented business processes and ❸ is presented a case study on agility of acquisition process in higher education institutions of Romania.
Key words: Service Oriented Architecture (SOA), Business Process Management (BPM), business agility, standards, process metrics, collaborative environment

Introduction

Service Oriented Architecture (SOA) has captured the attention of researchers in recent years in terms of seeking ways to increase the agility of organizations by offering flexible business processes. Service-orientation of business processes is the result of the existence of multiple organizational levels and of the increasing need for integration, complexity reduction [3] and flexibility. At the same time, BPM (Business Process Management), Case Management and other tools and solutions have been created to meet the current requirements of organizations in the collaborative process modeling. With these analytical tools, organizations can improve delivery programs and customer service and can proactively monitor service delivery, costs and results.

The use of SOA within organizations involves adapting tools and methodologies for modeling and management of business process to service-oriented architecture. Another solution may be getting some new tools for modeling service-oriented processes, but both solutions lead to additional costs for the organization. Current state of research in this area

offers a number of approaches to process modeling methodology and service-oriented development (examples: [3], [7], [22], [23], [24], [26]).

The need for further research arises from the fact that there are gaps in the integration of BPM with SOA, and that there are few studies on the assessment environments of tools and methodologies for modeling of process/cases for collaborative environments, comparative analysis of their use on different types organizations and their use in service-oriented environments. Moreover, the solutions of service-oriented business process management have to face increased complexity resulting from the intense use of knowledge in the *collaborative* context and at the same time to achieve the *agility* required by the business activity.

1. Aligning BPM with SOA to achieve business agility

Business agility can be achieved by combining agility of employees with agility of business processes and information technology within the organization [19]. Agility of organization personnel is considered the pillar of business agility, resulting in an agile management within the organization. Agility of business processes can be achieved through BPM [25], conducted by the organization's information systems (e.g. Business Process Management System - BPMS). Technological agility concerns IT (Information Technology) infrastructure and architecture of information systems and can be achieved through SOA. SOA and BPM have captured the attention of researchers concerning their use both independently and together (Table 1), facilitating a new stage of evolution of business processes.

Table 1. Possible situations about SOA and BPM utilization

SOA	BPM	Results
Yes	No	reuse and reliable services, but not further agile framework [8]
No	Yes	continuous improvement and optimize, but un-scalable and un-adaptive process [15]
Yes	Yes	services to be used as reusable components that can be orchestrated to support the needs of dynamic business processes [13], iteratively design and optimize business processes that are based on services that can be changed quickly [4], and, as result, maximize *business agility* [16]

A first step toward understanding how SOA and BPM can be combined is to identify the most important similarities and differences between them. The main similarities are [4]: encouraging, accommodating dynamic changes, observing iterative process, dealing with distributive environment, supporting loose coupling. Regarding the differences between BPM and SOA (Table 2), special importance is given to the characteristics of processes and architectures in terms of business perspective and technological perspective. At the same time, more and more studies refer to the fact that BPM tends to combine information technology and management methodologies.

Table 2. A comparison of BPM and SOA (based on [4], [12], [14], [20])

Characteristics	BPM	SOA
Perspective	business	technology and business
Practitioner	business managers	business and system architects
Objective	optimizes business process	organizes IT infrastructure
Demand for	insight	encapsulation
Driven	directly by business goals	indirectly by business goals, translated to a need for IT agility and governance
Orientation	business planning	information technology management
Metaphor	E/R-diagram	Relational Database Management System
Strategic level	decision are taking top-down	strategy can be perform by top-down, bottom-up or meet-on-the-middle
View	process-centric	service-centric
Implementation approach	top-down	bottom-up

Organizations that combine BPM and SOA are in the best position to maximize their agility, operate efficiently and respond rapidly to changing business needs (Figure 1). Using an integrated approach allows ❶ business process semantics to be implemented into composite services and ❷ services to be recombined, re-sequenced or even substituted to lodge business semantics or process changes in the new business context.

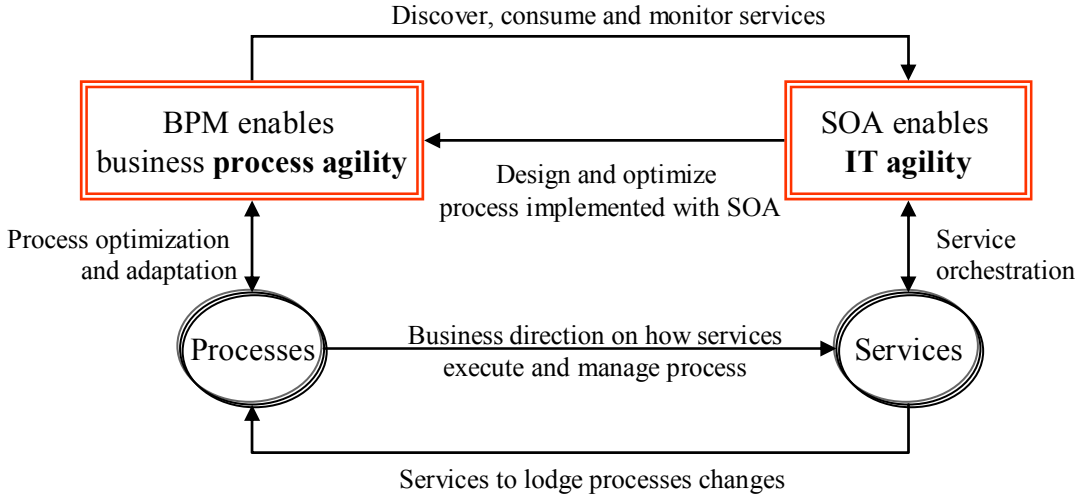

Figure 1. BPM and SOA enable business agility

Aligning BPM and SOA leads to a new stage of business processes evolution, that of service-oriented business processes. The management of these types of business processes will be done in accordance with the principles of abstraction, specialization, and separation of concerns in addition to the flexibility that service-oriented architecture

promotes. In addition, the management tools of business processes should provide collaboration capabilities (e.g. discovery, modeling, optimization of processes) and dynamic capabilities (e.g., process flows and dynamic services driven by business rules) within flexible business processes [18]. Dynamic capabilities provide agility by detecting patterns and rapidly adapting business processes to events and agents (clients, businessmen, analysts and programmers, architects and process analysts) [11].

Business process generally involves running a set of activities and using data to achieve a business objective. Control of process execution, of business data and activities is carried out by different services within the organization. They have access to business activities and data through specialized components, known as business objects (Figure 2). Service-oriented business process includes, beside the specific business process, the network services (a service that has implemented a certain business-process function and has been capsulated and published on network [27]).

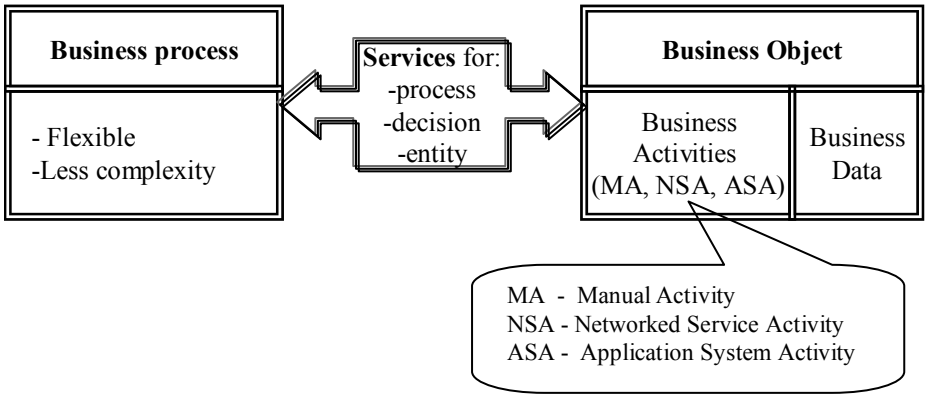

Figure 2. Service oriented business process

The existence of manual activity is due to intensively knowledge-based processes, which allows only a subset of activities within the processes to be automated (activities are implemented by an enterprise application system or a networked service). Complex interactions between participants and the need for the use of knowledge lead to a complexity of activities that many traditional modeling systems and system applications are not able to support. In addition, within a collaborative environment, solutions have to enable integration of systems, business partners and business users and to respond to external events (system events and events of transactions) and internal events (generated by internal agents and systems) that generate frequent changes in the organization. These facts lead to the need for the use network services.

Increasing use of services within a collaborative environment leads to the necessity of obtaining a high performance service oriented business process with loosely coupled services (Figure 3). To this end, organizations should identify business processes and services needed by these processes. In order to achieve success, it is necessary that service-oriented business processes, workflow and service orchestration tools fit perfectly with SOA IT [10].

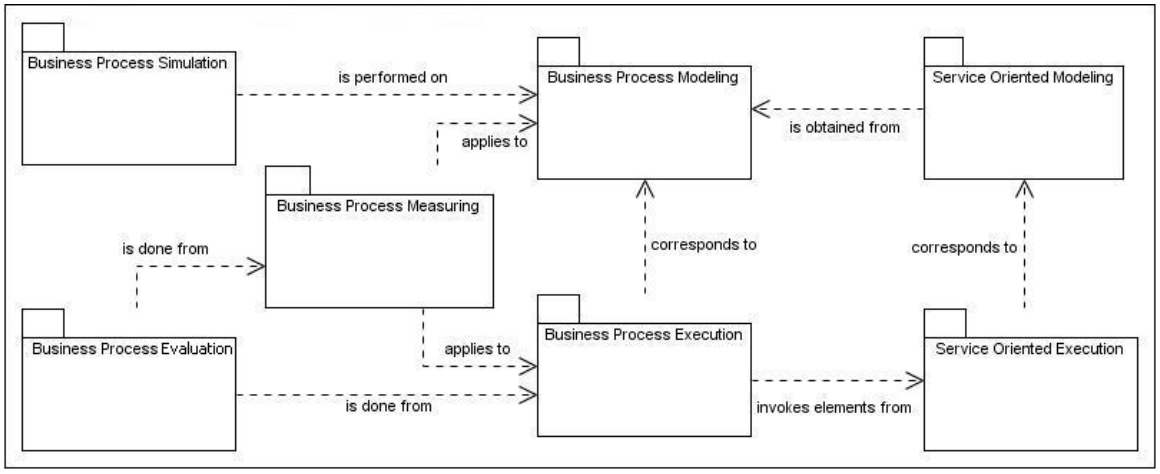

Figure 3. High level ontology for service oriented business processes [9]

2. Management of service oriented business processes

According to research in this field, business process management activities can be grouped into following categories: design, modeling, deployment, execution, monitoring, and optimization. Using a combination of BPM and SOA requires an analysis of each specific BPM activity in terms of service-orientation. Service-oriented business process management can be achieved based on several standards in the areas of modeling, implementation, execution, monitoring and optimization (Figure 4).

