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Differences between Offer and Demand on the ICT specialist's Czech Labor Market

Petr Doucek[1], Lea Nedomova[1], Milos Maryska[2]

University of Economics, Faculty of Informatics and Statistics,
[1]Department of System Analysis and
[2]Department of Information Technologies, W. Churchill sq. 4, Prague, Czech Republic;
{doucek, nedomova, maryskam}@vse.cz

Global changes in the information society are placing ever greater emphasis on professionals in all areas of human activity and in the area of ICT (Information and Communications Technology) especially. This article provides methodology how to measure knowledge level requirements on ICT specialists in business, ICT and non ICT skills in graduates of tertiary education level. It shows also an example of data collecting in academic sphere and among business unites. Practical experiences from the five years research are presented at the end of in this contribution. These results are successfully applied for human resource management and innovation management in competences of ICT professionals in small and medium enterprises (SMEs) in the Czech Republic.

Keywords: Information and Communication Technology (ICT), Human Resources in ICT, ICT Education, competencies in SMEs.

1 Introduction

The contemporary turbulent economic environment (Saee, 2004) places elevated emphasis on managerial skills in various fields. The same is also true of managerial abilities and skills in the area of introduction of information and communications technologies (ICT) into everyday economic practice and their subsequent operation. In 2010, almost 5.4% of the employed global population was working in positions of ICT professionals (OECD, 2010). Their knowledge must constantly expand and, simultaneously, the typical knowledge of ICT professionals (Frinking et al., 2005) is being increasingly combined with other non ICT knowledge, such as marketing, business, etc. (OECD, 2010; EC, 2010, Kunstova, 2011). Similar conclusions were drawn by (Fernandez, 2006), who states that a combination of ICT and non-ICT knowledge is more important for companies in selecting employees than only specific ICT knowledge. The general frame of requirements on ICT specialists in actual business was developed and presented by Joseph et al. (2007) – Figure 1.

This concept suggests three-level analysis framework as a guideline for research on ICT specialist's behavior. The upper level is the environmental analysis, which includes the ICT labor market, ICT technological trends and national cultures. The middle level – the corporate level analysis focuses on the corporate level factors – ICT strategy, ICT structure and human resources practices. The lowest level represents the individual analysis. This level includes job related factors, individual attributes and perceived organizational factors. (Jing and Hoon, 2010). This framework was used by our research and development work, but not in the complex of all three levels. We investigated only the **Individual level** with special accent on individual knowledge and ICT and non-ICT skills in our research. There could be distinguished in practice two types of surveys linked to the area of knowledge and skills in ICT:

- surveys realized by the universities or educational institutions,
- surveys realized by non-educational institutions.

Similar surveys as ours were realized at a lot of universities in the world. For example two detail surveys were realized in Saudi Arabia (Al-Jabri and Fraihat, 2005) and in Croatia (Varga et al., 2004). The structure of knowledge analyzed in these surveys is similar to structure of knowledge analyzed by the authors of this paper. Non-technical skills of Australian business graduates are for example analyzed in Jackson D. and Chapman, E. (2012). But this survey was more generally focused then only on ICT specialists.

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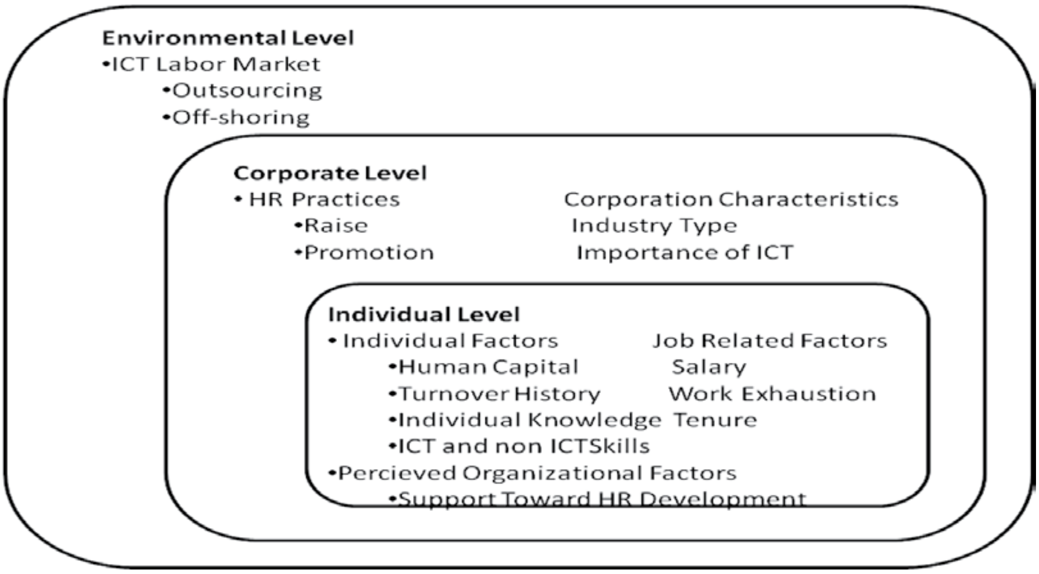

Figure 1: Research Framework for Turnover of ICT Professionals (Joseph et al., 2007)

Surveys aimed on assessing ICT knowledge are realized for example by Department of Labour Te Tari Mahi and ITCP on New Zeeland (Department of Labour, 2005) and (ITCP, 2012), ACS organization in Australia (Information, 2012).

2 Problem Formulation

As a reaction to the relatively low flexibility of the Czech Republic formal education system in the ICT skills area, six years ago the Faculty of Informatics and Statistics decided to initiate a research project in order to map:

- ICT education offered in the Czech Republic.
- Demand for ICT skills in the Czech Republic.

University education (tertiary education) forms an important component of the education system in each country in the world and this level should be one of the most effective and required in the area of ICT. Very similar ideas and questions are for example presented in Henno, Jaakkola, and Mäkelä (2012).

The aim of this project was to motivate universities and formulate recommendations for further development of the Czech university education in the area of ICT. To set up and formally pass the accreditation process of a new study program takes one year at least (only under conditions that relevant school or university has enough experts in required knowledge areas).

The main goal of our research was firstly to identify:

- The topics of education process and number of credits devoted to different IT subjects at all universities and technical specialist schools, which are involved in ICT education.
- *The actual number of students*, expected number of graduates in the actual school year and the actual number of new students in the first year.

The second goal was to carry out a survey of the ICT graduates skill requirements in the Czech market. The survey made among universities was performed three times (2006, 2009 and 2011) and the survey among companies two times (2006 and 2010). Our results could be compared with surveys about the acceptability of ICT university graduates in practice in other countries as for example are Marks and Huzzard (2012) and Wickramasinghe and Perera (2010).

3 Methodology

For realizing our research goals we had to solve some "side" problems. Main side problems were:

- To answer the question "Who is the ICT professional?" and "What are basic **ICT roles in business**?"
- What are the most important **ICT skills and knowledge categories** for each ICT business role?
- How to **measure the level of knowledge** and skills?
- What **level** of academic knowledge **is acceptable for business**?

3.1 Roles in ICT – General Concept

Our project prefers classification of specific roles in ICT (rather than particular professions which are in this context too detailed) underlining the competitive ability of graduates based on their knowledge potential (Valenduc and Vendramin, 2005). ICT specialist in this context is educated and qualified to use his/her knowledge potential mainly in the design, implementation and operation of ICT and their application (Round and Lovegrove, 2004; Clear, 2000). For the purpose of this project his/her competencies were described as follows:

- Design and development of ICT.
- Design and development of ICT applications.

- Implementation, customization and integration of ICT applications within enterprise or other economic subject, thus changing and modifying working procedures and effectiveness of staff.
- Implementation and ICT operation management including user application support.
- Management of ICT projects.
- Information services management and knowledge distribution.
- ICT services and products promotion and purchase – applying professional skills with aim to promote detail awareness of ICT services and products and promoting their effective use.

End users of ICT are not (for the purpose of this survey) considered as ICT specialists, even though most of the current university graduates (physicians, financiers and architects) are by definition active in data processing and computer-aided operations. This category was excluded as it does not require specific ICT education. For example, the user of SAP does not fit into our classification of an ICT specialist, but the methodology designer responsible for the overall SAP architecture is covered by our role definitions (Doucek et al., 2007).

Due to the fast developments and relatively high specialization in the area of ICT two levels of specialists were defined – the first level consists of core ICT roles with corresponding key knowledge and activities. This level is relevant for our research as it concentrates on the core competencies and procedures rather than on the detailed technical knowledge which universities could not provide in an up-to-date manner. The second level lists ICT professions included in the core roles (Business Process Analyst/Designer, IS/ICT Development and Operations Manager, Dealer - Business Person in ICT Products and Services, Developer/ IS Architect, Administrator of Applications and of ICT Infrastructure and Lector in ICT). An example of the role description is presented in Table 1.

As is evident from Table 1, there were specified following attributes for each role – concrete professions in business informatics, key required knowledge and key business activities in corporate informatics.

Furthermore, there are some obligatory skills required for all ICT roles in each economy:

- high level of creativity,
- team work ability,
- communication competence,
- fluent spoken and written foreign language. For Europe in majority, English or other foreign languages depending on a region.

There were identified new knowledge requirements on ICT specialists, especially thanks to the social networks boom, during working out our tasks (Doucek et al., 2011b):

1. There will be a higher expectancy of **communication skills** for webmasters/profile managers. Interactive nature of social network requires an empathy and social sensibility.
2. There will be a growing demand for **Facebook developers**, fluent in the **Facebook Markup Language (FBML)**. Also Facebook/LinkedIn application programmer will be needed.
3. Since Facebook is highly multi-language environment, we can expect **higher demand for foreign languages**.

Table 1: ICT Professions – Developer/IS Architect (Doucek et al., 2007)

Developer / IS Architect **Professions:** developer, programmer, tester, system integrator, ICT architect, system development manager.	**Key knowledge:** ■ Technologies and procedures needed for design, integration and operation of applications. ■ Design and development of user-friendly applications with simplified operational requirements. ■ Design of suitable technological and application architecture of IS/ICT organization. ■ Management of the team of designers and developers. **Key activities:** ■ Analysis and design of ICT applications (on-line services, BI, effectiveness of business processes, personal/tailored application, entertainment). ■ Database design. ■ Data mining. ■ Programming of client, server, database and web applications. ■ Grid programming. ■ Application testing. ■ Application documentation (design, program, operational, users). ■ Maintenance and administration of application versions ■ Integration of applications. ■ Design of hardware, software and data architectures. **Note:** Thanks to easy outsourcing these professions might be transferred to countries with low labor costs – except analysts and designers of applications.

4. Video is a very popular format within social networks, therefore **skills related to creation; editing and postproduction** would be expected.

These facts are not included into this article, because this survey was only preliminary and final version of the questionnaire is distributed to respondents at this time.

3.2 Skill Categories (Domains)

In cooperation with the association of ICT managers (CACIO – Czech Association of CIOs), we formulated the requirements on obligatory knowledge and skills of ICT professionals, required in all the roles. We consider that they include particularly a high degree of creativity in resolving tasks, good knowledge of the English language (written and spoken), ability to work in a team and communication abilities and also, e.g., the ability to learn from practical examples. We did not determine these skills in the study.

We related the definition of obligatory knowledge and skills to the definition of knowledge domains in the sense of communicable words (pedagogical process) or practical exercises of acquired knowledge and skills. Here we defined the knowledge and skills that are required for the individual roles with various levels of necessity.

This study concentrates on 16 skill categories (based, but not limited to the respected IT curricula – Strawman curricula (Strawman, 2004) and their weight in the university graduate or employee profile.

Following ICT knowledge categories (domains) were identified for our research: MS01 – Process modeling, MS02 – Functionality and customization, MS03 – Management IS/ICT, MS04 - Analysis and design, MS05 - Software engineering, MS06 – Data and information engineering, MS07 – IS/ICT knowledge, MS08 – Operational excellence, MS09 – Team leadership skills, MS10 – ICT market knowledge.

The main non-ICT knowledge categories (domains) were identified as following: MS11 – Organizational management methods, MS12 – Enterprise finance and economics, MS13 – Sales and marketing, MS14 – Mathematics, MS15 – Law, MS16 – Knowledge in business sectors.

We described each of these knowledge domains so that the respondents in the survey would be capable of assigning ECTS (European Credit Transfer and Accumulation System) credits obtained by the students in the subject areas to the relevant domains. The individual domains, their description and mapping between the various surveys are described, e.g., in (Maryska et al., 2012).

3.3 Knowledge Levels

In order to compare the "amount" of knowledge devoted to each skill category by university program or by business requirements non-linear scale was defined as follows on Table 2:

Table 2: Levels of Knowledge

Level	Description
0	No knowledge.
1	Overview (relevant to **1-2** credits or intensive training days).
2	Basic orientation and terminology (relevant to **3-5** credits or intensive training days).
3	Good orientation and basic practical skills (relevant to **6-20** credits or intensive training days).
4	Good orientation and good practical skills (relevant to **21-40** credits or intensive training days).
5	Highest knowledge quality and advanced practical skills (relevant to **41 and more** credits or intensive training days).

On the basis of long discussions with representatives of universities and enterprises in the ICT area, we decided to employ this scale also for questioning companies. For companies, we replaced the number of ECTS credits for economic entities by the more comprehensible term "number of days of training". The recalculation mechanism was chosen as the ratio 1 ECTS credit = 1 day of training. We arrived at the equivalence 1 ECTS credit equals one day of training, i.e. 8 hours, after analyzing the teaching plans for subjects in informatics in the Czech Republic, Germany, Austria and Poland. This corresponds to direct effective teaching.

3.4 Knowledge Profiles and Their Distances

Set of knowledge levels for each of the skill categories was defined in this research as "knowledge profile" and used to compare the requirements of business with the supply of universities.

The distance between the knowledge profiles in our research was analyzed. Distance between university knowledge profile A and business knowledge profile B is expressed by the number of additional intensive training days required for the graduate with knowledge profile A to fulfill the minimal requirements of profile B. The smaller the distance the "cheaper" the graduate of university for the relevant ICT role in business is.

We applied the modified method of distance from ideal variant for comparison between A and B profiles.

$D(a) = d(A,B)$,

where

d is the function of the distance,

vector A contents evaluation of each knowledge domain of academic profile,

vector B contents evaluation of each knowledge domain of business profile for each ICT business role.

Function of the distance is calculated for each knowledge domain by following metric:

$d(A_i,B_i)= 0,$ for $A_i>= B_i,$

$d(A_i,B_i)= B_i-A_i$ for $A_i<B_i.$

The aggregated distance between academic knowledge profile and ICT business role profile is then calculated as $D(a) = \Sigma\, d_i(A_i,B_i)$ for all i = 1, number of domains (16) and its interpretation is number of training days, that must be invested into the new enrolled ICT professional. Following discussions with representatives of enterprises and professional companies, we considered that 60 days of training is an acceptable limit to the number of days of extra training (acceptable distance), where the graduate is still not too expensive for the economic entity.