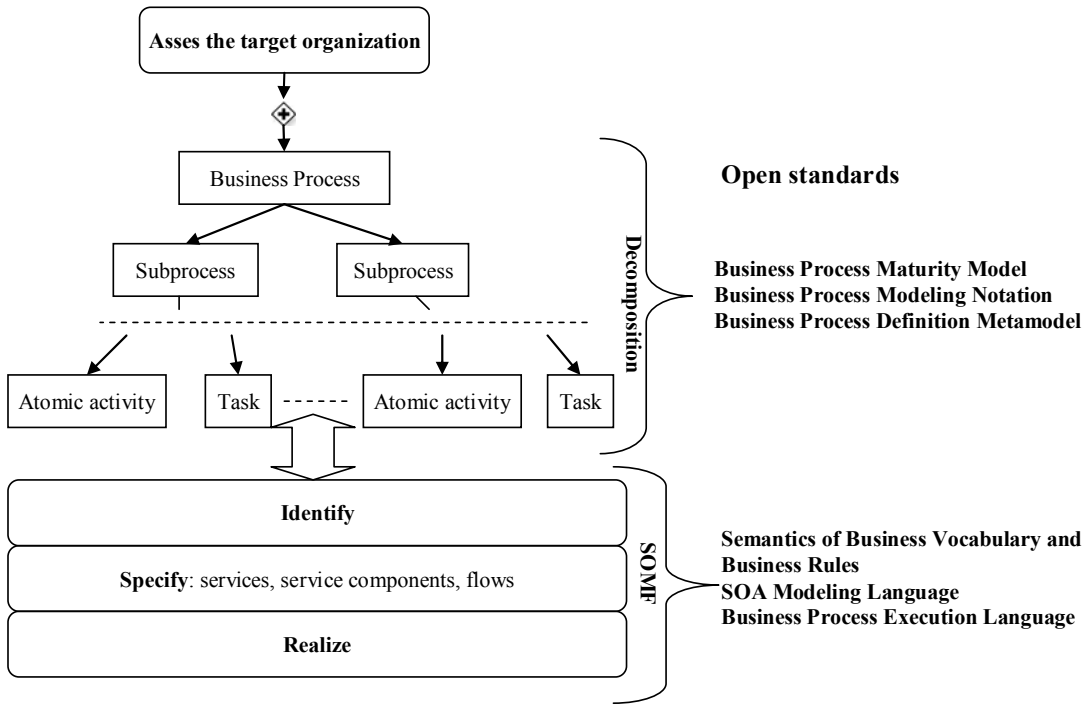

Figure 4. Management of services oriented business process

Business Process Management Initiative (BPMI) has developed three standards to facilitate BPM [21]:

- Business Process Modeling Notation (BPMN), as a standard for modeling business processes;
- Business Process Modeling Language (BPML), as a standard business execution language;
- Business Process Query Language (BPQL), as a standard management interface for the deployment and execution of e-Business processes.

BPMN can be used for modeling business processes in accordance with SOA. BPMN has service modeling capability which allows a participant to use service activities to send messages to other participants. BPMN and Unified Modeling Language (UML) have very different approaches. UML offers an object-oriented approach to the modeling of applications, while BPMN takes a process-centric approach [21].

The new breed of BPML includes the Business Process Execution Language (BPEL) for Web Services (BPEL4WS), created through effort of BEA, IBM, Microsoft, and BPMI.ORG. Making web services work is a four stage process [21]: *designing* the processes with BPMN, *verifying* them for efficiency with simulation, *making* them *available* by publishing them using a BPEL, and *orchestrating* and *coordinating* using a BPMS.

In the process implementation phase, the key technology of SOA is BPEL. This language minimizes the semantic gap between the process model and the actual execution code. BPEL enables business processes to be executed directly. Process models can manually, semi-automatically, or automatically be translated into BPEL.

Service Oriented Modeling and Architecture (SOMA) provided by Rational Software [5], as a methodology, address the gap between SOA and object orientation. It addresses how to move from business model to the models required by an SOA. SOMF (Service Oriented Modeling Framework) is a service-oriented development life cycle methodology. It offers a number of modeling practices and disciplines that contribute to a successful service-oriented life cycle management and modeling.

OMG (Object Management Group) provides SOAML (SOA Modeling Language), a standard that includes a set of extensions to UML that supports SOA modeling [2]. SoaML was adopted in 2009 [6] and provides a higher-level of abstraction, and more complete service modeling capability that BPMN could benefit from [12]. BPMN can be combined with SoaML for more comprehensive service construction and consumption modeling.

Taking into account the managerial recommendations and the practice in this field, in order to achieve success in the integration of services oriented business process, it is recommended that any organization should create a transition environment that should be based on management instruments for the existing knowledge within the organization, the elements under transition should be included into a management program, and at the organization level should be developed a policy of organization change management.

Among the activities that might be provided for this purpose we will mention [17]: reengineering of facilities, setting the competence base, appointing the SOA mentors, reengineering the existing standard documents, development of stuff training and reallocation programs, implementation of the quality management system, defining communication strategies, creating the excellence centers, creating the users groups, developing alliance creation strategies, etc.

The transition environment should allow, inside the analyses, the calculation of specific metrics of service oriented business process management. At the same time are important evaluating and measuring costs and benefits of integrating service oriented processes, as they having major effects on the business. Without correct evaluation of the impact of implementation, the organization may be confronted with the situation of adopting a solution that would not lead to the expected results. Next, we shall present several metrics that may be used in measuring service oriented business process performance (figure 5).

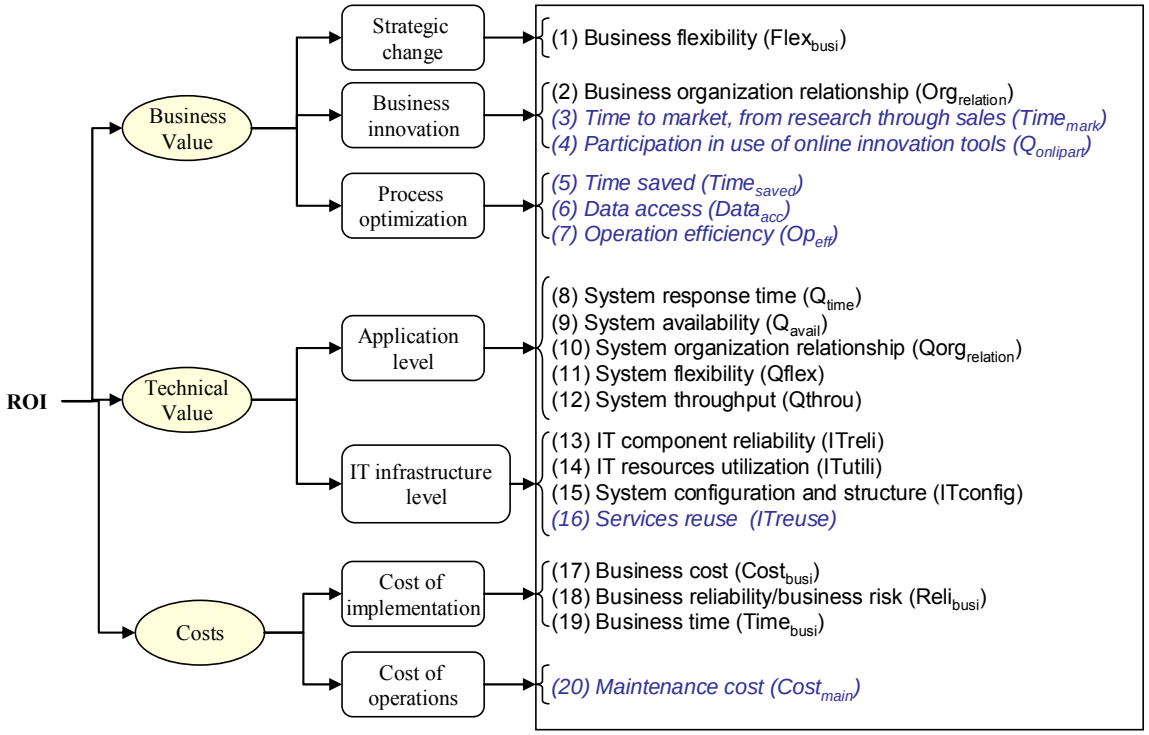

Figure 5. ROI for service oriented business process management

The following metrics, $Flex_{busi}$, $Org_{relation}$, Q_{time}, Q_{avail}, $Qorg_{relation} \in (0,1]$, *Qflex, Qthrou, ITreli, ITutili, ITconfig* $\in (0,1]$, $Cost_{busi}$, $Reli_{busi} \in (0,1]$, $Time_{busi}$, are detailed in [27]. Zeng, Huang and Fan offer analyses on the service-oriented process modeling and its performance metrics correlations among service, service oriented business process, and enterprise. They made an AHP and simulation-based performance evaluation method applicable to evaluating performance of business process in a loosely coupled environment like that of service-oriented computing. Other indicators proposed in figure 5 are presented below.

❖ Time to market, from research through sales ($Time_{mark}$)

$$Time_{mark} = Time_{saved} + Nh_r + \sum_{i=1}^{n} Nh_i \ , \ \forall h_i \neq \forall h_j \qquad (3)$$

where $Time_{mark}$ represent the saved time between research and sales, $Time_{saved}$ – time saved with service oriented process automation, Nh_r – number of hours reduced due to the reuse of services, n – number of people involved in process creation, i,j – the person involved in the process creation, Nh_i – number of hours saved by the person i, due to the use of process management tools.

❖ Participation in use of online innovation tools ($Q_{onlipart}$)

$$Q_{onlipart} = \frac{N_{onlipart}}{N_{allpart}} \times 100 \quad (4)$$

where $Q_{onlipart}$ represent percent of participation in use of online tools, $N_{onlipart}$ – number of participation in use of online tools, $N_{allpart}$ – number of participation in use of all tools.

❖ Time saved ($Time_{saved}$)

$$Time_{saved} = Time_{PA} + Time_{CA} \quad (5)$$

where $Time_{PA}$ – the saved time with process automation, $Time_{CA}$ - reducing the time that is spent on corrective action (automated corrective action) and they are calculated as:

$Time_{PA} = Time_{MP} \times I_{rtm}$, where $Time_{MP}$ – manual process cycle times, I_{rtm} - time reduction index due process automation

$Time_{CA} = Time_{MC} \times I_{rtc}$, where $Time_{MC}$ – time spent with manual correcting errors, I_{rtc} - time reduction index due corrective action automation, I_{rtm} and I_{rtc} are calculated use a process simulation to compare current process cycle times and costs to one or more alternatives.

❖ Data access ($Data_{acc}$)

$$Data_{acc} = ADC \times I_{adc} \times 12 \quad (6)$$

where *ADC* – month cost of access to data, I_{adc} – access cost reduction index.

❖ Operation efficiency (Op_{eff})

$$Op_{eff} = 12 \times \sum_{i=1}^{n} H_i \times C_i \quad (7)$$

where *n* - number of users in process creation, *C* - hour cost / employee, *H* - no. productive hours/month due to re-allocation of workforces.

❖ Services reuse (IT_{reuse})

$$ITreuse = t \times WC \quad (16)$$

where *t* represents the time saved as a result of finalization of migration by reuse of services, *WC* wage costs needed for migration. SOAs can dramatically reduce labor costs over time through component reuse.

❖ Maintenance cost ($Cost_{main}$)

$$Cost_{main} = (1 - Icr)TC + SC + HC + OMC \quad (20)$$

where *Icr* represents the cost reduction index (reutilization standard factor), *TC* represents training costs, *SC* – software costs (basic software code maintenance, software and hardware application upgrades, other), *HC* – hardware upgrade costs, *OMC* – other maintenance costs. Typically operations costs begin after the roll out of the first improvement phase and continue into the future, until the solution is changed or improved again or sunset at the end of its life cycle [27]. Business rules and business policies can improve IT and business productivity and reduce maintenance costs.

3. Case study on agility of acquisition process in higher education institutions

In the modern knowledge-based economy, universities should behave just like any business, in the prospect of becoming intelligent universities. Increasing competition between universities, financial crisis, the opportunity of distance learning, the efficient use of resources and alignment with sthe Bologna declaration directives require the use of *agile* systems in the educational environment. In addition, increased pressure in the educational environment implies the need to ensure quality and improve quality management of all university processes.

One of the support processes for achieving the basic processes in universities (teaching and research) is the public acquisitions process. Given the expense, complexity, vulnerability and importance of operations, the greater responsibility involved by public acquisitions, all public institutions have a separate department specialized in public acquisitions, with an important role within the institution.

Activities of this department are verified and monitored by internal and external audit teams, which must assess the extent to which the department complies with the law, recommendations of authorities, acquisition risk management, internal procedures, and quality management policy within the department. Regarding quality management, the public acquisitions department should be able to prove the existence and functionality of at least the following elements:

- the extent to which the department's employees know and comply with quality standards and legal regulations on public acquisitions;
- the annual program of permanent improvement of quality management system in order to maximize stakeholders' satisfaction;
- quality policy and specific measurable quality objectives;
- systematic and regular assessment of suitability, adequacy, effectiveness and efficiency of the quality management system in relation to quality policy and quality objectives and identifying opportunities for improvement;
- procedures to ensure information flow quality within IT substantiation of documentation for granting public acquisition contracts - the fundamental element of acquisitions processes;
- the extent to which there is compliance to quality management system requirements and principles.

The quality management system of the acquisitions process must have at least the following features:

- ability to integrate with the university systems;
- ability to integrate stakeholders into the acquisition system in order to ensure quality;
- ability to simulate the acquisition process in order to improve its quality;
- ability to monitor, control and improve quality of the acquisition process in real time;
- ability to make changes in the acquisition process, with minimal effort.

Service-oriented modeling and the automation of the acquisition process (Figure 6) is due to several internal and external factors, such as: various demands, changes in preferences, the diversity of research projects and emerging needs, changing of laws, connecting with suppliers, existing problems in information flows.

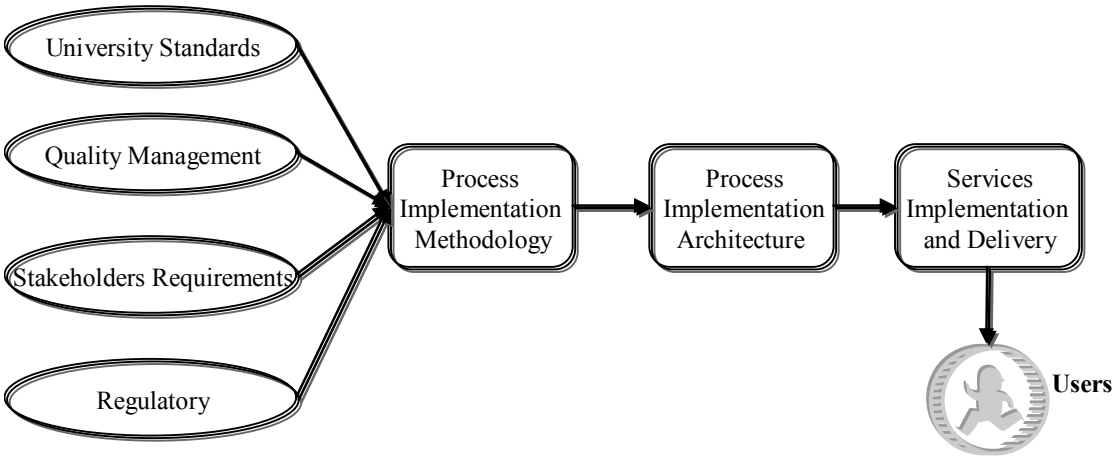

Figure 6. Automation of acquisition process

SOA exposes and shapes the existing infrastructure to provide customer-orientation [1] and process-oriented strategy. In addition, creating an infrastructure that combines the principles of SOA with BPM principles, principles of quality management and legislative principles leads to operational efficiency and ultimately to the *agility* of public acquisitions process (Figure 7).

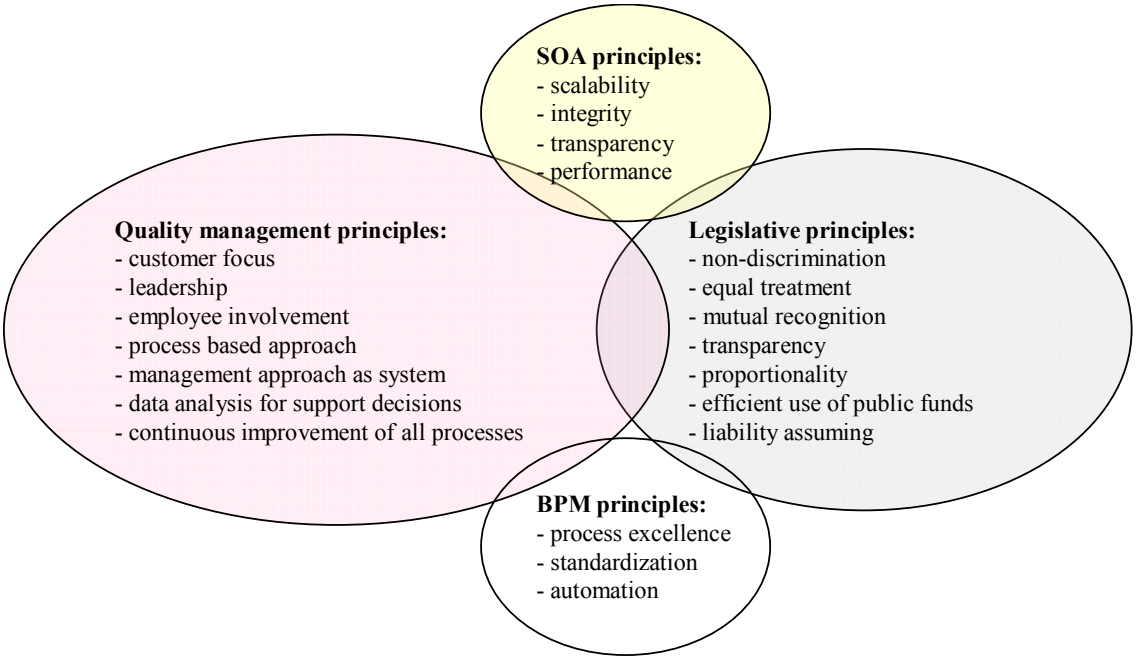

Figure 7. Principles of creating an agile architecture for acquisition process

Acquisition processes are decomposed into sub-processes and assigned to department employees according to their role. For example, the head of department creates the acquisition plan, makes the activities plan, assigns tasks, approves procedures, and participates in acquisition procedures, while the acquirers carry de acquisition procedures, take part to the evaluation, monitor contracts, etc. Services provided to the public acquisitions process are: ❶ entity services - providing access to resources, ❷ decision services - executing rules of the acquisition process to support decisions (approval, planning, risk, communication, monitoring), and ❸ process services - like planning, monitoring, management. Figure 8 presents an example of modeling of a public acquisition procedure according to quality requirements.

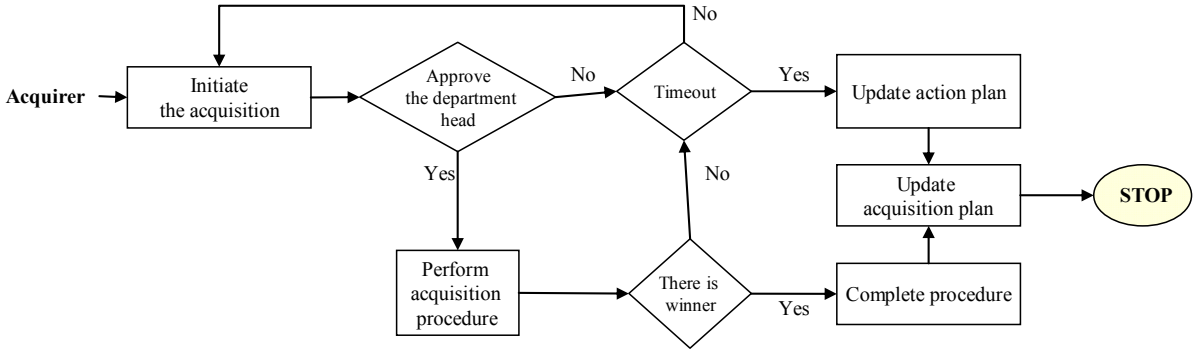

Figure 8. Example of modeling the sub-process of public acquisition procedure

Conclusions

Given the benefits of using a BPM and SOA integrated approach, organizations are encouraged to integrate these solutions and provide practical experiences that would lead to the creation of best practices in the management of service-oriented business processes. However, the decision to adapt to the service-oriented environment must take into account the type of organization, the business and IT strategy and must be accompanied by a cost-benefit analysis to determine the opportunity of this adjustment. Without correct evaluation of the impact of implementation, the organization may be confronted with the situation of adopting a solution that would not lead to the expected results.