3.5 Data collection

Survey and data collection were performed in two main streams – the first one were the universities and the second one the business units in the Czech Republic. The questions were based on the consult with experts on questionnaires surveys, creative applying the rules thus defined, based on theoretical principals for indirect sampling (Lavalleé, 2007; Thompson, 2012).

There were used similar questionnaires for both realized surveys divided into two sections:

- Identifications of the respondent's unit (university or company).
- Seventeen questions on knowledge level (scale of this knowledge level is presented in Table 2) provided by universities/requested by companies (companies answers questions on knowledge for all defined ICT roles).
  - **For universities**
  - Number of students studying defined study program (number of new (entrance) students, number of all students, number of graduates students)
  - Method for evaluation students that are studying defined ICT related study program (ECTS credits, credits of direct lectures per semester etc.).
  - Sum of all credits for study subjects which have to be fulfilled in this study program.
  - Knowledge domains (16 knowledge categories, domains) that are evaluated as a sum of credits that are lectured in defined ICT related study programs. Number of all credits represented by total sum of credits in each knowledge domain. These credits were divided into two groups: obligatory and optional.
  - **For business units**
  - Sum of expected/required knowledge in each domain expressed in level of appropriate knowledge (Table 2).

Questionnaire was based primarily on closed questions, but there was a place for written text in which respondent could provide additional information about the study field, knowledge provided to students and other to the survey relevant facts.

Survey among Businesses

All active economic subjects in the Czech Republic on the end of 2005 (the first survey was held in 2006). According to data of the Czech Statistical Office, there were 1,266,336 subjects of various size and main economic activity.

Size of entity: According to the number of employees, 6 categories were used: 0, 1 – 9, 10 – 49, 50 – 249, 250 – 999, 1,000 and more.

Sector of main economic activity: There are 17 main sectors in Industrial Classification of Economic Activities of the Czech Statistical Office. According to the requirements on information technologies, these sectors were coded into 3 categories: sectors with the lowest requirements (LIT), sectors with the middle requirements (MIT) and sectors with the highest requirements (HIT).

Method of sampling from the population: According to the size of subject and the category of its economic activity, the population was grouped into 18 subpopulations. Afterwards, stratified sampling was applied. There are no homogenous subgroups in the population. As can be seen in Table 3, their size varies much. Because of the number of employees the variation of number of IT workers in subject is certainly very heterogeneous, too. Optimal allocation requires knowledge of this variability (it was un-known). So, this heterogeneity was taken into account at least in the following way: the sampling fraction was higher in strata with more employees and in sectors with the higher requirements on information technologies. The interviewing methods used were CAWI (Computer Aided Web Interviewing) and CATI (Computer-Assisted Personal Interviewing). Realized sample size was 1,002 (Table 4).

Table 3: Sector Map for Business Units in the Czech Republic (2005)

	0	1 – 9	10 – 49	50 – 249	250 – 999	1,000 +	Total
LIT	263,289	49,914	14,270	4,317	369	87	*332,246*
MIT	697,380	138,555	28,014	6,217	1,164	182	*871,512*
HIT	49,851	9,590	2,216	710	170	41	*62,578*
Total	*1,010,520*	*198,059*	*44,500*	*11,244*	*1,703*	*310*	*1,266,336*

Table 4: Structure of the Observed Sample 2006

	0	1 – 9	10 – 49	50 – 249	250 – 999	1,000+	Total
LIT	56	28	28	28	37	16	*193*
MIT	56	56	56	56	71	36	*331*
HIT	56	110	160	122	26	4	*478*
Total	*168*	*194*	*244*	*206*	*134*	*56*	*1,002*

The structure of the sample for the second survey in 2010 was changed. The main changes were realized in structure of the sample, as the categories 0, 1-9 were removed from the sample (based on the analysis of the 2006 results and on the recommendation of the Czech Statistical Office experts), and the last two categories 250-999 and 1,000+ were joined into the category 250+. The second survey between business sectors was realized in 2010 on the sample size of 1,011 companies (Table 5).

Table 5: Structure of the Observed Sample 2010

	10 – 49	50 – 249	250 +	Total
LIT	45	46	44	*135*
MIT	57	474	98	*629*
HIT	66	142	39	*247*
Total	*168*	*662*	*181*	1,011

Both of surveys were realized by the private research company which disposes of needed sample of companies which guarantee comparability of results from both surveys. Although the samples of companies in both surveys were different numbers of companies in each cluster were similar in both surveys.

Variables:

a) Number of IT employees in 2010 in the following structure: business analyst, IT manager, IT salesperson (dealer), architect of information networks, administrator and lector. Expected number of IT workers for some following years. This data are not presented in the paper.
b) Knowledge requirements on particular professional positions: there were 16 skill categories defined (thus, 16 ordinal variables with values 0 – “no knowledge (0 training days)” … 5 – “highest knowledge (more than 41 training days)” (Table 2).
c) Classification variables: number of employees, sector of main economic activity, requirements of the sector on information technologies, IT supplier or customer, national or external owner.

Knowledge requirements:

With respect to the nature of variables, **medians were used**. To compare different professional positions and different skill categories, box plots (for sampling distributions) and scatter plots (for medians) were used.

All collected data were processed using cluster analysis method built in MS SQL Server version 2008.

Survey among Universities

The surveyed population:

All Higher Education Institutions (HEIs) providing university level ICT related study programs based on evidence of the Czech Ministry of Education. There were identified 71 faculties (376 study programs) in that evidence. To all of these subjects a questionnaire was sent via Internet and they were asked to fill it for each IT related study program they provide. The response rate is presented on the following Table 6.

Table 6: Response Rate for Survey 2011

	Universities	Faculties	Specializations
Identified	31	71	376
Response	21	29	196
Response rate	68 %	41 %	52 %

Method of sampling data from the population:

As the whole population was surveyed no sampling method had to be used. Missing quantitative data (number of enrolled, number of students, number of graduates) from not-replying subjects have been reconstructed from the official resources of the Czech Ministry of Education. Missing qualitative data (number of credits devoted to each skill category) were not reconstructed and these faculties were excluded from final results. These were marked as “not classified” segment.

Variables:

a) Number of students, number of enrolled (new entrants to the study program each year) number of graduates in the school years 2000 to 2009 and expected numbers for some following years. These data are not presented in this paper.
b) Number of credits devoted to each of 16 skill categories defined.
c) Classification variable: level of study program – bachelor, master (2 year), master (5 year; these are the “pre Bologna” programs ending in 2006 or 2007 school years).

In order to identify study programs with common patterns (from the perspective of the knowledge provided to their graduates) we have used cluster analysis (with the expectation-maximization algorithms). ICT programs were classified into eight segments (four for bachelor and four for master programs). To express the location of particular obtained knowledge in each segment, medians were used again. The star charts ("spider" charts) were used to compare the knowledge obtained and required in particular skill categories for each professional position. The concept of distance (described in previous chapter) was used as a metric of relevance of appropriate study program and business requirements on appropriate ICT role. This metric then shows the number of additional training days for each business role. Only these graduates that have distance less than 60 training days are acceptable for business positions.

Note: "1 credit = 1 intensive training day" comparison ratio was used. This relation was set up after long discussions with ICT managers and experts from businesses. Six ECST credits are represented by 52 direct teaching hours in thirteen weeks semester. It represents 8.7 teaching hours on 1 ECTS credit. We spend approximately 0.7 hour per credit of teaching time for organizing course and for public holidays in Czech conditions.

Both of surveys were realized by the research team of the University of Economics in Prague. Although the survey was realized as census the structures of responses were different. We have identified reasons as follows: new study fields were newly established and some of existing study fields was dissolved and not all of appealed universities sent to us filled up questionnaires.

3.6 Data processing

In relation to the further performed statistical analysis of the answers of the respondents in the survey, we evaluated the variables mainly by the statistical method of the median. We employed the technique of box plots (for sampling distributions) and scatter plots (for medians) to compare the differences in the individual professional roles and differences in knowledge categories.

The data obtained from respondents were processed by the methods and instruments of cluster analysis with support from the instruments of the MS SQL Server 2008 R/2 platform. In the context of the principles of cluster analysis, it should be added that we used EM (Expectation-Maximization) algorithms (Bilmes, 1998; MacLennan et al., 2009).

4 Results

4.1 Business Units

Data characteristics

There were analyzed 1425 companies` answers from 1011 companies in the Czech Republic which were selected according to the structure of the market in the Czech Republic. Descriptive statistics of the data collected from companies are presented in Table 7. Each of selected companies can provide answers to 0-7 ISC roles.

Knowledge is required on level 3 in majority of ICT knowledge domain. Exception is created by knowledge domain IS/ICT knowledge and Operational excellence which are on the level 4 (3.5).

We have found different result in non-ICT knowledge domains. There are only three knowledge domains (MS09 Team leadership skills, MS10 ICT market knowledge and MS16 Knowledge in business sectors) required on the level 3 and other non-ICT knowledge domains are required on level 2.

Knowledge requirements

The following Table 8 presents business requirements on the defined ICT roles. This table describes in higher detail previous Table 7. Data in following table are based on the median of knowledge required for defined role by all analyzed companies.

We can say that in general companies requires ICT knowledge at least on the level 3 and in selected roles also on the level 4 (especially for the role Enterprise Architect). From our point of view are interesting results for role Lecturer whose knowledge are required on the level 3 and in knowledge domains MS03 Management IS/ICT and MS05 Software engineering only on the level 2.

On contrary the highest requirements are demanded of the role Enterprise architect. All knowledge domains are required on the level 4 and only knowledge domain MS06 Data and information engineering is required on the level 3.

Similar results as in Table 8 are displayed in the Table 9. Table 9 describes business requirements on defined roles but in additional training days which have to be invested into the new employee without any knowledge in the knowledge domain (previous Table 8 was based on required level of knowledge).

4.2 Universities

Data characteristics

There were analyzed data from study programs and specializations (196) with general orientation on informatics in the Czech Republic. Descriptive statistics of the data collected from universities are presented in Table 10.

Bachelor Level of Education

Some results of our survey (2010) in area of knowledge and skills that offers main education stream ICT are presented on different level of university graduates in ICT related study programs. The first part of our survey was focused on bachelor study level. Knowledge profiles of bachelor segment are shown on Figure 2.

There were identified following results for Bachelor graduates on the Czech universities – Figure 2. Data were split by clustering method in four clusters. The Bc-A11 cluster offers good knowledge in software engineering, data and information engineering and ICT knowledge. Graduates in this cluster are specialized for entering labor market immediately in business roles Administrator, Analyst, Manager ICT and Lector (Table 11). Bc-B11 cluster is one of the weakest

Table 7: Descriptive Statistics of Collected Data (Companies Aggregated)

	n = 1425								
	Avg.	**Med.**	**Mod.**	**Max.**	**Min.**	**σ**	**σ^2**	**δ**	**τ**
MS01 Process modeling	2.64	3.00	3.00	5.00	0.00	1.40	1.96	-0.14	-0.81
MS02 Functionality and customization	2.96	3.00	3.00	5.00	0.00	1.22	1.48	-0.49	-0.23
MS03 Management IS/ICT	2.94	3.00	3.00	5.00	0.00	1.32	1.73	-0.35	-0.45
MS04 Analysis and design	3.02	3.00	4.00	5.00	0.00	1.30	1.68	-0.53	-0.24
MS05 Software engineering	2.71	3.00	3.00	5.00	0.00	1.32	1.74	-0.32	-0.61
MS06 Data and information engineering	2.94	3.00	3.00	5.00	0.00	1.20	1.44	-0.21	-0.26
MS07 IS/ICT knowledge	3.49	4.00	4.00	5.00	0.00	1.12	1.26	-0.74	0.42
MS08 Operational excellence	3.27	3.50	4.00	5.00	0.00	1.28	1.64	-0.50	-0.49
MS09 Team leadership skills	2.74	3.00	3.00	5.00	0.00	1.37	1.86	-0.29	-0.67
MS10 ICT market knowledge	2.80	3.00	3.00	5.00	0.00	1.26	1.60	-0.26	-0.47
MS11 Organizational management methods	2.43	2.00	3.00	5.00	0.00	1.37	1.88	-0.02	-0.87
MS12 Enterprise finance and economics	2.19	2.00	2.00	5.00	0.00	1.29	1.66	0.02	-0.56
MS13 Sales and marketing	2.06	2.00	2.00	5.00	0.00	1.28	1.64	0.11	-0.72
MS14 Mathematics	2.24	2.00	2.00	5.00	0.00	1.32	1.73	0.09	-0.69
MS15 Law	2.36	2.00	2.00	5.00	0.00	1.30	1.68	0.12	-0.72
MS16 Knowledge in business sectors	2.95	3.00	3.00	5.00	0.00	1.37	1.87	-0.35	-0.60

Table 8: Business Requirements in Levels of Knowledge - Median

Knowledge domain/Business role	**Developer**	**Administrator**	**Lecturer**	**Sales**	**Manager**	**Business Analyst**	**Enterprise Architect**
MS01 Process modeling	3	2	3	3	3	3	4
MS02 Functionality and customization	3	3	3	3	3	3	4
MS03 Management IS/ICT	3	3	2	3	3	3	4
MS04 Analysis and design	4	3	3	3	3	3	4
MS05 Software engineering	4	3	2	2	3	3	4
MS06 Data and information engineering	4	3	3	3	3	3	3
MS07 IS/ICT knowledge	4	4	3	3	4	3	4
MS08 Operational excellence	3	3	3	3	4	3	4
MS09 Team leadership skills	3	3	3	3	3	3	3
MS10 ICT market knowledge	3	3	2	4	3	3	3
MS11 Organizational management methods	2	2	3	3	3	3	3
MS12 Enterprise finance and economics	2	2	2	3	3	3	3
MS13 Sales and marketing	2	2	2	4	2	2	3
MS14 Mathematics	3	2	2	2	2	3	3
MS15 Law	2	2	2	3	2	2	3
MS16 Knowledge in business sectors	3	3	3	4	3	3	4