Acknowledgements

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JOURNAL
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APPLIED
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METHODS

OPEN SOURCE AND FREE SOFTWARE CONCEPTS IMPLEMENTED IN PUBLICATION OF ACADEMIC RESEARCH

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Abstract: This paper aims to point the importance of Open Access, Open Source and Free Software in academic research and publication. Not being known by many, the differences between the concepts exists and their creators want them to be public. There are presented as well international catalogues and directories of open access research, and some Romanian journals are described as example.

1. General Context

The academic journals which are providing free access to their content started to gain an increasing importance. This approach is only possible due to the amazing development of the Internet in the last two decades.

There are, in this context, academic journals which are providing free and unrestricted access to the online version of the journal for anyone who want to read/download the content of the published articles. There is the option of providing the open access with a temporary delay (especially for those journals which are printed as well) in order to facilitate the depletion of the initial printed version.

This initiative comes to help especially the small universities (with libraries that have less features and which are less actualized) or those institutions located in areas/countries economically disadvantaged.

The present paper aims to present, in its first part, the concepts and terminology from an economically point of view. Then a short review of catalogues with academic open access journals and academic Romanian journals which are using the system.

2. Open Access system in the academic field

Open access is a concept about improving and extending access to scientific research. It's desirable the resources to be made available for as many persons as possible through their internet publication with free access.

Open access literature it's written in digital format, online accessible, free with no copyright restrictions. All this is possible because of the internet and authors or copyright holder's consensus.

Peer review evaluation is supported in Open Access and all the major initiatives which are using this concept for academic and scientific literature publication are highlighting the importance of this kind of evaluation.

Most times, for elaborating academic papers the universities don't pay the authors and this is why the try of implementing a system such Open Access leads to the loss of some possible gains.

Even if its realization is cheaper then classic literature, the Open Source literature is not realized without any costs. The efforts are not focused in realization of academic Open Access literature with fewer costs but focused in searching for better ways to cover the costs than taxing the readers and creating access barriers for resources. The ways of cover the costs depends on the way Open Access literature is published.

There are two ways of publishing:
1. Open Access Journals
2.Open Access Archives (storages)

There is a big difference between the two ways of publishing: archives are represented by non peer reviewed articles and the journals are with peer reviewed articles. This difference explains other major differences between the two ways especially the costs differences and the realization modality.

Open Access Archives are non peer reviewed articles free for everyone. They can be papers circulated before printing without evaluation, papers circulated after printing or both. Archives can be propriety of institutions, universities, laboratories or fields (example given: Economic field). The authors can archive their scripts before printing without someone's consensus. Many journals allow the authors to do so. There are protocols of Open Access Initiatives which are harvesting data from archives making them interoperable with other archives, the users being able to find a particular archive without prior knowing about its content, location or existence. Open source software has been developed for this issue.

Open Access Journals are containing peer reviewed articles and evaluated this way they are made available for everyone. The costs for realization of such journals are for articles evaluation, script realization and storage space on servers. Open Access journals are covering their costs very similar the televisions or radio stations are doing this thing: the interested persons in content publishing will cover the production costs and so the access to articles is free of charge for everyone has the necessary equipment. Some times this means that journals must have subsidies from host universities. In other situations journals receive a fee for processing the accepted articles, fee paid by the author or his sponsor. Journals remove this fee in economic adversity conditions. Usually, when there are subsidies from institutions there are no processing fees. In the situations of income from other sources (like: publications, advertising or auxiliary services) the fees will be decreased. There are discounts as well. For a diversity of situations, the paying methods for Open Access Journals could be creatively realized. [2]

There are as well **hybrids** Open Access Journals. In this journals only some articles are Open Access – the ones for which the fees were paid by the authors. The **delayed** Open Access Journals are those journals in which some articles are with free access only after an embargo period.

The articles published in the main Open Access Journals are included in bibliographic data bases for every domain.

The advantages of using Open access are multiple. Starting with the main advantage: the public access to the content for everyone, the authors will have popular articles and better integrated in scientific structure, the readers from institutions which cannot afford the journal will have access and researchers from small institutions whose libraries cannot afford the journal will have access as well. The financial supporters of the journal, those who are paying fees will see the results of research for which they are paying, the patients and medical personal will be updated with the last medical scientific research. [3]

About Open Access publications after conferences there are some official declarations: Budapest (February 2002), Bethesda (June 2003), Berlin (October 2003). The principles of Open Access Publishing were presented as well as definitions, goals and various characteristics.

The Open Access Budapest Initiative describes the way of publishing with open access:

"By open access to this literature, we mean its free availability on the public internet, permitting any users to read, download, copy, distribute, print, search, or link to the full texts of these articles, crawl them for indexing, pass them as data to software, or use them for any other lawful purpose, without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. The only constraint on reproduction and distribution, and the only role for copyright in this domain, should be to give authors control over the integrity of their work and the right to be properly acknowledged and cited." [4]

Based on Bethesda Open Access Publishing Declaration, open access publishing has to meet the following two conditions:

1) The author(s) and copyright holder(s) grant(s) to all users a free, irrevocable, worldwide, perpetual right of access to, and a license to copy, use, distribute, transmit and display the work publicly and to make and distribute derivative works, in any digital medium for any responsible purpose, subject to proper attribution of authorship, as well as the right to make small numbers of printed copies for their personal use.

2)A complete version of the work and all supplemental materials, including a copy of the permission as stated above, in a suitable standard electronic format is deposited immediately upon initial publication in at least one online repository that is supported by an academic institution, scholarly society, government agency, or other well-established organization that seeks to enable open access, unrestricted distribution, interoperability, and long-term archiving (for the biomedical sciences, Pub Med Central is such a repository). [5]

What's to notice is the fact that open access is more a feature of individual work than a characteristic of journals or publishing houses.

3. About Free Software and Public GNU license

GNU project was started in 1984 for developing a full operating system similar to UNIX, which is free software: the GNU Operating System. Versions of GNU Operating System which are using Linux kernel are widely used; although these systems are often called "Linux" they have to be correctly called GNU/Linux. The kernel of GNU Operating System is not finished yet. This is the reason for still using UNIX kernel. There are many versions of GNU/Linux.

GNU is the acronym from GNU 's not UNIX and is pronounced the way is written. Among the versions the recommendation is for the distributions which are one hundred percent free software, in other words respecting the freedom.

The initiator of this project was Richard Stallman:

"Of course your values could be different from my values, but I just tell you that my values are: I don't want software if it doesn't respect my freedoms. In fact I so much don't want it that I won't take it. If someone offers me a program with only condition that I will not share it with you then I'm going to tell him: "No". I will tell him that to be a good neighbor I will have to refuse that software, I will refuse it!" [6]

This quote shows the values that are the base of GNU and Free License development. What Richard Stallman wanted to implement was a platform almost identically with UNIX system in which a program could run, could be copied, distributed, studied or could be modified freely. The initiator wanted to be no more bound to restrictions in software using. He wanted that every software product to be given to others.

In one email sent on September the 27th 1983 he wrote:

"Free Unix! Starting this Thanksgiving I am going to write a complete UNIX-compatible software system called GNU (for GNU 's Not UNIX), and give it away free to everyone who can use it.

To begin with, GNU will be a kernel plus all the utilities needed to write and run C programs: editor, shell, C compiler, linker, assembler, and a few other things. After this we will add a text formatter, a YACC, an Empire game, a spreadsheet, and hundreds of other things. We hope to supply, eventually, everything useful that normally comes with a Unix system, and anything else useful, including on-line and hardcopy documentation."[7]

All this technology was going to make the rule possible to respect, the rule mentioned as well, by him:

"I consider that the golden rule requires that if I like a program I must share it with other people who like it. I cannot in good conscience sign a nondisclosure agreement or a software license agreement.

So that I can continue to use computers without violating my principles, I have decided to put together a sufficient body of free software so that I will be able to get along without any software that is not free."[8]

This project has been developed until today mean while the GNU Public License was born (also called GNU GPL General Public License). This license sets all the principles of the free software.

The first version of GNU GPL was published in 1989 by Free Software Foundation, Inc. from United States.

This version was for the software products of this company or any other software product of which author wanted to use this license. Among the main features of the license specified in that publication were ideas which are the basis for next versions.

"The license agreements of most software companies try to keep users at the mercy of those companies. By contrast, our General Public License is intended to guarantee your freedom to share and change free software--to make sure the software is free for all its users. The General Public License applies to the Free Software Foundation's software and to any other program whose authors commit to using it. You can use it for your programs, too.

When we speak of free software, we are referring to freedom, not price. Specifically, the General Public License is designed to make sure that you have the freedom to give away or sell copies of free software, that you receive source code or can get it if you want it, that you can change the software or use pieces of it in new free programs; and that you know you can do these things." [9]

Those are the principles the GPL Public License is based on. These principles are extending the users freedoms for his sake and others.

GPL License is bound to the free software concept which is explained further.

4. Free Software Concept

In the computers vocabulary it is usually now days the "free software" term. The majority of persons using "free software" term does not know very clearly what does this mean and the differences between free software and other terms like open source. Mostly the concept of free software creates confusions.

The "free software" term is a matter of freedom not a mater of price. For a better understanding of this term we can use the words of the founder of the system based on free software:

"Free software means free as in free speech not free as in free beer."[10]

We understand this way that free software doesn't really mean the price of the software. The free software idea gives the users the right to run, copy, distribute, study change and improve the software. More exactly it refers four types of freedom for software users:

Freedom 0: the freedom to run the program for any purpose

Freedom 1: the freedom to study how the program works and change it to make it do what you wish. Access to the source code is a precondition for this

Freedom 2: the freedom to distribute copies so you can help your neighbor

Freedom 3: the freedom to distribute copies of your modified versions to others. By doing this you can give the whole community a chance to benefit from your changes. Access to the source code is a precondition for this. [11]

It's obvious the fact that such a way of creating software brings the problem of financing the projects because volunteering does satisfy only a part of necessities.

Free Software Foundation

The main organizational sponsor of the GNU project is Free Software Foundation. Free software Foundation raise founds from many sources like big corporations, charitable foundations or individual supporters. Besides the primary mission which is the same with GNU goal (giving the right to study, copy, modify and redistribute the programs), Free Software Foundation helps freedom of speech, press freedom and an internet associations, the rights to use encryption software for private communication and the right of writing soft products unstopped by private monopolies. Even if it was born in America, Free Software Foundation has "sister" organizations in Europe, Latin America and India.

5. Open Source Concept

Open Source Initiative is a charitable corporation from California, founded in 1998. Open Source Initiative is formed by Open Source Definition representatives and the community founded for revising and approving of compatible Open Source Definition licenses. Open Source Initiative is active involved in building Open Source communities in education and public speeches for promoting the competence and importance of non owned software. The Open Source Initiative member's team travels frequently in the whole world for participating at Open Source conferences and events, meetings with open source software developers and users and for discussions with executives from the public and private sectors about how technologies, licenses and Open Source developing models can provide strategic and economic advantages. [12]

Open Source History is linked to UNIX history, internet and free software. The next link in the chain of events is year 1997 when Eric Raymond published an article "The Cathedral and the B a z a r". This article presentation in September 1997 at O'Reilly Pearl conference leaded Netscape firm to announce in January the 22nd 1998 that it is planning to make public the source code of the popularly browser as free software. The "Open Source" term was invented in the 3rd February 1998 session at Palo Alto, California. Later in the same year at another conference it was decided that is time to quit the moralistic attitude which was associated in the past with "free software" term and to focus the idea strictly on practically and business considerations as well as in Netscape case.[13]

Open Source is therefore a newer concept than Free Software launched on different considerations but they have in common some principles (the public source code, licenses for free copy etc).

Yet, the GNU and Free Software founder, Richard Stallman in his published essays remembers that a difference between the two terms should be known. Some of his arguments are listed bellow:

"In 1998, a part of the free software community splintered off and began campaigning in the name of "open source." The term was originally proposed to avoid a possible misunderstanding of the term "free software," but it soon became associated with philosophical views quite different from those of the free software movement."[14]

"Free software" and "Open Source" movement are two different movements with different goals even if some times they are cooperating at some practically projects.

The fundamental difference between the two movements consists of their values, in their ways of seeing the world. For Open Source movement the reason for which a software should be open source is not an ethically one but a practically one. "Open Source" is a development methodology and "Free Software" is a social movement. For "Open Source" movement the programs that are not free represent a non optimal solution. For "Free

Software" movement the soft programs which are not free represent a social problem. The solution is "free" programs.

At the Open Source Developers Day, in August 1998 some commercial developers invited, said that they intend to transform only a piece of their work in "Open Source". The focus of their business is the development of temporary add-ons. They want to sell these add-ons to free software users.

These practices of some Open Source producer's doest correspond to the "Free Software" principles and this is why the "Free Software" founders are trying to inform the public that since the beginning there is a difference between "Open Source" and "Free Software" goals. The founders are saying that these differences must be known by the public.

6. Open source and Open access in academic research

Types of items assessment to an academic journal

There are many systems of article evaluation depending on every journal's policy. It could happen that a journal has less valuable scripts of which to choose from and this is why it could be a bit stimulant in selecting other scripts. On the contrary, when the publishing space is limited or there are very little funds, peer review could be used for selecting an extremely small number of scripts.

Mostly, the decision of making a script "good enough" is totally the task for the editor or the organizer of the journal. In other situations the reviewers could be in charge to do this thing with only a little guidance from the coordinator about which level of stringency to use.

Very popular journals have very strictly standards for publishing and articles with a good scientific quality will be rejected if the editors will consider that they are not a progress in the field. Generally, such of those journals has a 2 level evaluation system. In the firs stage editorial team checks if what the article highlights would be innovative enough for warranting the publication. Most articles are rejected in this stage. The articles which pass these evaluations are sent for a depth review by external reviewers. Even if the reviewers are giving their consent for publishing and all suggestions, evaluations and critics are done the articles still could be returned to authors to be shortened for fitting the journal's length limits.

Other journals send generally all the articles (excepting those ones which they easily see that unfit) for being evaluated by multiple reviewers. Reviewers are questioned not only in the scientifically quality and the correctitude but if the article is addressed as well to a general group of readers, not only for some group of specialists. In the last case the recommendation is, usually, the publishing in a specialist journal. The editor could give authors the opportunity to send the script and its evaluation to such of this magazine where it could be accepted without a further evaluation.

The magazines specialized on scientific field are using the evaluation firs for filtering the obvious mistakes and incompetence and plagiarism as well the too segmented work or application of already known methods. At some journals only 5% of received articled are published as long as other journals are publishing 70% of what they receive. Some Open Access journals have the policy of making the reviews public. In these situations the review is published with the script.

For keeping the integrity of reviewing process the authors who send articles to a journal are usually not informed about who is going to review the paper. Some other times they don't even know the identity of the editor responsible with publishing their article.

In the "blind" or "double-blind" review system the author's identity is hidden for the reviewer for this thing to not influence the quality of the evaluation. In such of this situations it is possible that the editor which is responsible for the article to know the author's identity. The system in which the reviewer knows the author's identity is called "single-blind" review and is different from "double-blind" review.

The critics of "double-blind" review system are highlighting the fact that besides the editorial effort to assure the anonymity, the process very often fails because specific approaching, methods, writing styles, notations, etc could lead to certain groups of people from the research field and even to a particular person. The double-blind review supporters are argument is that this system has the same efficiency as the classical one and it leads to a better perception of correctitude and equality in the global publishing domain. They say as well that if the reviewers of some work are known to each other, the responsible editor for the article may very easily verify the peer's objectivity. The single-blind system is dependent on the participants' willingness.

When the single or double blind review system is not used, when interest conflicts appear between authors and assessors knowing each other, is recommended this conflicts to be made public so for the assessor is forbidden to say it's opinion about the article.[15]

International Catalogues with Open Access Journals

Because there are many Open Access Journals from lots of various fields, the International Catalogues were created. They contain Open Source Journals from different fields.

Examples of such catalogues: DOAJ, Open J Gate, OAIster, RePEc. Further is a presentation of the most important and popular catalogues with statistics about the number of articles and journals, the time evolution and information about their foundation.

Directory of Open Access Journals

Directory of Open Access Journals has a very big journals data base at the end of 2008 it was listing 3765 journals. From these journals, in 1312 the article level searching is possible; the total number of including articles was 222745. [16]

The titles are from very various fields as: agriculture, biology, business, chemistry, medical field, history, literature, law, math and engineering. The goal of Directory of Open Access Journals is to increase the recognition of Open Access Academic Journals making their usage easier and raising their impact. The content of Directory of Open Access Journals is comprehensive and there is a quality guarantee system.

The included journals may opt for introduction of every single article in Directory of Open Access Journals data base. The indexed elements are: the title, the authors, abstract, ISSN, year of apparition, the volume of apparition, the number of apparition, starting page, ending page, keywords. Further the users of this Directory could access the information on three levels of details.[17]

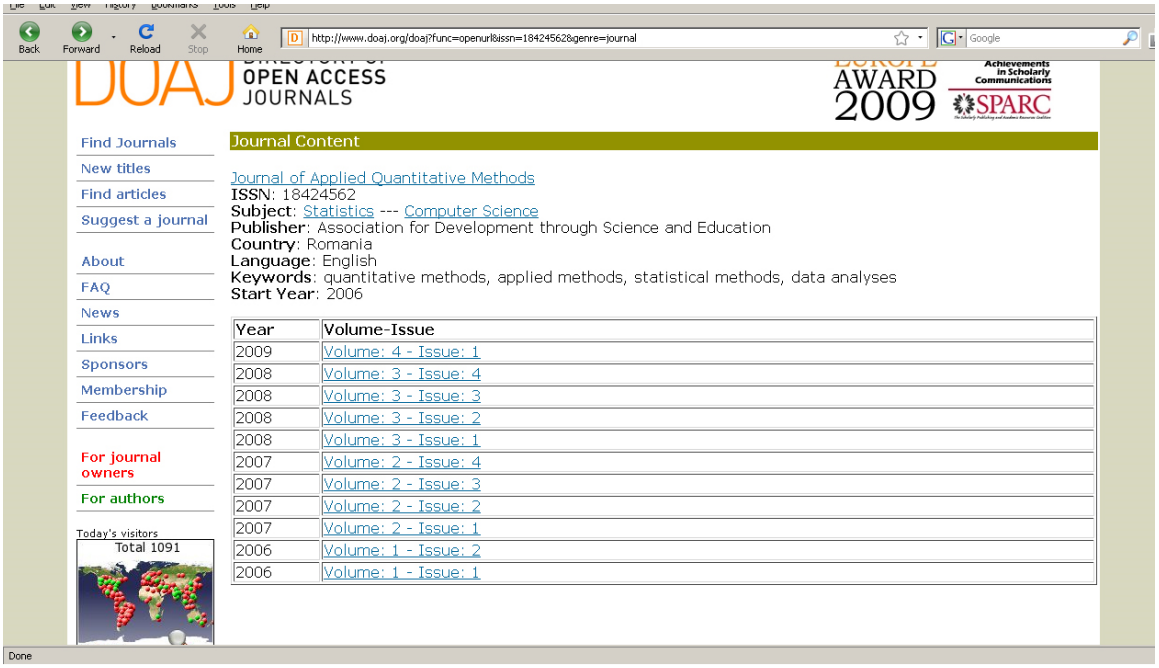

Figure 6.1 - An indexed DOAJ journal

In **Figure 6.1** we can see that the first particularization level is a general one. Besides synthetically information about the journal (name, web link, scientific fields, the publishing house, the origin country, language, keywords and starting year of journal) it offers a summary in which the indexed content for a journal is chronologically listed.