Table 9: Business Requirements in Training Days

Knowledge domain/Business role	Developer	Adminis-trator	Lecturer	Sales	Manager	Business Analyst	Enterprise Architect
MS01 Process modeling	13	4	13	13	13	13	31
MS02 Functionality and customization	13	13	13	13	13	13	31
MS03 Management IS/ICT	13	13	13	13	13	13	31
MS04 Analysis and design	31	13	13	13	13	13	31
MS05 Software engineering	31	13	4	4	13	13	31
MS06 Data and information engineering	31	13	13	13	13	13	13
MS07 IS/ICT knowledge	31	31	13	13	31	13	31
MS08 Operational excellence	13	13	13	13	31	13	31
MS09 Team leadership skills	13	13	13	13	13	13	13
MS10 ICT market knowledge	13	13	4	31	13	13	13
MS11 Organizational management methods	4	4	13	13	13	13	13
MS12 Enterprise finance and economics	4	4	4	13	13	13	13
MS13 Sales and marketing	4	4	4	31	4	4	13
MS14 Mathematics	14	4	4	4	4	13	13
MS15 Law	4	4	4	13	4	4	13
MS16 Knowledge in business sectors	14	13	13	31	13	13	31

Table 10: Descriptive Statistics of Collected Data (Bachelor and Master Study Programs Aggregated)

Knowledge Domain	n = 196							
	Avg.	Med.	Mod.	Max.	Min.	σ	$σ^2$	δ
MS01 Process modeling	1.62	2	3	0	1.31	1.71	-0.282	-1.687
MS02 Functionality and customization	1.45	2	3	0	1.46	1.69	0.047	-1.993
MS03 Management IS/ICT	1.80	2	4	0	1.34	1.74	-0.390	-1.432
MS04 Analysis and design	1.82	2	3	0	1.36	1.73	-0.506	-1.616
MS05 Software engineering	2.75	3	5	0	1.52	2.58	-0.887	-0.519
MS06 Data and information engineering	2.80	3	5	0	1.68	2.47	-0.675	-0.828
MS07 IS/ICT knowledge	3.38	3	5	0	1.57	2.73	-0.921	0.273
MS08 Operational excellence	1.92	3	4	0	1.38	1.92	-0.551	-1.543
MS09 Team leadership skills	1.88	3	4	0	1.45	1.91	-0,411	-1.614
MS10 ICT market knowledge	1.51	1	3	0	1.39	1.56	0.019	-1.899
MS11 Organizational management methods	1.40	2	4	0	1.41	1.75	0.142	-1.806
MS12 Enterprise finance and economics	2.32	2	5	0	1.71	2.45	0.014	-1.101
MS13 Sales and marketing	1.22	2	3	0	1.26	1.27	0.212	-1.704
MS14 Mathematics	3.05	3	5	0	1.66	2.63	-0.770	-0.316
MS15 Law	1.80	2	3	0	1.11	1.29	-0.517	-1.049
MS16 Knowledge in business sectors	0.25	0	2	0	0.66	0.50	2.349	3.630

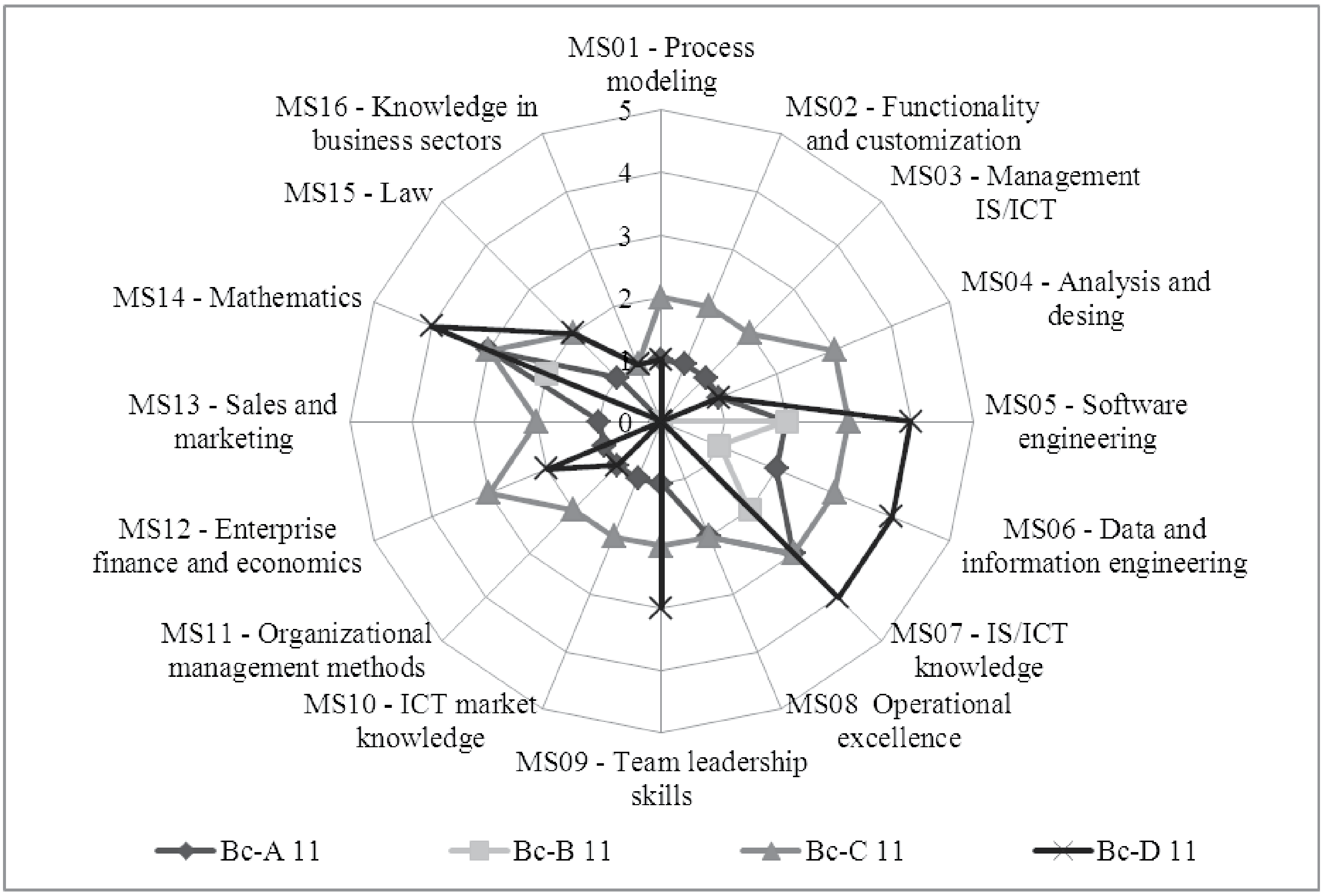

Figure 2: Bachelor Studies Knowledge Profiles, Obligatory and Optionally Courses (Source: authors)

clusters with accent on ICT knowledge, data and information engineering and mathematics. Other skills and knowledge are missing in the scope of education process. Knowledge of this cluster does not offer knowledge for any business role (Table 11). Optionally courses do not help to change this fact (Table 12). Bc-C11 cluster offers complex common education in area of business informatics without strong specialization. Graduates of this cluster could be linked with business roles Administrator, Analyst, Developer, Manager ICT and Lector (Table 11). Optionally courses add to this role position Dealer (Table 12). Cluster Bc-D11 offers very good education in mathematics and its topic seems to be in software, data and information engineering and ICT knowledge. Graduates of this sector fit very well to business requirements on roles Administrator, Analyst, and Lector (Table 11). Subscribing optionally course enlarge their acceptance for other business roles – Developer and Manager (Table 12).

Optionally courses offer enlargement of ICT knowledge profile. Differences caused by additional optionally courses are visible as differences between appropriate cells in Table 8 and Table 12.

Master and Bachelor Level of Education - Aggregated

There are presented (Figure 3) results of analysis of aggregated knowledge in bachelor and in consequential master study programs (Mgr5) in this chapter. The majority of bachelors continue to master study programs at in the Czech Republic the same faculty, therefore such aggregation is relevant in this context.

There were identified four clusters in this segment of ICT related study programs graduates. Cluster Mgr-5A 11 produces graduates with basic skills in knowledge domains –MS01 Process modeling, MS02 Functionality and customization, MS03 Management IS/ICT, MS08 Operational Excellence, MS09 Team leadership skills, MS11 Organizational management methods and MS13 Sales and marketing., Good orientation and basic practical skills are taught in following knowledge domains – MS04 Analysis and design, MS05 Software engineering, MS10 ICT market knowledge, MS12 Enterprise finance and economics and MS15 Law. Knowledge domains MS06 Data and information engineering, MS07 IS/ICT knowledge and MS14 Mathematics provide knowledge on other highest knowledge levels. Cluster Mgr5-B 11 offers very little of ICT oriented knowledge to its graduates. Basic knowledge is taught in domain MS07 IS/ICT knowledge, MS05 Software engineering, MS06 Data and information engineering and MS14 Mathematics. There are not covered by taught knowledge other domains in this cluster. Graduates of this cluster do not fit to any of identified roles (Table 13) and work hypothesis is that they are leaving tertiary education either on position programmer or they are enter the working process as qualified ICT users and optionally courses do

Table 11: Bachelor Knowledge Profiles – Obligatory Knowledge (The bold written values are acceptable for business practice)

Cluster	Administrator	Analyst	Architect	Dealer	Developer	Manager	Lector
Bc-A 11	**43**	**41**	148	89	77	**63**	**35**
Bc-B 11	80	79	194	127	122	104	70
Bc-C 11	**34**	**27**	129	70	**65**	**51**	**24**
Bc-D 11	**47**	**55**	164	104	80	**70**	**47**

Table 12: Bachelor Knowledge Profiles – Obligatory and Optionally Knowledge (The bold written values are acceptable for business practice)

Cluster	Administrator	Analyst	Architect	Dealer	Developer	Manager	Lector
Bc-A 11	**37**	**36**	139	83	67	**56**	**31**
Bc-B 11	76	79	190	127	118	100	70
Bc-C 11	**23**	**17**	110	**59**	**50**	**39**	**15**
Bc-D 11	**36**	**43**	140	93	**58**	**58**	**38**

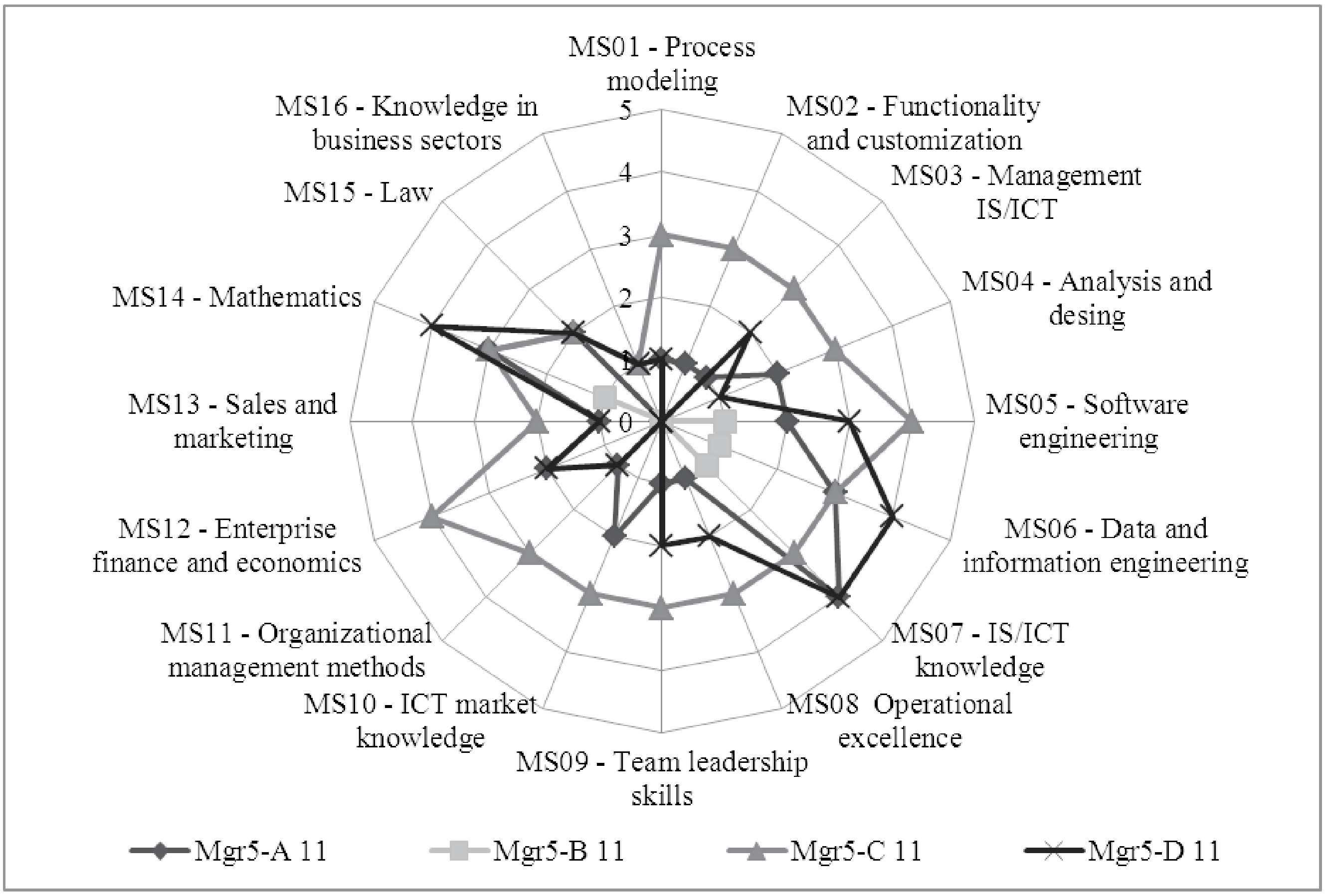

Figure 3: Bachelor and Master Studies Knowledge Profiles, Obligatory and Optionally Courses (Source: authors)

not help them get enough knowledge for ICT business roles (Table 13). Graduates of the cluster Mgr5-C 11 can get very good education in business informatics. Their knowledge profile is based on good orientation and basic practical skills in domains MS01 Process modeling, MS02 Functionality and customization, MS03 Management IS/ICT, MS04 Analysis and design, MS06 Data and information engineering, MS07 IS/ICT knowledge, MS08 Operational excellence, MS09 Team leadership skills, MS10 ICT market knowledge, MS11 Organizational management methods and MS14 Mathematics. Good orientation and good practical skills are characteristic for domains MS05 Software engineering and MS12 Enterprise finance and economics. Graduates of this cluster do fit very well to business roles Administrator, Analysts, Developer, Manager of ICT and Lector (Table 13). Optionally courses enlarge knowledge in all business roles and enrich portfolio of accepted business roles for the role of Dealer. Mgr5-D 11 graduates get basic orientation in knowledge domains MS03 Management IS/ICT, MS08 Operational excellence, MS09 Team leadership skills, MS12 Enterprise finance and economics and MS15 Law. Good orientation and good practical skills are in domains MS05 Software Engineering, MS06 Data and information engineering, MS07 IS/ICT knowledge and MS14 Mathematics. They mostly fit to business roles Administrator, Analyst and Lectors. Optionally courses enrich portfolio for business roles Developer and Manager (Table 14).

5 Conclusions

Immediate results of data evaluation of the ICT education supply side in the Czech Republic study programs are:

- ICT oriented study programs significantly differ in the level of knowledge provided to the student.
- There is no direct relationship among the specific study program and specific ICT role. Some study programs form excellent background for any of the defined ITC roles, others are not useful for any of them.
- Graduate bachelors in the Czech Republic do not have sufficient knowledge spectrum to enter into business on leading positions without additional training. They are too “expensive” for further education in companies. It also depicts the situation in the Czech Republic, where only about one third of ICT graduates *do not continue* with the Master studies. Bachelor study programs are then formulated not as standalone, but rather as prerequisites for the Master studies.
- There are not enough relevant students and graduates with required ICT knowledge profiles in the Czech Republic. Especially roles as *Information System Architect* (similar conclusions are mentioned in (Gala and Jandos, 2010)) and *Dealer - Business Person in ICT Products and Services* are not covered by the actual ICT education system in Czech Republic.
- There are significant differences in answers we receive from companies and universities. Companies in general require knowledge on lower level in year 2011 than in year 2006. Universities in general provides the same level of knowledge in both surveys but these knowledge is provided in better structure in the relation to requirement of business companies (in detail for example: (Maryska et al, 2012)).
- Differences in answers for university ICT oriented study programs in 2005 and 2011 are presented in Table 15. Changes are presented with arrows in the last column of the table.

Table 13: Bachelor and Master Aggregated Knowledge Profiles – Obligatory Knowledge (The bold written values are acceptable for business practice)

Cluster	Administrator	Analyst	Architect	Dealer	Developer	Manager	Lector
Mgr5-A 11	**48**	**51**	158	99	85	70	**45**
Mgr5-B 11	90	87	211	133	139	114	76
Mgr5-C 11	**26**	**20**	116	67	**46**	**43**	**17**
Mgr5-D 11	**46**	**54**	158	102	78	**64**	**45**

Table 14: Bachelor and Master Aggregated Knowledge Profiles – Obligatory and Optionally Knowledge (The bold written values are acceptable for business practice)

Cluster	Administrator	Analyst	Architect	Dealer	Developer	Manager	Lector
Mgr5-A 11	**36**	**38**	141	82	71	**56**	**34**
Mgr5-B 11	90	87	211	133	139	114	76
Mgr5-C 11	**13**	**9**	76	**50**	**22**	**23**	**8**
Mgr5-D 11	**31**	**37**	129	88	**51**	**47**	**33**

Table 15: Comparison Bachelor and Master Aggregated Studies – Obligatory and Optionally Knowledge - Median

Knowledge domain	Mgr 5 - 2005	Mgr 5 - 2011	Change
MS01 Process modeling	3	2	↓
MS02 Functionality and customization	2	2	→
MS03 Management IS/ICT	2	2	→
MS04 Analysis and design	3	2	↓
MS05 Software engineering	3	3	→
MS06 Data and information engineering	3	3	→
MS07 IS/ICT knowledge	3	3	→
MS08 Operational excellence	2	3	↑
MS09 Team leadership skills	2	3	↑
MS10 ICT market knowledge	0	2	↑
MS11 Organizational management methods	2	2	→
MS11 Organizational management methods	1	2	↑
MS12 Enterprise finance and economics	1	2	↑
MS13 Sales and marketing	3	3	→
MS14 Mathematics	2	2	→
MS15 Law	0	0	→

- When we compare our results for example with results presented in study (Varga et al., 2004) we see that the level of required knowledge is different in Czech Republic and in Croatia. For example, knowledge domain relevant to MS04 Analysis and design is more important in Croatia. The Czech results present that this domain has lower importance than other ICT knowledge domain.
- Other special Czech aspect is represented by business requirements on domain MS14 Mathematics. Knowledge of mathematics is held as ability and skill to apply logical thinking on problem identification and on problem solving. That is why mathematics skills are required in so high level in Czech conditions. Other surveys (for example at Curtin University of Technology – Cajander et al., 2010) present requirements on thinking skills and ability to apply discipline knowledge.

The lack of well-educated ICT professionals in economies is the main problem of ICT improvement into global society and into corporations as well. Low number of ICT experts in Czech economy cause lower innovation activities in this region in the comparison to USA, Japan and Canada. How to remove this disadvantage of Czech? Increase investments into schooling start to prepare new oriented ICT related study programs focused on required ICT business roles in order to remove the gap between supply and demand on the ICT specialist's labor market.

Secondary contributions of this project to ICT education development:

- Building up the network between businesses oriented experts, universities and middle schools in order to coordinate the education of ICT in the country.
- Setting up of the methodology for evaluation of competitiveness of ICT related study programs across the country and possibility their evaluation to business requirements.
- Evaluation of this methodology by practical surveys.
- Identification of gaps in ICT education system – missing courses and study programs for education for some business roles (for example IS Architect).
- Open issues:
  - investigation of macroeconomics characteristics of the ICT sector impact on the economy (some fact are presented for example in (Doucek et al., 2011a),
  - to analyze all in project described parameters in time scale (data series analysis).

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Petr Doucek heads the Department of System Analysis at University of Economics, Prague since 2007. His main topics in research and development work focus on information management, IS/ICT security management, project management and impacts of information society on economics and human.

Lea Nedomová graduated the Natural Science Faculty at the Charles University, Prague in Pedagogy of Chemistry and Biology in 1992. She has been working as assistant professor of the Department of System Analysis at the Faculty of Informatics and Statistics at the University of Economics, Prague since 1996. Her main research and development topics include system approach to global society and sustainable development and its relation integrated management system - quality management, environmental management and sustainability.

Miloš Maryška has graduated at the Faculty of Informatics and Statistics at the University of Economic, Prague, in Information Technologies in 2006. In year 2010 has graduated in Applied Information Technologies and gained degree Ph.D. Since 2010 he has been working as a senior lecturer at the Department of Information Technologies at the Faculty of Informatics and Statistics at the University of Economics, Prague. Within his pedagogic and research work he focuses on management of economics of business informatics, Business Intelligence and ERP systems. He is co-author of 5 books, and author and co-author of several conference papers and in journal articles. In the company Lodestone Management Consultants works as a senior consultant and a team leader.

Razlike med povpraševanjem in dejanskim znanjem informatikov na trgu dela v Češki republiki

Globalne spremembe v informacijski družbi vse bolj vplivajo na zaposlene na vseh področjih človekove dejavnosti, še posebej na področju informacijske in komunikacijske tehnologije (IKT). Članek predstavi metodologijo kako meriti raven zahtevanega znanja in spretnosti informatikov na področju IKT in na drugih zahtevanih področjih, in znanja diplomiranih diplomantov na čeških univerzah. Predstavljeno je tudi zbiranje ustreznih podatkov na univerzah in v podjetjih. Ugotovitve raziskave se koristno uporabljajo v kadrovskem managementu in managementu IKT kompetenc informatikov majhnih in srednje velikih podjetjih v Češki republiki.

Ključne besede: Informacijska in komunikacijska tehnologija (IKT), človeški viri, izobraževanje, kompetence, mala in srednja podjetja

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Quantitative Model for Economic Analyses of Information Security Investment in an Enterprise Information System

Rok Bojanc[1], **Borka Jerman-Blažič**[2]

[1]ZZI, Pot k sejmišču 33, 1231 Ljubljana-Črnuče, Slovenia, rok@bojanc.com
[2]Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia, borka@e5.ijs.si

The paper presents a mathematical model for the optimal security-technology investment evaluation and decision-making processes based on the quantitative analysis of security risks and digital asset assessments in an enterprise. The model makes use of the quantitative analysis of different security measures that counteract individual risks by identifying the information system processes in an enterprise and the potential threats. The model comprises the target security levels for all identified business processes and the probability of a security accident together with the possible loss the enterprise may suffer. The selection of security technology is based on the efficiency of selected security measures. Economic metrics are applied for the efficiency assessment and comparative analysis of different protection technologies. Unlike the existing models for evaluation of the security investment, the proposed model allows direct comparison and quantitative assessment of different security measures. The model allows deep analyses and computations providing quantitative assessments of different options for investments, which translate into recommendations facilitating the selection of the best solution and the decision-making thereof. The model was tested using empirical examples with data from real business environment.

Keywords: Modelling, Security Technology, Economic metrics, Investment, Enterprise Information System

1 Introduction

The Internet is a public space in which reliability and safety of e-business and e-commerce operations is guaranteed by the infrastructure security for operators, and the software and data security for the authorized users and owners. As a consequence, the individual, corporate and government assets are taking an increasingly dematerialized form, as the storage of digital data is becoming equivalent to the productivity gains in all respects. The volume of data and information doubles each year, while the value of the corporate and government assets is increasingly derived from or encapsulated in this digital, cultural and industrial asset base. Introduction of the concept of digital assets opened up a rift with much wider implications than those of the general information management; namely, it includes the intellectual property rights management (IPR), digital rights management (DRM), copyrights and online sharing of information.

A significant portion of new companies own almost exclusively intangible industrial assets (databases, computing programs, manufacturing processes, logistic process design, other business secrets, and IPR assets), which are overtaking in importance the real estate and other tangible assets. The security objectives related to the digital-asset base are expressed in terms of confidentiality (non-disclosure to unauthorized persons), integrity (non-alternation of content), and availability (the ability of authorized users to access and use these assets without being hindered by unintentional or malicious acts). Despite the architectures deployed to ensure greater reliability and service connectivity, and despite the anti-piracy measures undertaken to protect sensitive data, it is clear that computer systems regularly fail or are subject to malicious attacks.

Architectural security of the Internet network and data security (software and data) still present the key challenges for the future Internet design. The digital world is open to all, which means that security has to be provided by the underlying architecture; nevertheless, the socio-economic environment needs to be taken in account as well.

Almost a decade ago, a number of researchers began to realize that information security is not a problem that could be resolved by technology alone; thus, they tried to include

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the economic point of view into the equation. This approach enables business managers to develop better understanding of security investments, because technical analysis of implications of security failures was replaced by an analysis of economic losses (Acquisti et al., 2006). This is the reason why security- aware organizations are shifting the focus from what is technically feasible to what is economically optimal in terms of the prevention of potential failures (Schneier, 2004; Anderson, 2001; Anderson and Schneier, 2005).

When looking at the information security system from the economics point of view, many answers can be found to the questions where strictly technical explanations fail to give satisfying answers (Gordon and Loeb, 2002). How to provide security for the IT-based operations? Which security level is adequate? How much money should be invested in security? Companies mainly seek answers to these questions in the framework of risk management.

Information security risk management is the overall process which integrates identification and analysis of risks to which an organization is exposed, assessment of the potential impact on the business, and decision regarding the action to be taken to eliminate or reduce the risk to an acceptable level (NIST, 2004; 2005). It requires a comprehensive identification and evaluation of the organization's digital assets, consequences of security incidents, and likelihood of successful attacks on the systems exposed to the digital world, as well the cost and benefit analysis of the security investments (Hoo, 2000). Risk management process typically consists of two main stages known as risk assessment and risk treatment. Risk assessment is the process of deciding whether existing protection is sufficient to protect information assets against possible threats. The assessment provides information about the threats to which organization assets are exposed and information system vulnerabilities that could be abused by the threats. Risk treatment is a process of selection and implementation of security measures to reduce risk. The treatment usually consists of risk avoidance, risk mitigation, risk transfer and risk acceptance. Standards and guidelines are available for the information security management, such as the ISO 27000 series and NIST publications (ISO, 2005). However, the advancements in the field of technology require more sophisticated decision-making approaches when it comes to for the security technology investments, and data and digital asset protection (Gordon and Richardson, 2004).

This paper presents a mathematical model for the security technology investment evaluation and optimal decision-making, based on the quantitative analysis of the security risks and digital asset assessments. The novelty of the model is in the use of the results of a quantitative analysis of different security measures that counteract individual risks within the information processing in a particular organization. The risk is identified with the analysis of the potential threats. The selection of security technology is based on the efficiency of the security measures and the related cost. Economic indicators are used for the efficiency assessment of the measures. Measures are compared and most appropriate protection technology is selected. The model is presented as a procedure that provides overall assessment of all possible security measures that reduce the risk in a particular organization with identified vulnerabilities in the information processing, related asset values and the available protection technology. The advantage of the model is in the completeness of the considered security measures that encompasses not only the protection technology but also organizational approaches, insurance possibilities or outsourcing solutions. The model provides good guide lance for practical use. The usability of the model is illustrated with several examples of possible security incidents and the selected measures.

2 Related research

Information security was traditionally considered as a technical discipline, whose purpose was to provide the maximum level of security (McGraw, 2006). In the last decade, a major economic component was considered in the related research as investments in information security are rapidly increasing (Anderson, 2001). Information security economics, a relatively new field of study, uses economic theory and models (Bojanc and Jerman-Blažič, 2007) to analyse incentives between the involved stakeholders. Cavusoglu (2004) argues that information security should be viewed not just as a cost, but as a value creator that supports and enables e-business operations. Cavusoglu (2004) claims that a secure environment for information and transaction flows can create value for companies and their partners. An analysis of investments in information security requires quantification of costs and benefits of the investments in a comparable way. The cost of an investment includes the price of the required hardware, software and labour (among others); however, it is more difficult to quantify the benefits. At the same time, it is important that the investment value is not higher than the value of the protected asset. Estimation of the total cost of security breaches can be done in several ways. Some approaches try to quantify short-term and long-term costs, or tangible and intangible costs, while other methods use the market efficiency theory and capital market valuation of companies to quantify the costs (Bojanc and Jerman-Blažič, 2008). The loss in market value in the days surrounding the announcement of the accident is just an approximate value of the true cost of the security breach (Farahmand, 2003). Farahmand (2003) suggest a simple probability-based model for the valuation of possible attacks. The probability assessment for each incident is subjective, grading the identified threats on a five-step scale - from very low to very high probability, and assigning the probabilities to the various steps on the scale. The approach is semi-quantitative, because it uses the qualitative approach to obtain quantitative probability estimates.