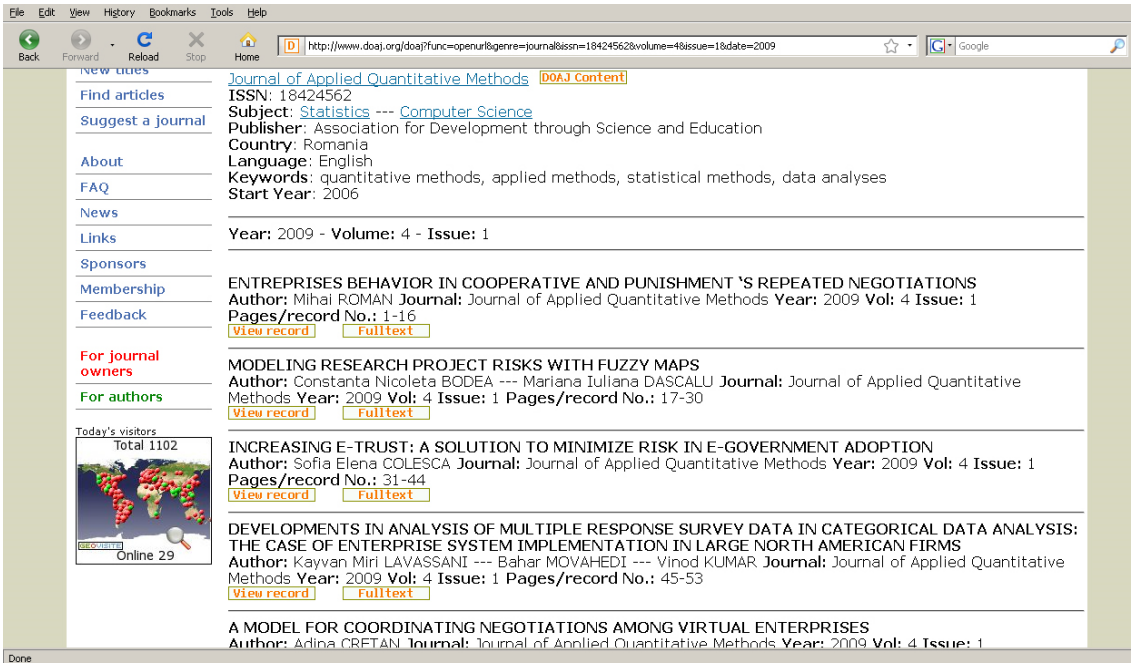

Figure 6.2 - An DOAJ indexed journal number

The users of Directory of Open Access Journals can opt for visualization of the indexed content of an particularly journal number (as it's visible in (**Figure 6.1**)). At this level of details it is possible to see information about: article name, authors, publishing year,

the volume in which the article was published, the number in which the article was published, the starting page, ending page, link to the full article (usually to the journal's site) and link to the next detailing level.

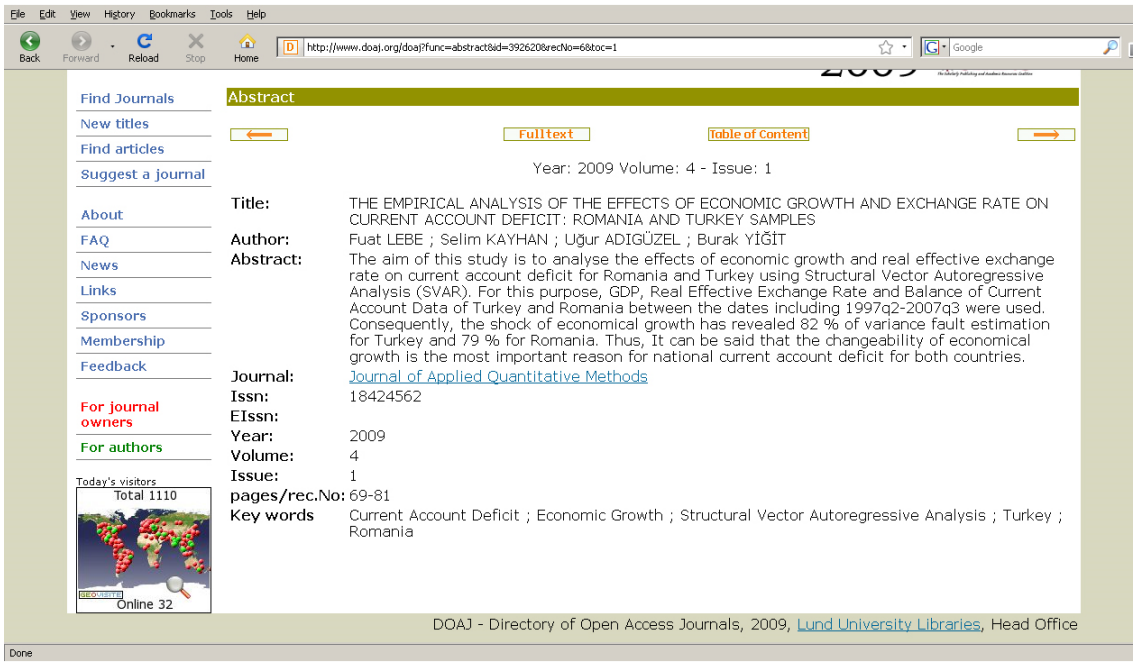

Figure 6.3 – Summary of an DOAJ indexed article

At the next level of indexed content presentation by Directory of Open Access Journals it is possible to detail the elements of an article. There are, that way, available: link to the full version of the article from the page of the journal, link to the superior detailing level (prior presented), the title, the authors, abstract, ISSN, the year of apparition, the volume in which the article was published, the number in which the article was published, start page, end page and keywords.

Open J Gate[18]

Open J Gate is a portal to journals and literature at a global level, literature that is using Open Access System. It was created in 2006 and it is the contribution of Informatics (India) Ltd for the promotion of Open Archives Initiative. It is ass well a journals data base in which are indexed about 5700 Open Access Journals with links to the texts from editor's web sites.

It contains academic journals for research and industry. The main elements which are characterizing this portal are: -this is the portal with the largest number of journals. From the total of 5634 journals, 3267 are peer reviewed; –it has links to one million Open Access Articles and this number is increasing with 300 000 articles/day; -it has different searching facilities.

OAIster [19]

This is a project of Digital Library Production Service from University of Michigan. It's main goal is to create a huge collection of digital academic resources which were very difficult accessed, free resources easy to reach and find by anyone. Besides these online journals, OAIster is using data from Open Archive Initiative and international deposits.

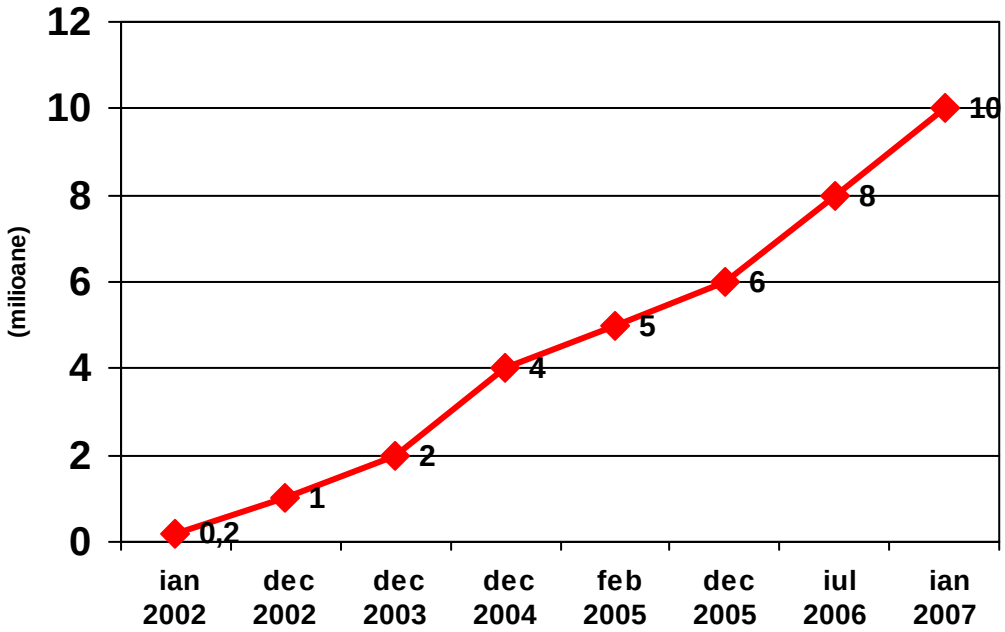

Figure 6.4 – Time evolution of number of records in OAIster

The OAIster data deposits are scattered in countries like: United States (272), Germany (72), England (63), France (32), Canada (27), Brazil (23), Spain (18) and other countries (Spain, Sweden, Scotland, Poland, Finland, etc).[20]

RePEc[21]

Research Papers in Economics is the collaborative effort of hundreds of volunteers from 76 countries for improving the research publishing in the economic field. The heart of the project is a decentralized Open Source Journal and Articles data base available for everyone. RePEc data base is populated with more than 760 000 objects of interest 648 000 being available online:

- 295 000 newspapers;
- 450 000 journal articles;
- 1 800 software components;
- 13 000 books and chapters listing;
- 20 500 publications and publications quotations;
- 11 200 listing from institutional contacts.

RePEc gives institutions the possibility to create personal archives. The non institutions users have the possibility to load their materials into one archive (Munich Personal RePEc Archive) for being included in RePEc because personal archives are not supported.

Romanian Open Access Journals

Since the beginning of year 2000 in Romania appeared a series of Open Access Journals, especially academic journals from fields like: informatics, economics, mathematics, physics, electronics, medical field, etc. Example: Journal for the Study of Religions and

Ideologies, Journal of Applied Quantitative Methods, the Romanian Economic Journal, Economic Informatics Journal, Theoretical and Applied Economics, Open Source Science Journal, etc. Further is a presentation of these journals.

Economic Informatics Journal[22]

It is an Open Access journal founded by the Economic Informatics Department from Academy of Economic Studies, Bucharest. It was published with the support of Ministry of Education, Research and Innovation. This journal is listed in various Open Access catalogues like Directory of Open Access, Open J Gate and others. Founded in 1997 it becomes an Open Access Journal since 1999.

The published Articles content includes research from informatics domain like: Algorithms, Artificial Intelligence, Business Intelligence, Collaborative Systems, Computer Networks, CRM, Data Compression, Data Mining, Data Structures, Data Warehouses, Databases, Decision Support Systems, Distributed Systems, Document Management, E-Society, E-Business, E-Commerce, E-Learning, ERP, Image Processing, Information Systems, IT Audit, IT Economics, IT Security, K-Management, Mobile Solutions, Multimedia, Programming Languages, Project Management, Quantitative Methods, Software Engineering, Software Metrics, Software Optimization, Software Quality, Software Testing, Systems Analysis, System Design, Telecommunication, Web Development.

Starting with the first number of 2007 the journal is published exclusively in English. It is accredited CNCSIS in B+ category. This journal can be accessed at www.revistaie.ro.

Journal of Applied Quantitative Methods[23]

Founded in 2006 and member of Association for Development though Science and Education) it is a quarterly Open Access Publication.

Journal of Applied Quantitative Methods is a double-blind peer-review scholarly publication in the broad area of quantitative methods whose goal is to identify relevant problems in high need of solutions by encouraging the application of quantitative methods across disciplines including but not limited to the following: Biostatistics, Computer Systems and Networks, Content Management, Data Mining, Data Modeling, Data Quality, Distributed Systems, Information Management, Information Technologies, Knowledge Management Metrics, Neural Networks, Operational Research, Patterns and Practices, Project Management, Quality and Reliability, Quantitative Analyses Using IT Methods, Optimization Problems, Information Security, Simulation, Social Sciences, Statistical Methods.