Calculation of optimal investment in information security is relatively new approach in the area of enterprise information technology. The focus regarding IT security solutions was previously oriented exclusively on search of technical tools and methods, without any consideration of the financial costs. In the last ten years few approaches for solving the problem were proposed. The proposed analytical models are based on a cost-benefit analysis. The potential risk of security incidents is considered in relation to the likelihood they to happen and the potential damage. One of the first analytical decision-making frameworks for evaluating different IT security policies was proposed by Hoo (2000). In his work he is replicating the group of protective measures or policies, and for each policy is trying to find the best compromise between costs and benefits. Gordon and Loeb (2001) propose an economic model that determines the optimal amount to invest in information security by calculating the marginal benefits of information security investments. An organization should only invest up to the point where the marginal benefits of the investment equal the marginal costs. Whenever the marginal benefit is larger than the marginal cost, the investment should be increased. Willemson (2006) emphasizes that the suggested upper limit of the model may not be correct when the model is applied to the general case and to all possible vulnerability functions. Ryan and Ryan (2006) view security as an inversion of the risk and establish a quantitative approach to measure the gains in security through the expected-loss-risk measurements. The approach to base their investment decision on expected loss is suggested by Gordon and Loeb (2002), and the rule of thumb is that a positive expected net benefit is an attractive investment. The approach is based on the ability to obtain probability distributions for information security failures. It uses survivor and failure functions, but since available data are censored and therefore biased, the quality of results is questionable. For this reason, Ryan and Ryan (2006) introduce the Kaplan-Meier and Nelson-Aalen estimators that can be used instead. The basic assumption is that an investment in security reduces the risk of successful attacks. The advantage of an investment is measured as the difference between the expected losses in the investment or no-investment scenario. Based on these findings, Bojanc, Jerman-Blažič and Tekavčič (2012) presented a general mathematical model for quantitative evaluation of investments in a variety of security measures and the selection of the optimal security solutions. An alternative method uses the so-called game theory (Cavusoglu, 2004). Cavusoglu argues that the traditional decision-analytic approaches to evaluating IT security investments treat the security technology as a black box and do not consider the difference between the investments in information security solutions from general IT investments. He is treating the information security as a game between organization and the potential attackers with a motive to cause damage for personal profit or satisfaction. McGraw`s (2006) view on software security is based on 'the idea of engineering software that continues to function correctly under malicious attacks.' In order to solve the problem of software security, McGraw (2006) proposes three pillars: (1) applied risk management, (2) software security touchpoints (best practices into the software development life-cycle) and (3) knowledge. He also argues that an ICT system is usually built on the assumption that the system would not be intentionally abused, resulting in the cases of use that describe the system's normative behaviour, predicated on the assumption of the correct usage. The past breaches of information security have resulted in both immediate and indirect losses. Indirect losses have often been more serious than the direct ones. The optimal level of information security investments is treated on the basis of the expected cost/benefit investment trade-offs.

In this work we focus on the more exact quantification of the security risks and on the digital asset assessments required for optimal selection of the security technology investment. The security measures that counteract individual risks are quantified in the context of their application within the information processes that take place within an organization. The target security levels for all identified business processes are quantified, as well as the probability of a security accident together with the expected loss. The model is applied on several examples of possible security incidents and illustrated with the results based on simulations.

3 Quantitative risk assessment

The objective of risk assessment is the identification and measurement of risk in order to obtain relevant information for decision-making process. Risk assessment requires information about the information assets within an organization, the threats to which assets are exposed and system vulnerabilities that threats could abused. The model is based on *business processes P* that are supported by *information assets a*. The risk assessment procedure determines and evaluates the vulnerabilities and the threats for every information asset. The risk assessment output data is the *security risk R* defined as a product of the estimated probability of occurrence of a security incident ρ and the loss due to a security incident L:

$$R = \rho \cdot L \quad (1)$$

Information security incident is defined as single event or a series of unwanted or unexpected information security events with a probability of compromising the business operations. There are different kinds of security incidents. Some incidents result in abuse of confidentiality, such as the disclosure of bank accounts. Incidents can also related in abuse of integrity, such as malicious deletion or modification of the business data. Other incidents may abuse the service availability and they are known as Denial-of-Service (DoS) attacks. *Probability of a security incident occurrence* ρ ($0 \leq \rho \leq 1$) depends on the probability T of a threat occurring, and the vulnerability v, defined in the model as the probability that a threat once realized (i.e., an attack) would be successful (Gordon and Loeb, 2002).

$$\rho = T \cdot v \quad (2)$$

Threat can be defined as a potential cause of undesired incidents that may cause damage to the system or organization (ISO 27000, 2009). *Threat probability* T ($0 \leq T \leq 1$) is defined as a probability of an attack occurrence on information assets. Some of threats can be successful, resulting in a security incident, while others are not successful. The potential for a success is measured with the probability parameter.

Information assets have vulnerabilities that threats could exploit. Vulnerability can be defined as a weakness of an asset or control that can be exploited by a threat (ISO 27000, 2009). Vulnerability can also be seen as increasing the likelihood of a successful attack on the system. For example, leaving a laptop in an unlocked office, instead of in a locked office, significantly increases the vulnerability of the notebook to a theft. Vulnerability by itself does not cause loss, vulnerability is just a condition (or set of conditions) that can allow a threat to impact on information assets. In our model the *vulnerability* v $(0 \leq v \leq 1)$ is defined as the probability a threat to be successfully realized as incident on an information asset. The effectiveness of threat is determined with the level of the vulnerability of an information asset. Limit value $v=0$ indicates that the information assets are completely protected and secured, while $v=1$ means the information assets are totally vulnerable.

Function ρ in equation (2) fulfils two basic boundary conditions. Incident probability has zero value when there are no attacks (attack probability is zero), and probability of a security incident is zero when the system is free of vulnerabilities (vulnerability is zero).

In case of a security incident, an organization suffers *financial loss L*. The loss $L>0$ is measured in monetary units (e.g., in euro). The true financial loss of a security incident is difficult to assess. It is relatively easy to calculate the immediate direct loss due to an incident. This represents losses of revenue, losses of productivity and increased costs. Much more difficult is assessment of indirect loss that is sometimes higher than the immediate loss and can also have a much longer negative impact on the customer base, the supplier partners, financial market, banks and business alliance relationships. The quantitative evaluation of loss can be supported through the allocation of losses to individual factors and separately calculate the loss of each factor:

$$L = L_s + L_r(t) + L_i(t) + L_p(t) + L_{SLA} + L_{indirect} \qquad (3)$$

Detailed definitions and mathematical derivation of the individual factors in equation (3) is explained in details in Bojanc, Jerman-Blažič and Tekavčič (2012).

Cost of equipment replacement L_s is the price of new equipment. These types of losses are the easiest ones to evaluate, since the data are usually available or relatively easy to obtain. The cost of repair works in cases of equipment failure can be significantly reduced by investments into guarantees issued by producers or maintenance service providers.

Cost of repair works $L_r(t)$ is the price of repair works of employees or external contractors, to eliminate the consequences of the security incident and restore system or service in normal operation

Corporate *income loss* $L_i(t)$ represents the loss suffered on the revenue side due to system or service failure as a result of the incident.

Organization *productivity loss* $L_p(t)$ is evaluated as reduced business productivity due to system or service failure.

Loss due to non-compliance with statutory provisions or contractual obligations is denoted as L_{SLA}. Its value depends on a contract and/or legislation. For example, the service provider offers their customers a particular service according signed in the Service Level Agreement (SLA) contract. In cases when the availability of offered services are below the limit value specified in the SLA, this represents a cost for the provider, as it must pay back some amount to customers.

Indirect losses $L_{indirect}$ with potentially long-term consequences represent damage to the reputation of the organization, the interruption of business processes, loss of intellectual property, and damage to customer confidence.

Security incident can cause downtime of the information system or services. Downtime consists from the *time to detect* t_d a security incident and *time to repair* t_r information system and restore the functionalities of a system. Time t_d is accounted for from the moment of an incident occurrence to the moment of the incident detection.

The equation (3) can be simplified by grouping the items in three factors. The first factor depends on t_r, the second factor depends on t_d and third factor which is not time dependent (Bojanc, Jerman-Blažič and Tekavčič, 2012). Individual factors in the equation (3) may contain either t_r, t_d or both. The factors L_r, L_p and L_i contain time parameter t_r, the factors L_i and L_p contain time parameter t_d, while factors L_s, L_{SLA} and $L_{indirect}$ have no time dependence. Considering that, the equation (3) can be rewritten by taking in account the dependence of the time parameter t_r and t_d:

$$L = L_1' \cdot t_r + L_2' \cdot t_d + L_3 \qquad (4)$$

Factor L_1' includes data on the L_r, L_i and L_p, factor L_2' includes data on the L_i and L_p and factor L_3 includes data on the L_s, and L_{SLA} and $L_{indirect}$. Factor L_3 is expressed in monetary units (e.g. the Euro), the factor L_1' and L_2' are expressed in monetary units per unit time (e.g. Euro / hour).

Taking into account the financial loss in equation (4) and the likelihood of an incident in equation (2) the security risk R from equation (1) may be specified as presented in equation (4).

$$R = T \cdot v \cdot \left[L_1' \cdot t_r + L_2' \cdot t_d + L_3 \right] \qquad (5)$$

The security risk R represents the expected financial loss caused by the security incident measured in the same monetary unit as L (e.g., in Euro).

4 Determination the risk treatment

There are multiple strategies available to treat each security risk. On the basis of risk assessment the organization can select one of the possible options, such as:

- *Reduction* of security risk by implementing an appropriate technologies and tools (such as firewall, antivirus systems etc.) or adopting appropriate security policies (like passwords, strong authentication tools, access control, port blocking etc.). This reduces the probability of security incident or limits the loss in case the incident happens. Reduction is primary risk management strategy.
- *Transfer* of security risk to either outsourcing security service provision bodies or insurance agency. This way of transferring the risk recently has become important strategy in provision of security measures within the organization.
- *Avoidance* of security risk by eliminating the source of risk or the asset's exposure to the risk. This is usually applied in cases when the severity of the impact of the risk outweighs the benefit that is gained from having or using particular type of assets such as full open connectivity to Internet. When engineering manager selects risk avoid-

ance, organization terminates some of its activities on the network or protects them against risk.

- *Acceptance* of security risk as a part of business operations. Risk acceptance is a reasonable strategy for risks where the cost of investment or insuring against the risk would be greater over time than the total losses sustained.

In some cases, it is difficult to determine the boundary between each treatment. For example, a firewall can be understood as risk reduction or risk avoidance. Combination of several measures is also an option; e.g. an organization first reduces risks with an investment, and then either transfers the remaining risk to an insurance agency, or assesses the remaining risk to be acceptable, thus introducing no additional measures.

Selection of appropriate risk treatment can be presented on the risk treatment diagram as probability of the incident and losses due to an incident. This is presented in Figure 1. The curves on this diagram represent the points with the same risk value. Selected risk treatment option, which reduces the risk *R*, moves the risk point to a lower risk curve. If the selected risk treatment reduces the probability of incident ρ, the risk point is moving vertically downward from point R_0 to R_1 on the diagram. However, if the chosen risk treatment reduces the loss *L*, the risk point is moving on the diagram horizontally to the left from point R_1 to R_2.

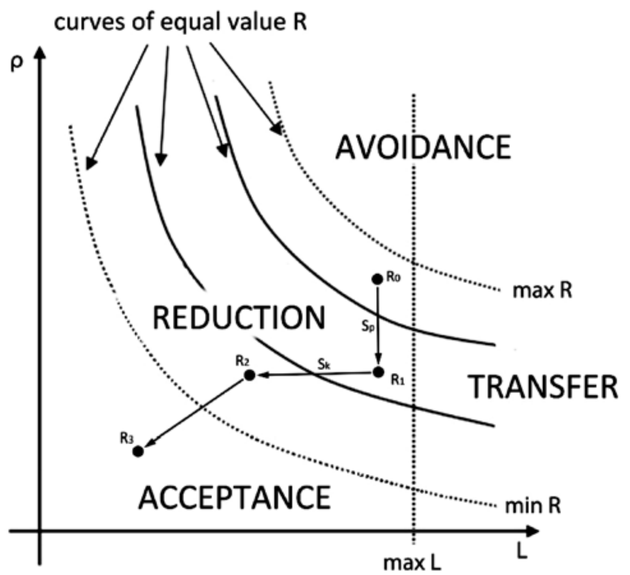

Figure 1: Risk treatment determination

Each of this risk treatment option represents certain area on the graph. It is necessary to define a *risk parameter limit values* which present the three border lines dividing area in the graph into four units, where each area correspond to a specific risk treatment option (Bojanc and Jerman-Blažič, 2008). Risk limit values are specified as follows:

- R_{max} – maximum risk value still acceptable for the organization
- L_{max} – maximum one-time loss still acceptable for the organization
- R_{min} – minimum risk value still plausible for the organization

In a risk treatment process the risk parameter values of *R* and *L* are compared to the risk limit values R_{max}, L_{max}, and R_{min}. The first border line sets the minimum risk value ($R<R_{min}$). Below this value, the risk is negligible low, so the implementation of a security measure is not financial justified and risk is accepted. The second border line is the maximum risk value ($R>R_{max}$) above which the risk is avoided. The third boundary line is the maximum single loss ($L>L_{max}$) due the incident. Schneier (2003, p. 23) goes as far as saying that serious consequences, regardless of their low frequency of occurrence, are not acceptable. Above this value the risk impact can have catastrophic consequences and recommended risk treatment option for this area is a transferring the risk. Security risk in the rest area ($L<L_{max}$) is treated by reducing risk through the investment in security measures.

5 Security measure selection

Security measures are activities, procedures or mechanisms to prevent or reduce damage caused by the realization of one or more threat. Security measures may be physical protection, diagnostic sensors, alert devices, software solutions for protection, organization policies and procedures. Many of the measures include detection, deterrence, prevention, mitigation, repair, recovery, control and awareness. Appropriate selection of security measures is essential to effective information security. Figure 2 shows how the organization protects itself against potential security attacks by implementing *security measures* that can be classified into three categories according to their impact on the risk parameters *R*, ρ and *L*:

- *Preventive security measures* s_p, which reduce the probability of a security incident ρ (e.g., firewall, antivirus protection).
- *Corrective security measures* s_c, which reduce the loss *L* in the event of an incident (e.g., maintenance contract with subcontractors, plan for continuous operations, backup data, redundant system, implementation of various standards).
- *Detective security measures* s_d, which reduce the time needed for an incident detection t_d, and enable the threat information gathering (e.g., IDS systems).

The introduction of preventive measure s_p (at Figure 1) shifts the risk point on the graph vertically downwards (from R_0 to R_1) to a lower risk curve. The corrective security measures are different from the preventive security measures reducing the incident probability as they act towards the reduction of the loss in case of a successful incident. The introduction of corrective measures s_c and detection measures s_d move the risk point horizontally on the graph to the left of the lower curve of risk (from R_1 to R_2). Detective security measures enable a detailed analysis of the security events, detect incidents, and warn against them. In case an incident is not detected by detective security controls, it can be identified through the consequences and from other footprints left behind by the malicious user or malicious code. The use of detective protection enables loss reduction and a more realistic assessment of attack probability *T*, and incident probability ρ. When companies are not using detective controls, the probability values

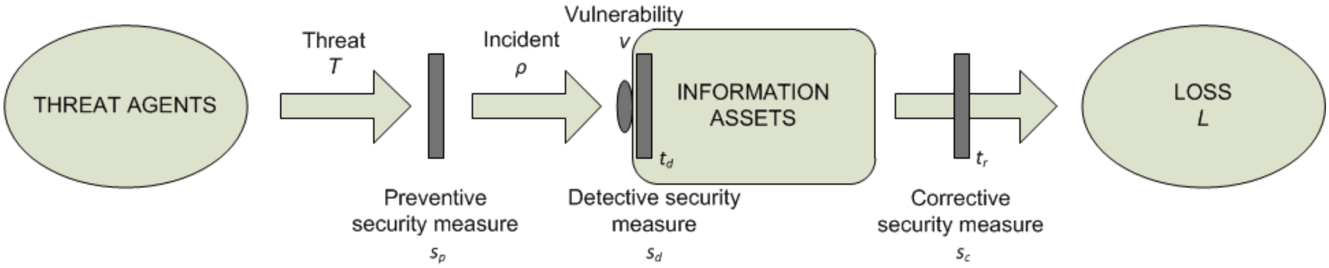

Figure 2: Integrating security measures into the model

are merely an estimate and they can differ much from realistic values. Wrong assumptions can also lead to non-optimal selection of security measures.

5.1 Security measure quantification

Each *security measure s(α, C)* is defined by two quantitative parameters productivity of measure *α* and cost of measure *C*. *Security measure productivity α(t) > 0* presents the impact of a security measure on the risk reduction. *Cost of measure C* is defined as an investment expressed in some currency (e.g., in euro). This takes in account all expenses related to the implementation of the selected security measure, expenditure in capital investment and operational costs. An example of capital investment is purchase of a new system for intrusion detection in the network, which reduce the likelihood of security intrusions in particular time period in the organizational network. Operational costs are one-time cost of implementation, testing and training, the cost of fixes and upgrades, maintenance cost and other expenses related to the introduction of a measure.

When introducing the security measures it is always necessary to consider the corporate budget for security investments C_{IT_budget}, which must be above the cost C of an individual measure ($0 \le C \le C_{IT\_budget}$). If the cost of a measure is higher the implementation of the measure is not possible. A CSI research has shown that almost half of the companies spends more than 6% overall budget resources for IT security (CSI, 2011).

Gordon and Loeb (2002) estimate that the optimal cost for the security measure is ranged from 0% to 37% of possible losses *L* due to security incidents. Other researchers have extended this estimation and find situations where it is justified that the cost of measure is up to 100% of possible losses (Willemson, 2006). These findings have been also successfully proven by empirical researches (Tanaka, Sudoh and Matsuura, 2005; Tanaka, Liu and Matsuura, 2006).

5.2 Security risk reduction

Security measures *s(α, C)* reduce security risk *R*. The introduction of preventive security measure $s_p(\alpha_p, C_p)$ reduces security incident probability ρ. Function ρ in equation (2) is supplemented in a way that introduces dependency from the *preventive security measure* investment C_p. Various incident probability ρ functions are available (Matsuura, 2009; Gordon and Loeb, 2002). In the presented model we used:

$$\rho(T, v, C_p) = T \cdot v^{\alpha_p C_p + 1} \quad (6)$$

This function fits the boundary condition that in case of an unlimited investment, the incident probability limits towards zero:

$$\lim_{C_p \to \infty} \rho(T, v, C_p) = 0 \quad (7)$$

Preventive security measure s_p reduces the incident probability; this can be described as:

$$\frac{\partial \rho}{\partial C_p} < 0, \frac{\partial^2 \rho}{\partial C_p^2} > 0 \quad (8)$$

Corrective security measures $s_c(\alpha_c, C_c)$ reduces the time to repair, consequently reducing the organization's loss caused by the incident. This is expressed by the following equation:

$$t_r = t_r^0 e^{-\alpha_c C_c} \quad (9)$$

Where t_r^0 represents the time needed to repair without the implementation of a security measure. The function t_r is declining and convex throughout the interval $0 \le C_c < C_{ITsec\_budget}$:

$$\frac{\partial t_r}{\partial C_c} < 0, \frac{\partial^2 t_r}{\partial C_c^2} > 0 \quad (10)$$

As for *detective security measures* $s_d(\alpha_d, C_d)$**,** we can say that:

$$t_d = t_d^0 e^{-\alpha_d C_d} \quad (11)$$

Function t_d is declining and convex throughout the interval $0 \le C_d < C_{ITsec\_budget}$:

$$\frac{\partial t_d}{\partial C_d} < 0, \frac{\partial^2 t_d}{\partial C_d^2} > 0 \quad (12)$$

One of the possible security measures according to the risk treatment options in chapter 4 is also the *transfer of risk to an insurance company*. In such a case, investment *C* represents a monthly premium; in case of an incident, the insurance agency pays a compensation *I* to cover the loss. Since the risk transfer only reduces the loss in the event of an incident, and has no impact on the incident probability, this is considered a special type of a corrective security measure, which is dealt with differently. $I(C) \geq 0$ parameter is added to the equation (4); this parameter represents the compensation received by the company in case of an incident. In cases where companies decide to invest into security measures other than insurance, then $I = 0$. Losses upon the occurrence of a security incident can be written as:

$$L = L_1^{'} \cdot t_r + L_2^{'} \cdot t_d + L_3 - I \quad (13)$$

Taking into account equations (9) and (11), losses incurred due to a security incident in equation (13) can be written down as:

$$L = L_1^{'} \cdot t_r^{\,0} \cdot e^{-\alpha_c C_c} + L_2^{'} \cdot t_d^{\,0} \cdot e^{-\alpha_d C_d} + L_3 - I \quad (14)$$

Cloud and hosting services is another example of the risk transfer; in case of using cloud or hosting services an organization transfers its information system (or part of its system) to the provider. In this case, the equation (3) simplifies to $L_s = 0$ and $L_r = 0$, since an organization does not invest into its own equipment. However an organization should sign an SLA with the provider, which stipulates that an organization is entitled to the compensation in case of an incident, then $I \geq 0$.

By taking in account the equations for the probability function intrusion ρ (6) and loss L (14), and the quantitative equation for security risk R from equation (5) the total risk can be now calculated as follows:

$$R = T \cdot v^{\alpha_p C_p + 1}\left[L_1^{'} \cdot t_r^{\,0} \cdot e^{-\alpha_c C_c} + L_2^{'} \cdot t_d^{\,0} \cdot e^{-\alpha_d C_d} + L_3 - I\right] \quad (15)$$

6 Return on security investment

For the assessment of economic impact of a certain security measure can be analysed with the economic indicators Return on Investment (ROI), Net Present Value (NPV), and Internal Rate of Return (IRR) which are the most often used security metrics in practice (CSI, 2011).

Return on investment (ROI) is popular accounting metric for comparison of business investments. ROI simply defines how much organization gets from the spent amount of money. Therefore ROI can help organization to decide which of the possible options gives the most value for money invested. ROI compares the investment *benefits B* and *investment cost C*. The result is investment profitability expressed in percentages; positive ROI value means that an investment is economically justified.

$$ROI = \frac{B - C}{C} \quad (16)$$

Calculation of investment cost C in information security is described in the previous section. Unlike the cost of security measure C which shall be determined relatively easily it is much harder to identify, evaluate or measure the benefits (Hoo, 2000). Security measures (e.g. firewall, antivirus and IDS systems) itself do not bring direct financial benefits that can be measured.

In general, the benefits of investment in information security are viewed as a cost savings by reducing the probability of an incident or reducing the consequences of security incidents. These benefits are normally very hard to predict accurately. The biggest problem is because it is an assessment of the cost savings related to potential events that have not yet occurred. The more successful information security is harder is to see tangible benefits. The security measure investment *benefits B* are equal to the risk reduction due to the implementation of a security measure. This can be written as the difference between risk levels before the introduction of the measure R_0 in equation (5) and the value of risk after introducing a security measure $R(C)$ in equation (15):

$$B = R_0 - R(C) \quad (17)$$

Reduced risk in equation (17) is a technical element of the benefits. Moreover, the value of the benefit is also influenced by organizational elements, therefore we add *negative consequences* δ of the security measure on business performance which decrease benefits. We expect that the higher level of security diminishes operational capacities of a system, thus impacting productivity and business performance. We also add *indirect positive effects* μ of a security measure which increase benefits in equation (17) (e.g., improved corporate image and status, references, self-esteem, interconnectivity with the existing protective elements, fulfillment of legal duties, lower insurance premium, etc.).

$$B = R_0 - R(C) - \delta + \mu \quad (18)$$

Using the equation (18) ROI in equation (16) can be written as:

$$ROI = \frac{R_0 - R(C) - \delta + \mu - C}{C} \quad (19)$$

The calculation of an example illustrates the calculation: the assessed risk of the threat of virus infection on a web server is €8.750, and after the purchase and implementation of a €1.600 worth antivirus safeguard, the reduced risk is valued at €3.400. The annual cost of maintenance and operation of the measure is €450, so the ROI in the first year is:

$$ROI = \frac{€8.750 - €3.400 - €1.600 - €450}{€1.600 + €450} = 160\% \quad (20)$$

The ROI calculation may be applied for different security measures that are presented in section 5. If the selected risk reduction strategy is an investment into a *preventive security measure* s_p, which reduces the vulnerability of the asset, the ROI equation (19) gets the following form:

$$ROI_p = \frac{T \cdot v\left(1 - v^{\alpha_p C_p}\right) \cdot L - \delta + \mu - C_p}{C_p} \quad (21)$$

In this case the loss L equals the equation (4).

If the selected risk reduction measure is to invest into a *corrective security measure* s_c, which reduces the loss, then the ROI equation (19) has the following form:

$$ROI_c = \frac{TvL_1^{'} t_r^{\,0}\left(1 - e^{-\alpha_c C_c}\right) - \delta + \mu - C_c}{C_c} \quad (22)$$

If the selected risk reduction measure is an investment into a *detective security measure* s_d, the ROI equation (19) takes the following form:

$$ROI_d = \frac{TvL_2^{'}t_d^{\ 0}\left(1-e^{-\alpha_d C_d}\right)-\delta+\mu-C_d}{C_d} \quad (23)$$

Transfer of risk to an insurance company represents a corrective security measure, because the transfer of risk to an insurance company does not reduce the incident probability; it only mitigates the consequences of an incident. Since the risk transfer to an insurance company does not represent an intervention within the system, it means that δ≈0. Cost *C* denotes a monthly premium paid to the insurance company. The equation (19) can be simplified as follows:

$$ROI_t = \frac{TvI+\mu-C}{C} \quad (24)$$

While ROI tells what percentage of return will be provided with the investment over a specified period of time, it does not tell anything about the magnitude of the project. So while a 124% return may seem attractive initially, in cases when the amount of investment is taken then the decision become easier: would the organization rather have a 124% return on a €10.000 project or a 60% return on a €300.000 investment?

In the case of long-term investments the time attribute presents a problem in calculating the ROI and managers are mainly using the financial metric *Net Present Value (NPV)* for comparing benefits and costs over different time periods. The methodology behind NPV is in discounting all anticipated benefits and costs to today's value, where all benefits and costs are expressed in a monetary unit (e.g., Euros):

$$NPV = \sum_{t=0}^{n}\frac{B_t-C_t}{(1+i)^t} \quad (25)$$

In equation (25) *i* present the discount rate and *n* present the period of time. Discount rate *i* is generally understood as the average cost of capital. Selection of the appropriate discount rate value to calculate NPV indicator is very important. NPV controls the risk with the discount rate value, the higher discount rate means a lower value of NPV. The NPV is measured in monetary terms, while an investment is economically justified when NPV is equal to or greater than zero. The essence of the NPV approach is to compare the discounted cash flows associated with the future benefits and future costs to the initial investment costs. For ease of calculation it is often assumed that the future benefits and costs, with the exception of the initial investment cost, are realized at the end of the time period.

The NPV is useful in cases when alternatives are being evaluated. For example, an organization may select between two security solutions where one costs €15.000 in advance, and the other costs yearly €5.000 for three years. Both solutions cost €15.000, but the second solution is better because organization can invest the remains money in other places for a defined time. Therefore, the real cost of the second solution is less than €15.000.

Internal return rate IRR enables the findings of the discount rate at which NPV equals zero, or in other words, the discount rate at which the present value of inflows equals the present level of outflows.

$$\sum_{t=0}^{n}\frac{B_t-C_t}{(1+IRR)^t}=0 \quad (26)$$

In the search of an optimal security measure from the economical prospective it is certainly advisable to consider the security solution with the highest ROI, NPV, and IRR. However, this is sometimes difficult to achieve since it could happen that ROI is in favour of one of the solutions, NPV of another, and IRR of a third one. In such cases other parameters have to be considered and decision has to be taken on subjective terms. Although ROI has some weaknesses compared to the NPV and IRR, ROI is still the most popular indicator in practice. According to the survey CSI (2011) 54% responders use ROI, 22% use NPV and 17% use IRR.

Another interesting result that the model offers is cost assessment for the *economical optimal investment* in security measure. For economical optimal investments, the net benefits (i.e. benefits minus costs) are at maximum. This assessment is useful when the price frame is required or when it is necessary to know how much a certain measure deviates from an optimal selection. The method for the investment cost assessment determines the biggest net benefit of a measure (difference between benefits and costs). To simplify the calculation we assume that the parameters δ and μ are linearly dependent on the cost of security measure *C*:

$$\delta = k_1 \cdot C \quad (27)$$

$$\mu = k_2 \cdot C \quad (28)$$

Since the best net benefit is looked for, the following must be true:

$$\frac{\partial(B(C)-C)}{\partial C}=0, \quad \frac{\partial^2(B(C)-C)}{\partial C^2}<0 \quad (29)$$

In reality, organizations must consider limitations of IT budget to assess the optimal investment in security measure. If the IT budget limit is above optimal investment, companies can invest up to an optimal level where the net benefits are at maximum. However, if the IT budget limit is below optimal investment, companies cannot invest to the optimum level, so the optimal value of the investment in this case is thus volume of IT budget. Calculations for the *preventive*, *corrective* and *detective security measures* are:

$$C_p^{\ *} = \begin{cases} \frac{1}{\alpha_p}\log_v\left[\frac{k_1-k_2+1}{\alpha_p \eta TvL\cdot \ln\frac{1}{v}}\right] & ,C_p^{\ *} < C_{IT\_budget} \\ C_p^{\ *} & ,C_p^{\ *} \geq C_{IT\_budget} \end{cases} \quad (30)$$

In this case the loss *L* equals the equation (4).

$$C_c^{\ *} = \begin{cases} \frac{1}{\alpha_c}\ln\left[\frac{\alpha_c \eta TvL_1^{'}t_r^0}{k_1-k_2+1}\right] & ,C_c^{\ *} < C_{IT\_budget} \\ C_c^{\ *} & ,C_c^{\ *} \geq C_{IT\_budget} \end{cases} \quad (31)$$

$$C_d^{\ *} = \begin{cases} \frac{1}{\alpha_d}\ln\left[\frac{\alpha_d \eta TvL_2^{'}t_d^0}{k_1-k_2+1}\right] & ,C_d^{\ *} < C_{IT\_budget} \\ C_d^{\ *} & ,C_d^{\ *} \geq C_{IT\_budget} \end{cases} \quad (32)$$

6.1 Selection the most favourable security measure from economic and business perspective

In the previous section we calculated the quantitative assessment of the return on security investments where we considered only the economic view of selecting the appropriate investment. In addition, companies have certain business security requirements for specific business processes. For example, from manager's perspective some information assets are more important than others and companies apply better security for these assets. It is therefore necessary to consider the business security requirements when comparing different security measures with each other and selecting the appropriate measure. In this way, the quantitative assessment of individual measures is properly weighted.