Proposals from other related spheres of research can be submitted to the editors. The journal is an open-access journal published on the Internet, with four issues per year. The language in which materials can be published is English.

Journal of Applied Quantitative Methods is listed in Directory of Open Access Journals and can be accessed at www.jaqm.ro. It is accredited CNCSIS in B+ category.

Journal for the Study of Religions and Ideologies[24]

Founded in 2002 Journal for the Study of Religions and Ideologies is a journal edited by S C I R I and S A C R I.

Open Access Journal since 2006 it is an academic peer review publication destined to the teachers and young researchers which are interested in the study of religions and ideologies. The publishing languages are Romanian and English. All the articles contain the title, abstract and keywords in English. The journal is exclusively published on the internet.

J.S.R.I. encourages interdisciplinary approaches engaging the following domains: religious studies, philosophy of religions, ethics, political philosophy and political science, anthropology, sociology, inter religious dialogue and communications theory. All articles must explore the religious dimension of the issues covered.

Published three times a year is the first Romanian journal included in Arts and Humanities Citation Index and Current Contents: Arts and Humanities of ISI data bases. The journal is listed in Directory of Open Access Journal and can be accessed on www.jsri.ro.

Theoretical and Applied Economics[25]

Founded in 1994 the journal becomes Open Access Journal in 2004. It is edited by General Association of Romanian Economists. It appears monthly and it has an economically multidisciplinary profile and its goal is to disseminate the theoretically and pragmatic results of scientific research in economic field or connected fields. The publishing of studies is done after following the assessment procedures.

This journal is indexed in RePEc data bases, Directory of Open Access Journals and others major catalogues with Open Access Journals. It is as well CNCSIS accredited in B+ category.

The Romanian Economic Journal[26]

This journal appeared for the first time in 1998 in Temper/Tempus Economics For Romania program (one of the largest such program which ever took place in our country).

In 10 years from the first apparition, the constancy and the high quality of the journal began to be very well appreciated in both Romanian and foreign academic field. The result is that The Romanian Economic Journal is accredited since 2000 by CCSIS.

Open Source Science Journal[27]

Founded in 2009 Open Source Science Journal is a quarterly scientific journal in the Open Source field.

The Journal is listed in INSPEC Index Copernicus, EBSCO, Google Scholar.

The editorial board includes professors and PhD students in Computer Science. Their practical experience is in object oriented programming, software quality and software engineering. The scientific board includes PhD in Computer Science or Economic Informatics, their research is focused on software development issues. They have published papers and books in the Computer Science field.

7. Conclusions

Open Access and Open Source are for now days an important field for developing applications especially for improving the academic research field and people access to information in journals and other publications.

In this paper the main goals of the both terms were discussed. An overview about the actual implementation of these technologies in scientific journals development is important and it is to be used for further improvements of the access to information.

As anyone must have easy and freely access to knowledge, developing Open Source applications must be the goal for both young and experimented developers.

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DETERMINATION OF OPTIMUM MAINTENANCE METHOD BASED ON MAINTENANCE COST

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Abstract: *The present economical and financial crisis that affects all industrial organizations, have also large impact on the maintenance activity .Unfortunately, due to the pressure of costs reduction, this activity still continues at a very low level, with important effects in the future. The decision to adapt a maintenance method should be the result of a scientific analysis, taking into account a series of technical and security factors, as well as, economic ones, and certainly, all the other costs this activity includes.*

Key words: total productive maintenance, corrective maintenance, systematical preventive maintenance, conditional preventive maintenance, probability of failure, direct costs, cost of downtime.

Taking into account all the maintenance methods from the specialized magazines all over the world, there are different opinions regarding the maintenance methods that are likely to be used, fact that comes from the reality belonging to different organizations from one country or another or even from the same country. Thus, there is a wide variety of maintenance methods starting with the traditional systems of maintenance and repairs (which are still in use in our country) and ending with „Total productive maintenance" (in Japan).

In our opinion, in order to define an efficient maintenance policy we should take into account the fact that there is not a „good maintenance method" itself, but we will have to adopt a particular maintenance method for each industrial equipment, achieving an economic and technical balance. As a consequence, we suggest the following classification of the possible methods of maintenance to be applied in our country: **corrective maintenance; systematical preventive maintenance; conditional preventive maintenance**[3]

1. The corrective maintenance is the maintenance which is used when the equipment breaks down. There is a slight ambiguity when defining the corrective maintenance as „correction" the breaking down includes the notion of betterment. After the failure that occurred within the maintenance and work repairs, we perform work repairing trying to work out the failing function. The corrective maintenance involves the following:

- an analysis of the causes of the breaking down;
- work repair;
- a potential correction trying to avoid the rework repair of the failure or to reduce its effects on the system;
- observing all the elements regarding the intervention (the cause, the works, spare parts, parts which have been replaced, the cost of the work, time of not functioning), thus allowing a future operation.

Corrective maintenance represents that type method of maintenance which is used before developing the systematical preventive maintenance, but the latter does not eliminate in all the equipment breaking, downs and, what is more, they cannot be applied in all the situations in acceptable economic conditions. As a consequence, this method is usually applied to equipments whose breaking down does not involve people's security and does not require high costs when it comes to the unavailability, of equipments. Also, this maintenance method can be applied to all equipments during the warranty period and especially during the operation time.

When we decide to adopt the maintenance method, we must estimate correctly the costs of breakdowns. The cost of an equipment breakdown comes from the cost of the necessary corrective maintenance to restart it (direct cost) and the cost of all the unavailable situations for the equipment (indirect cost).

The systematical preventive maintenance is that type of anticipated, organized maintenance and programmed before an anticipated breakdown. In order to apply the systematical preventive maintenance, the plant must have the terminology and the record of all the equipments in accordance with the terms of their usage, their preventive systematical maintenance /tear-and-wear as well as a short history of the equipments.

The systematical preventive maintenance can be of „surveillance" or „absolute" maintenance.

- „absolute"- means that no inspection is done between two scheduled maintenance checks;
- „surveillance"- there can be set "regular scheduled maintenance" checks to check the constant state and the estimated state when the average time of operation is identified.

In accordance with their complexity and the length of time, volume or preventive systematical maintenance, the systematical preventive maintenance can be divided on different levels, for each level we must set the operations that should be applied to an equipment (working or not working) such as, checks, replacements, renovations, etc of some critical elements.

The conditional preventive maintenance is that maintenance of the evolution of a typical symptom of an event which can be identified with the help of different means: diagnosis, the wear measurement, information from a receiver. This method of maintenance anticipates the appearance of some more sources of damage as a result of the unnecessary

disassembling taking action at the right time. This is the plus which is added to the „time's" and which improves the conditioned maintenance.

The control and diagnostic operations in case of a conditional preventive maintenance follow the lifespan of the equipment. The first condition to put this method into practice is that the equipment should be suitable for this method that is there should be a progressive and detectable degradation and there should be a correlation between the measurable parameter and the condition of the equipment. Taking into account this aspect, it is necessary to have a period of systematical and preventive maintenance in order to set a line of accessibility' where it should be a stop. It is compulsory to have "alarm" signal when intervention must take place.

The decision to adapt one of these methods must be the result of a scientific analysis on a basis of scientific models and methods and taking into account economic, technical and security factors. Unfortunately, the present financial and economic crisis that all the plants have to deal with has severe effects on the maintenance activity. This activity functions is at the minimum level due to the cost reduction. Taking into account this aspect and the fact that the maintenance service is not a real purpose but a quite expensive necessity for the production, we consider that it is difficult to consider it a useful method of maintenance without taking into consideration the economic aspect as well as the costs resulted from this activity.

The present approach has as a starting point the estimation and the comparison of the average costs of the three maintenance methods, mentioning at the same time that in case of an accidental breaking down, people's security will not be affected.

As for the **systematical preventive maintenance method**, we talk about interventions in a systematical manner as well as replacements or renovations of some elements of some critical situations after a while.

As a result, the optimum period of systematical intervention depends on reliability of some elements considered critical and this law can be defined in accordance with some indicators:

- $\lambda(t)$ = the rate of the breaking down;
- R(t) = the probability of survival;
- F(t) = the probability of breaking down;
- f(t)= the density of the probability of the breaking down.

In the case of „T" intervention within the systematical maintenance there is a probability of the breaking down F(t). As a consequence, the total cost of the maintenance and the unavailability (Ct_s) will be given by:

$$Ct_s = C_d + C_i \times F(t), \text{ where}$$

C_d = the direct costs or costs of maintenance;

C_i = the indirect costs of unavailability in case of a breaking down;

F(t) = the probability of breaking down.

If there is such an accidental breaking down before the moment T (that is $F(t)>0$), the average time to operate between two successive interventions m(t) will be smaller than T and it will be determined according to :

$$m(t) = \int_0^T R(t)\,dt$$

$$m(t) = \int_0^T (1-Fm)dt$$

$$m(t) = T - \int_0^T Fmdt$$

Consequently, the average cost per time unit for the systematical maintenance (Ct_{sm}) will be:

$$Ct_{sm} = [\, C_d + C_i \times F(t)] \,/\, m(t)$$

The optimum duration of operation between two successive interventions (Top) will be given by the value Ctsm which is the minimum. On the one hand, this depends on the shape of the curve of breaking down probability F(t) and, on the other hand, by the function: C_i / C_d (the indirect costs in case of a breaking down / direct costs of systematical maintenance). See in figure 1.