Business processes introduced in chapter 3 have certain business security requirements for the protection of data and other information relevant for a particular organization. *Business process P* of an organization and the associated set of *security requirements S(P)* are specified as the required confidentiality, integrity and availability of process *P*. The value of these variables represents the desired levels of security for individual business processes. Security parameters of *information assets an* engaged in a business process *P* are based on the business process security requirements.

$$S(a) = S(P) \tag{33}$$

If there is an *n* number of business processes, then each individual process is defined as a P_i ,(i=1,…,n). For the information assets engaged in more than one business process, the security requirements can appear with different target values. In this case, the highest security target value $S(P_i)$ is selected for *S(a)*.

$$S(a) = \max(S(P_1),...,S(P_n)) \tag{34}$$

This procedure sets the desired values of security requirements for every information asset. In this way, indicators ROI, NPV and IRR are properly weighted with business security requirements. This introduced the most favourable security measure from economic and business perspective, which combines the quantitative assessment of economically optimal security measure implementation and business security requirements:

$$ROI_{bus-eco} = S(a) \cdot ROI \tag{35}$$

$$NPV_{bus-eco} = S(a) \cdot NPV \tag{36}$$

$$IRR_{bus-eco} = S(a) \cdot IRR \tag{37}$$

The most favourable security measure from economic and business perspective is not intended for the financial evaluation purposes; it is intended for the comparative analysis of different security measures for different risks.

7 Model simulations

The examples used to illustrate the model application in real-life circumstances were prepared in cooperation with an organization working in the area of IT. These examples were used to test the implementation of the model in a real business environment. Different threats were selected; including threats, such as viruses, spam, phishing, unauthorized web page content alteration, and information service failure. Here the examples with phishing and web page content alternation are presented. An organization selected the following limit value for risk parameters:

- Maximum risk R_{max} = 725,000 €/year
- Maximum loss L_{max} = 2,900,000 €
- Minimum risk R_{min} = 23.4 €/year

7.1 Example No. 1: risk analysis of phishing

'Phishing' refers to misleading e-mails and websites, which are aimed at getting hold of users' identity. A person with malicious intent seeks to get hold of data such as passwords, credit card numbers, and other personal data. Such person tries to convince the users that they are providing them with personal information only. The following security parameters were taken:

- $v = 0.1$
- $T = 2.73 \cdot 10^{-4}$ /day
- $\rho = 2.73 \cdot 10^{-5}$/day
- t_r^0 = 16 hours
- t_{NA}^0 = 16 hours
- t_d^0 = 0 hours
- L_1' = 23.4 €/hour
- L_2' = 11.7 €/hour
- L_3 = 1000 €
- L = 1376.47 €

Security risk is estimated at:

$$R = \rho \cdot L = 2.73 \cdot 10^{-5} / day \cdot 1376.47€ = \\ = 0.0375€ / day = 13.71€ / year$$

The value of risk is such that the risk could be accepted, while another option is to reduce the risk by investing into the security measure. Assessment of the characteristics of the selected measures, productivity and measure costs for the period of 4 years are presented in Table 1.

The evaluation of each measure is presented in Table 2 and Table 3. Both measures give negative results for ROI and NPV, which coincide with the fact that the risk is acceptable for the organization due to its low level. The value of risk *R* in this example is too small and does not enable a security measure with positive result to be found. For positive ROI and NPV the costs *C* of such measure must be very small.

7.2 Example 2: risk analysis of unauthorized changes to website contents

Vulnerability of an application entails various incursions, such as SQL injection or cross-site-scripting, by way of which a user with malicious intent may alter the contents of a public website. Nevertheless, vulnerability of online applications is

Table 1: Cost assessment for phishing risk reduction measures

Measure	Purchase and upgrade costs (€)	Maintenance costs (€)	α (× 10-3)	δ	μ
Measure A: user training and awareness	initial cost: € 2,047.06 annual upgrade: € 500.00	annual maintenance: € 141.18	0.63	0	500 €
Measure B: security upgrade on the proxy server	initial cost: € 2,225.59 annual upgrade: -	annual maintenance: € 282.35	1.79	0	0

Table 2: Economic evaluation of individual measures aimed at reducing phishing risk

		A			B		
Year	Discount Rate	Benefits (€)	Purchase and upgrade costs (€)	Maintenance costs (€)	Benefits (€)	Procurement and upgrade costs (€)	Maintenance costs (€)
0			2047.06			2225.59	
1	0.05	510.32	500.00	141.18	13.08	0.00	282.35
2	0.05	510.32	500.00	141.18	13.08	0.00	282.35
3	0.05	510.32	500.00	141.18	13.08	0.00	282.35
4	0.05	510.32	500.00	141.18	13.08	0.00	282.35

Table 3: Calculation of ROI, NPV and IRR risk reduction measures for phishing

Measure	ROI	NPV	IRR
A	-56%	-2511.06 €	-
B	-98%	-3180.43 €	-

relatively slim due to the appropriate development of these applications. The following security parameters were taken:

- v = 0.05
- T = 2.73*10^{-3}/day
- ρ = 1.36*10^{-4}/day
- t_r^0 = 8 hours
- t_{NA}^0 = 16 hours
- t_d^0 = 8 hours
- L_1' = 93.6 €/hour
- L_2' = 0 €/hour
- L_3 = 8000 €
- L = 8093.6 €

Security risk is thus estimated at:

$$R = \rho \cdot L = 1.365 \cdot 10^{-4} / day \cdot 8093.6€ =$$
$$= 1.1088€ / day = 404.71€ / year$$

The value of risk is such that it can be reduced by making investments into the security measure. Assessment of characteristics of the selected measures, productivity and measure costs for a space of time of 4 years is presented in Table 4: The evaluation of each measure is presented in Table 5 and Table 6. From the economical point of view, measure A is the optimal measure because it gives positive values for ROI, NPV and IRR.

8 Conclusion

Information security is an area for which the interest among academia and real business is increasing rapidly. Organizations are increasingly aware that security is one of the basic elements of any information system. This raises crucial questions: “How secure is the information system?” and “How secure the information system should be?” It’s important that we are aware that a fully secure system does not exist. An enterprise should choose such security level that is acceptable to the organization. Determination of appropriate security level is a challenging task, which is implemented through the process of security risk management.

Risk management process helps organizations to decide on the necessary investments in security measures that are most effective for the organization. The basic risk management strategy is to reduce the risk by the introduction of appropriate technologies, tools or procedures. This reduces the probability of security incident or damage caused by the

Table 4: Cost assessment for risk reduction security measures in relation to unauthorized alterations of website contents

Measure	Purchase and upgrade costs (€)	Maintenance costs (€)	α (× 10-3)	δ	μ
Measure A – website security upgrade	initial cost: € 1,223.15 annual upgrade: -	annual maintenance: -	4.09	0	0
Measure B – firewall application warding off such assaults	initial cost: € 2,470.59 annual upgrade: € 500.00	annual maintenance: € 282.35	0.65	0	1000 €

Table 5: Economic evaluation of risk reduction security measures in relation to unauthorized alterations of website contents

		A			B		
Year	Discount rate	Benefits (€)	Purchase and upgrade costs (€)	Maintenance costs (€)	Benefits (€)	Purchase and upgrade costs (€)	Maintenance costs (€)
0			1223.15			2470.59	
1	0.05	384.47	0.00	0.00	1364.24	500.00	282.35
2	0.05	384.47	0.00	0.00	1364.24	500.00	282.35
3	0.05	384.47	0.00	0.00	1364.24	500.00	282.35
4	0.05	384.47	0.00	0.00	1364.24	500.00	282.35

Table 6: Calculation of ROI, NPV and IRR risk reduction security measures in relation to unauthorized alterations of website contents

Measure	ROI	NPV	IRR
A	26%	140.16 €	10%
B	-3%	-407.26 €	-2%

incident. Investing in measures related to information security is therefore inevitable for all organizations that are either included in the process of electronic commerce.

Persons who are responsible for investment are wondering about the best solution for investment and in particular about the amount of the investment. . Before investing in a particular measure it is good to know whether the investment is financially justified. Investment in information security technology and measures is no exception. The economic approach to managing security risk assessment and selecting optimal measure in information security is typically a large project. It implies a thorough analysis and evaluation of information assets, analysis of threats attacking information assets, analysis the consequences of information technology failure, analysis of the probability for a success attack and assess the costs and benefits resulting from investment in information security.

In the paper a comprehensive model for managing the information security risks is described. The model allows evaluation of investments in security and protection of business information systems. The model is based on quantitative analysis of security risks and allows evaluation of different investment options. The model is designed as a standard procedure, which leads organization from the initial input data selection to the final recommendations for the selection of an optimal measure that reduces a certain security risk. The biggest advantage of the model is that it allows direct comparison and quantitative evaluation of the various security measures: technological security solutions, the introduction of organizational procedures, training or transfer risk to an external company. The output data of the model is the profitability of each security measure as measured by ROI, NPV and IRR and comparison of individual measures with each other.

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Rok Bojanc obtained his Ph.D. in the field of Management Information Science from the University of Ljubljana. He works as an IT Manager at ZZI, a software solution firm active in e-business exchange area. As both a technical lead and project manager, he has worked in designing, developing, implementing and managing information systems for more than ten years. He is the author and co-author of several scientific articles published in recognized international journals. He has written many handbooks, technical articles and training courses for subjects including IT, networks, security, and information systems. He frequently lectures at conferences and seminars.

Borka Jerman-Blažič is a full professor at University of Ljubljana, Department of Economics and is heading the Laboratory for Open Systems and Networks at Jožef Stefan Institute. The Laboratory under her leadership is involved more than twenty years in European Union Framework Program projects in the area of ICT and related field (www.e5.ijs.si). At the University of Ljubljana, Faculty of Economics as a Full Professor she is teaching courses in electronic communications and information security. She is teaching as well postgraduate courses in Telecommunication Services and Technologies, Legal aspects and standards in ICT and E-commerce. She is teaching ICT Security in e-commerce at the Postgraduate School of Criminal Justice, University of Maribor and at the postgraduate international school Jožef Stefan. She has spent her postdoctoral at Iowa State University, Ames, USA and has worked as a project development officer for TERENA – The European Association of Academic and Research Networks. She is also acting as research adviser to the Security Unite of Stockholm University, Department for Computer and Systems Sciences.

Prof. Jerman-Blažič was leading research teams in many EU funded projects, most of them from the ICT Framework Program 4th , 5th , 6th , and 7th and was acting as evaluator and auditor. The last project she was working from FP7 was EIFFEL-Evolving Future Internet For European leadership. She is member of the editorial board of two international journals: International Journal on advances in internet technology, and International Journal of technology enhanced learning.

Prof. Jerman-Blažič is a member of the Scientific Council of the European Privacy Association and member of the FP7 SECURITY programming committee in DG Enterprise. She was appointed member to UNECE/CEFAT UN (Economic

Commission for Europe) group for Internet enterprise development, Ex-Chair of the Internet Society of Europe (www.isoc-ecc.org) in the first mandate (2004-2007), Distinguished Member of Slovene Society for Informatics, member of New York Academy of science, member of the editorial board of the international journal of Technology Enhanced e-Learning and International journal on advances in Internet technology. She is also member of the Grand Jury of United Nations for the e-content awards of WSIS and member of the State Council for electronic Communications. She is also Chair of Slovenian Standardisation Committee on ICT as well as chair of the Slovenian chapter of Internet Society and is member of the European ICT Standardisation Board (ICTB). Prof. Jerman-Blažič has published more than 300 articles in international journals, conferences, books and was an invited speaker in many international conferences and workshops. She is holding the ACM and IEEE Thai Section Plaque for significant achievement in the Internet technology.

Kvantitativni model za ekonomsko analizo naložb v informacijsko varnost v poslovnem informacijskem sistemu

Povzetek: V prispevku je predstavljen matematični model za vrednotenje naložb v varnostne tehnologije in odločitvene procese na podlagi kvantitativne analize varnostnih tveganj ter različnih varnostnih ukrepov, ki zmanjšujejo posamezna tveganja. Za vse ugotovljene poslovne procese se določijo želene stopnje varnosti, verjetnost za varnostni incident ter morebitna izguba, ki jo lahko utrpi podjetje. Izbor varnostne tehnologije temelji na učinkovitosti izbranih varnostnih ukrepov, pri čemer se za ocenjevanje učinkovitosti in primerjalno analizo različnih varnostnih tehnologij uporabljajo ekonomski kazalci. Za razliko od obstoječih modelov za oceno naložb v informacijsko varnost, omogoča predlagani model neposredno primerjavo in kvantitativno oceno različnih varnostnih ukrepov. Model omogoča podrobno analizo kvantitativnih ocen za različne vrste naložb, ter podaja priporočila, ki omogočajo izbiro optimalne varnostne rešitve. Model je bil testiran z uporabo praktičnih primerov s podatki iz realnega poslovnega okolja.

Ključne besede: modeliranje, varnostne tehnologije, ekonomski kazalci, naložbe, poslovni informacijski sistem

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Regression Analysis of Variables Describing Poultry Meat Supply in European Countries

Miro Simonič[1], Ksenija Dumičić[2], Gabrijel Devetak[3]

[1]Business School Murska Sobota, Noršinska ulica 13, 9000 Murska Sobota, Slovenia; miro.simonic@perutnina.eu
[2]University of Zagreb, Faculty of Business & Economics, Department of Statistics, Trg J. F. Kennedyja 6, 1000 Zagreb, Croatia; kdumicic@efzg.hr
[3]Faculty of Commercial and Business Sciences, Lava 7, 3000 Celje, Slovenia; mandrija@siol.net

In this paper, based on the analysis of official FAOSTAT and EUROSTAT data on poultry meat for 38 European countries for years 2007 and 2009, two hypotheses were examined. Firstly, considering four clustering variables on poultry meat, i.e. production, export and import in kg/capita, as well as the producer price in US $/t, using descriptive exploratory and cluster analysis, the hypothesis that the clusters of countries may be recognized was confirmed. As a result six clusters of similar countries were distinguished. Secondly, based on multiple regression analysis, this paper proofs that there exists the statistically significant relationship of poultry meat production on export and import of that kind of meat, all measured in kg/capita. There is also a high correlation between production, as a dependent, and each of two independent variables.