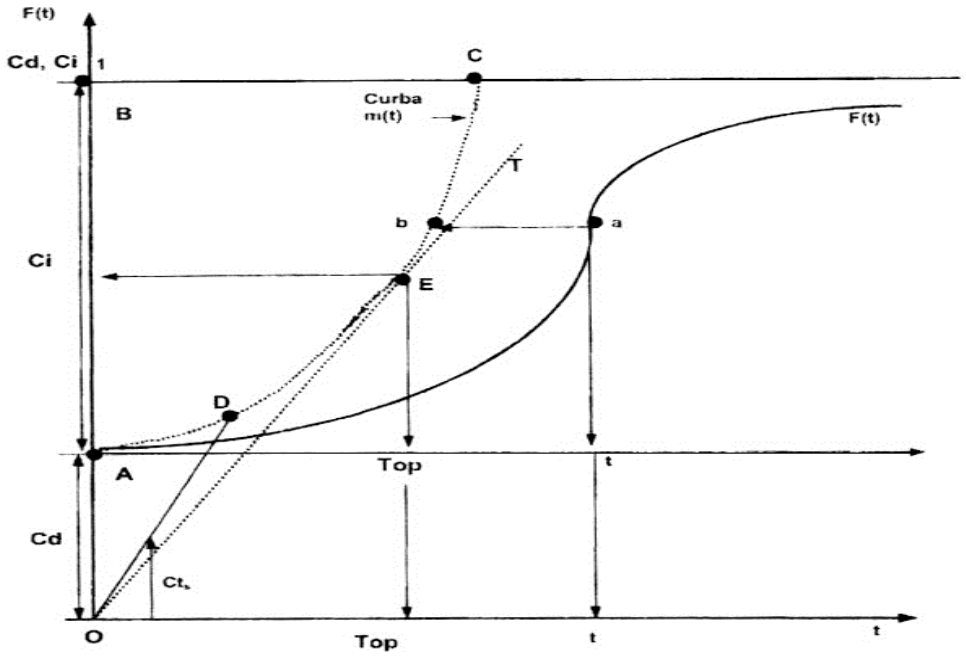

Figure 1. The graphic determination of the suitable time of operation in the systematical preventive maintenance.

The slant of the OD line represents the average cost per time unit which must be optimized by establishing the time of intervention. But this slant can be minimized when point D coincide with the contact point of the tangent which goes from the curve m(t) to point E.

This depends, on the one hand, on the shape of the curve of the breaking down probability F(t), and on the other hand, on the function C_i / C_d, where the indirect costs in

case of a breakdown and the direct cost of systematical maintenance as it is in figure 1. As a consequence, the optimum time of intervention Top depends on the shape of the curve F(t) (or R(t) which is symmetrical). This way, in case of a constant breaking down $\lambda(t)$ which is constant in time and which corresponds to a law of reliability (Rt), it is represented through a decreasing exponential function, the average duration between the two successive interventions m(t) is a line just like in figure 2.

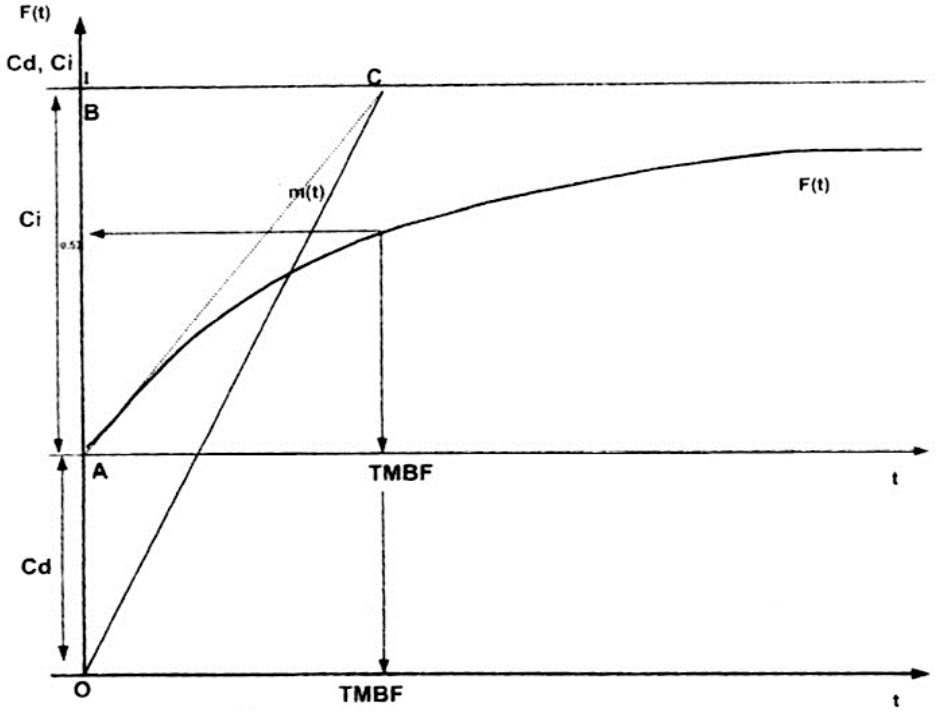

Figure 2 .The situation whom the rate of the breaking downs is steady

In this case, the tangent for the curve m(t) from the starting point towards the OC line. Consequently, the optimum time of operation between two successive interventions corresponds with the time of the breaking down, and the systematical preventive maintenance goes towards the corrective maintenance and the average duration of operation merges with the average time of good functioning (TMBF).

When the indirect costs of unavailability in case of a breaking down are unimportant as size, the tangent for the m(t) curve goes towards a straight line which is a parallel with the ox axis , and the tangent tends to go to $C_{i,}$ the superior point of the m(t) curve and it corresponds to a rate of the breaking down which is equal to 1 – that is the corrective maintenance. (figure 3).

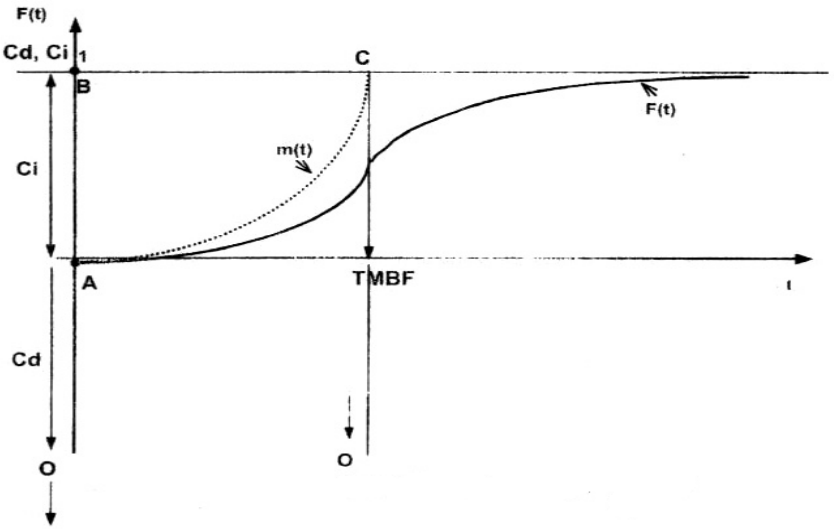

Figure 3. The case when the fraction $C_i/C_d \longrightarrow 0$

In the opposite situation where the indirect costs of unavailability in case of a breaking down (C_i) are very high, the point O will be very close to A (the origin of the m(t) curve, and the tangent OT to this curve is close to the abscissa).

The optimum duration (Top) matches the rate of Top, a reducing breaking down and Top is inferior to TMBF, the difference depends on the size of the function (the higher value the function will have, the higher the difference between TMBF and Top will be). This is shown in figure 4.

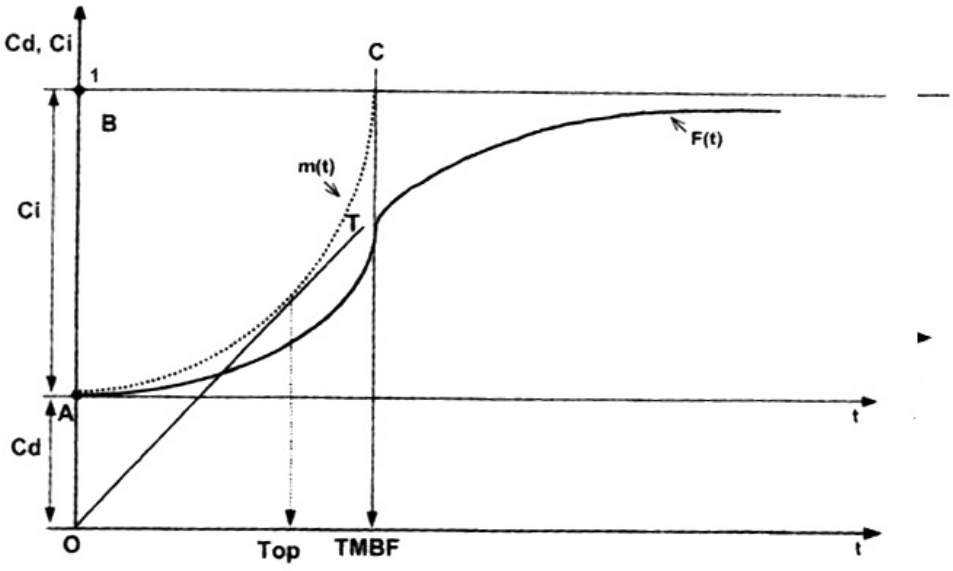

Figure 4. The case when the fraction C_i/C_d is higher

In case of the **conditional preventive maintenance**, the average duration between the successive interventions which is linked to the evolution of a symptom, is very close to TMBF. It can be calculated like this:

m(t) = K x TMBF, where

K = the coefficient which takes into account the necessary time between the alarm moment and the acceptable time when the conditioned and preventive maintenance has a value close to 1.

There exists a series of costs to implement this method of maintenance such as costs of acquisition of different measurement and control equipment and their use.

These costs to implement the conditional preventive maintenance between two successive interventions can be calculated as it follows:

$C_c = (A/ D \times TMBF) + C_a$, where

C_c = the costs to implement the conditional preventive maintenance;

A = the costs of acquisition of the necessary measurement and control equipment;

D = the probable duration of the use of these equipments;

C_a = the costs of these measurements and controls for critical elements for a certain period of time –

TMBF.

So, the average cost per time unit in case of conditioned and preventive maintenance (Ct_{cm}) will be:

$$Ct_{cm} = (C_d + C_c) / (K \cdot TMBF)$$

As for the **corrective maintenance**, the average cost per time unit (Ct_{crm}) will be:

$$Ct_{crm} = (C_d + C_c) / TMBF$$

If we are to compare the average cost per time unit which corresponds to each maintenance method, it can be identified the most efficient method of maintenance taking into account the costs.

When it comes to the indirect costs of the unavailability in case of a breaking down, they are not important, that is the function C_i/C_d is zero or it has a very small value (it has the tendency to go to zero), and the corrective maintenance method becomes the most advantageous; on the other hand, it can be justified the implementation of the conditional preventive maintenance methods or systematical preventive maintenance.

In case of a breaking down, people's security or the goods safety is severely damaged (C_i has a high value as it is well known that life is priceless) it is advisable to use the conditional preventive maintenance method; that involves a high rate of measurements and controls of the systems.

As it has already been shown, the method of conditional preventive maintenance involves the existence of a progressive degradation law which can be identified and the

correlation between a measurable parameter and the equipment state. If this is not possible, the systematical preventive replacements are a means to reduce the risk of breaking down. When it is difficult to identify a rate of the breaking downs, one last solution is to update the equipment.

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