Key words: poultry meat, marketing strategy, cluster analysis, correlation, multiple regression

1 Introduction

Due to technological developments in the last couple of years less physical work is needed, while it becomes continuously replaced with the modern machines. Parallel development of information and communications technology enables the performance of many operations on computers. Furthermore, a number of activities have been moved out of manufacturing and placed in the offices, from where the machines are controlled and monitored.

As the amount of work has declined, people have changed their eating habits. A calorie rich food is replaced by smaller portions and food easy to digest. Since meat is still the main ingredient in people's daily menu, people start to consume more and more poultry meat. Because of increasing demand for this kind of meat worldwide, its production increases (FAOSTAT, 2012).

In European countries the production of poultry products has developed differently. While some countries invested in the development of poultry in order to fulfill their needs, others increased their production in order to export more. Increased demand for poultry products resulted in the growth of its prices.

The objective of this paper is to determine the interrelations between production, import, export and prices of poultry meat in the selected European countries. The obtained results could be very useful for marketing management, when developing an export strategy (Klemenčič, Devetak & Števančec, 2012). The last available data for previously mentioned variables are available for year 2007 (FAOSTAT, 2012). The data are collected on the basis of annual reports about production in each country as well as from the EUROSTAT database (EUROSTAT, 2012).

Furthermore, the aim of this paper is also to find clusters of similar countries taking into account following variables: population, import, export and the prices of poultry meat. The observed clusters could be useful in planning marketing strategies and poultry sales in certain countries.

The first research hypothesis (H1) says that certain clusters of selected European countries may be recognized, considering four variables on poultry meat: production, export and import per capita, as well as the price of that kind of meat per quantity unit. The second research hypothesis (H2) is that there is at least one variable that is statistically significant for an explanation of poultry meat production per capita.

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Perner (2008) dealt with global food marketing by investigating the impact of economic and psychological factors that influence on the consumers of poultry products. The profitability of the integrated poultry farm was explained by Bamiro, Momoh and Phillip (2009), who studied the correlation between costs and investments of the poultry production. The habits of consumers were also investigated by Kos Koklič and Vida (2012), who concluded that the food origin is the main factor when buying the product. In the sample of 714 people questioned in Slovenia, 74,1% think that the food origin is very important. Moreover, (Vukasović, 2009) compared the chicken meat products of various producers in Slovenia and found that the Slovenians trust more domestic production.

To address the previous empirical findings, the authors set up a task to find a recent demographic data of the European countries on production, export, import and the prices of the poultry meat and to conduct exploratory descriptive, graphic and numeric, as well as clusters, correlation and regression analysis.

For this purpose, the secondary data are collected from the EUROSTAT and FAOSTAT database, while the descriptive, regression and cluster analysis was performed with the statistical program packages Excel, Megastat, PHStat 2,5 and Minitab 15.

2 Methodology

2.1 Data sources

Data on production, export, import and prices of poultry are taken from FAOSTAT database, while data on population are provided from EUROSTAT database. The sample consists of data for 38 European countries in the years 2007 and 2009. The methodology of data collection is performed with the cooperation of the governments of all countries of the world, through a questionnaire Food and Agriculture Organization of the United Nations (FAO), with the intention "for a world without hunger." The scope of the data collection is huge, therefore FAOSTAT refreshes and displays structured and comprehensive metadata only every five years. In meat and poultry is the last year of published data 2009th.

It should be pointed out that the data for Andorra, the Faeroe Islands, Gibraltar, Holy Seat, Lichtenstein, Monaco, Montenegro and San Marino are incomplete. Since these countries do not produce poultry meat, they are excluded from the analysis.

2.2 Descriptive data exploration

The data for production, export and import are given per capita, based on the information from the CIA World bank and EUROSTAT database. Furthermore, producers price on US$/t is also included in the analysis.

2.3 Cluster analysis practical application

The modern marketing research is based on data collected by professional international agencies. For the purpose of this research data collected by FAOSTAT (2012), EUROSTAT (2012) and CIA (2012) analyzed a statistical multivariate approach based mostly on regression and cluster analysis approach. Also, Wong (2009) applied the cluster analysis method studying the business opportunities, and she came to the perception that the usage of cluster analysis method new marketing strategies may be developed.

2.4 Food supply

Stagnation of economic development in the countries all over the world, and so in the European countries, caused an unemployment rising in the labor market. Providing food is becoming an increasingly important element of each of the European countries. Manufacturers are trying to increase grain yield per area unit (ha) using genetically modified organisms (GMOs), but these foods have not been well studied, to be able to lead to long-term solutions (Hall, 2010). From the data in Table 1 it is clear that many countries in Europe have invested and increased production of the classic poultry in the period from 2007 to 2009.

Following, the exploratory data analysis is conducted by using the methods of descriptive statistics. The results for 2009 are given in Table 2.

3 Results

Based on the indicators given in Table 2 for 38 European countries for the year 2009 and the obtained results for 2007, following is concluded:

- **Production:** On average, 18,96 kg/capita of poultry meat was produced in 2009, which is for 0,71 kg/capita more than in 2007. Furthermore, comparing with 2007, standard deviation increased by 0,88 kg/capita, while the coefficient of variation equals 58,27%. The frequency distribution is still positively skewed (skewness=0, 85), while the peak is sharper for 0,13 relative to 2007 (kurtosis=0, 92). Based on Table 4, poultry production of the following countries is still above the average: the Netherlands with 50,72 kg/capita, Belgium with 43,99 kg/capita and Hungary with 38,69 kg/capita. The biggest growth in production is achieved by Belarus with an increase of 5,73 kg/capita, Poland with 5,66 kg/capita and Slovenia with 5,13 kg/capita, respectively. The biggest fall happened in Luxembourg, where the production was decreased by 23,91 kg/capita, stimulating the strong decline in producer prices for 43,52%. The main cause of such a change lies in strong competition of nearby countries, i.e. Germany, Belgium and France, which have been producing the poultry meat under much lower prices. In this segment, Luxembourg is a serious outlier.
- **Import:** In 2009 the import of poultry meat averaged 7,81 kg/capita, (in 2007 it averaged 7,3 kg/capita) with standard deviation of 6,7 kg/capita and coefficient of variation of 86,71%, showing that the variability was for 3,65% bigger than in 2007. The distribution is still positively skewed (skewness=2,02) and peak becomes sharper relative to the normal distribution (kurtosis=6,36). Country

Table 1: Production, import, export of poultry meat in kg/capita and producer price in US $/t for 38 European countries in 2007 and 2009

Country	Production (kg/capita)		Import (kg/capita)		Export (kg/capita)		Producers price (US $/t)	
	2007	2009	2007	2009	2007	2009	2007	2009
Albania	4,10	5,32	5,66	8,23	0,00	0,00	2.954,30	3.341,40
Austria	14,89	14,99	10,47	11,06	6,80	7,00	2.700,20	2.790,30
Belarus	17,11	22,84	1,68	1,33	0,99	2,24	1.781,20	1.741,80
Belgium	43,02	43,99	16,20	16,20	34,04	38,11	1.633,10	1.588,30
Bosnia& Herzegovina	5,21	8,82	2,66	3,59	0,42	1,11	2.438,80	1.408,60
Bulgaria	16,13	17,25	5,51	8,39	1,58	3,86	1.759,70	1.846,20
Croatia	11,77	8,57	2,56	3,50	1,46	1,85	1.902,60	1.926,50
Czech Republic	21,01	19,29	6,09	8,40	2,47	2,58	1.306,50	1.380,70
Denmark	31,53	31,40	8,61	10,24	20,05	21,89	1.140,90	1.326,90
Estonia	8,58	11,09	13,05	13,35	4,33	4,99	2.197,50	1.964,80
Finland	18,58	19,37	1,85	2,25	2,10	2,09	1.562,50	1.722,20
France	26,32	28,16	4,57	5,48	8,48	8,74	1.839,40	1.906,10
Germany*	13,58	15,64	7,53	8,21	5,37	6,24	1.649,40	1.649,40
Greece	10,53	10,09	5,32	5,94	1,54	1,61	2.289,00	2.597,20
Hungary	37,56	38,69	3,02	3,38	10,00	12,21	1.521,30	1.531,90
Iceland*	24,83	22,61	1,18	1,14	0,00	0,00	5.874,70	5.874,70
Ireland	26,99	26,95	13,45	13,71	13,67	13,99	1.341,60	1.482,60
Italy	17,23	19,00	0,73	0,88	1,90	2,20	2.935,80	2.732,40
Latvia*	9,01	10,25	13,62	11,61	2,10	2,33	1.429,20	1.429,20
Lithuania	20,17	21,38	10,77	7,65	5,92	6,25	2.004,90	1.614,00
Luxembourg	24,37	0,46	16,11	17,23	0,65	1,10	8.607,60	5.722,20
Malta	11,46	11,70	17,19	18,85	0,01	0,00	1.382,00	1.644,70
Netherlands	45,86	50,72	26,76	35,48	56,68	61,52	1.393,50	1.402,20
Norway	14,83	16,91	0,13	0,24	0,03	0,02	2.659,90	2.680,00
Poland	25,59	31,25	1,46	1,04	6,69	8,83	1.664,70	1.580,20
Portugal	23,84	26,57	3,03	3,84	0,84	0,96	1.263,50	1.015,00
Republic of Moldova	8,75	9,63	3,66	2,38	0,13	0,00	1.948,50	2.195,20
Romania	14,42	17,24	5,32	5,49	0,43	1,70	2.255,00	2.052,60
Russian Federation	13,04	16,50	9,07	6,79	0,02	0,04	2.210,70	2.257,20
Serbia	7,09	8,14	0,17	0,27	0,29	0,21	1.837,80	1.658,30
Slovakia	15,52	13,90	5,72	7,09	3,24	3,22	1.560,10	1.572,80
Slovenia	24,51	29,64	4,76	5,84	9,02	8,81	1.724,40	1.980,60
Spain	25,90	26,41	3,44	3,54	1,89	2,29	1.988,10	1.862,80
Sweden	11,76	11,59	5,38	5,72	1,76	1,31	1.701,20	1.546,30
Switzerland	8,03	8,55	6,95	7,66	0,03	0,02	2.926,20	3.445,00
FYR Macedonia	1,72	1,61	17,80	15,78	0,08	0,08	1.080,30	360,20
Ukraine	14,90	19,56	2,65	4,27	0,06	0,42	1.703,00	1.689,70
United Kingdom	23,87	23,58	11,45	10,90	5,56	4,71	1.547,70	1.534,40

Note: Germany, Iceland and Latvia did not give data for 2009, so data imputations from 2007 were taken
Source: Author's calculation 2012, FAOSTAT, EUROSTAT

Table 2: Results of descriptive statistics for production, import and export of poultry meat "per capita" and Producer price on US$/t for 38 European countries in 2009

Descriptive statistics	Production (kg/capita)	Import (kg/capita)	Export (kg/capita)	Producer price (US $/t)
Number of countries	38	38	38	38
mean	18,96	7,814	6,17	2.054,07
minimum	0,46	0,24	0	360,2
maximum	50,87	35,48	61,52	5874,7
range	50,41	35,24	61,52	5514,5
population standard deviation	10,90	6,69	11,57	1.057,70
skewness	0,85	2,02	3,59	2,37
kurtosis	0,92	6,37	14,39	6,67
coefficient of variation (CV)	58,27%	86,71%	190,05%	52,18%
1st quartile	10,46	3,51	0,56	1,54
median	17,08	6,37	2,22	1,71
3rd quartile	26,53	10,74	6,25	2,16
interquartile range	16,07	7,23	5,69	622,18
mode	#N/D	#N/D	#N/D	#N/D

Source: Author's calculation 2012, Megastat

that import the most is still the Netherlands with 35,48 kg/capita, which is more than 8,72 kg/capita in comparison with the previous year.

- **Export:** The average export in 2009 was 6,17 kg/capita, which is for 0,63 kg/capita more than in 2007 and with an average deviation from the mean of 11,57 kg/capita, or relatively 190,05%, showing the decline of the variability in poultry meat export per capita for 10% relative to 2007. The analyzed data of export are still quite far from a stable normal distribution that is positively skewed (skewness=3,59). The Netherlands extremely increased its export at 61,52 kg/capita and still represents a serious outlier. Such a growth could be explained with the accession of new countries to the European Union, which do not have the borders, thus enabling the import of poultry meat under much lower prices.
- **Price:** Poultry meat price in US $/t has got the average 2.054,07 US $/t with the average deviation from the average of 1.057,70 US $/t, what is 52,18%. Such a result shows quite big variability of the data between the countries. Compared to 2007, the distribution of producer prices is less skewed (skewness=2,37), but still far from the normal distribution. In Iceland was recorded the highest price of 5.784,70 US$/t. High prices are caused by higher transportation costs, as Iceland is very far from other European countries. Moreover, the producer prices in the Netherlands decreased from 8.607,60 US $/t in 2007 to 5.722,20 US $/t in 2009. The reason for that lies in increased supply of the new EU members, i.e. the countries with lower GDP per capita.

3.1 Clustering European countries according to poultry meat supply data

The first research hypothesis (*H1*), according to which clusters of countries considering four variables on poultry meat: production, export and import per capita, as well as the price of that kind of meat per quantity unit, may be recognized. So, a cluster analysis was conducted and respective dendrogram charted for 2007 and 2009, based on standardized data, Ward linkage method and Euclidean distance measure, Figure 6.

3.2 Cluster analysis for 2007

The dendrogram given in Figure 1 shows six clusters of European countries considering poultry meat variables for 2007 given in Table 1.

In Table 3 the European countries are grouper according to the dendrogram from Figure 1.

In 2009 the Cluster 1 is comprised of 12 countries, as follows: Albania, Switzerland, Austria, Greece, Romania, Russian Federation, Italy, Norway, Bosnia and Herzegovina, Serbia, Croatia and Moldova. Cluster 2 is consisted of 4 countries: Estonia, Latvia, Malta and FRY of Macedonia. Cluster 3 is made by 2 countries: Iceland and Luxembourg. Cluster 4 is consisted of 11 countries, which are similar considering clustering variable, and these are: Belarus, Spain, Finland, Ukraine, Portugal, Bulgaria, Germany, Czech Republic, Lithuania, Slovakia and Sweden. A separate Cluster 7 covers: Denmark, Ireland, United Kingdom, France, Slovenia,

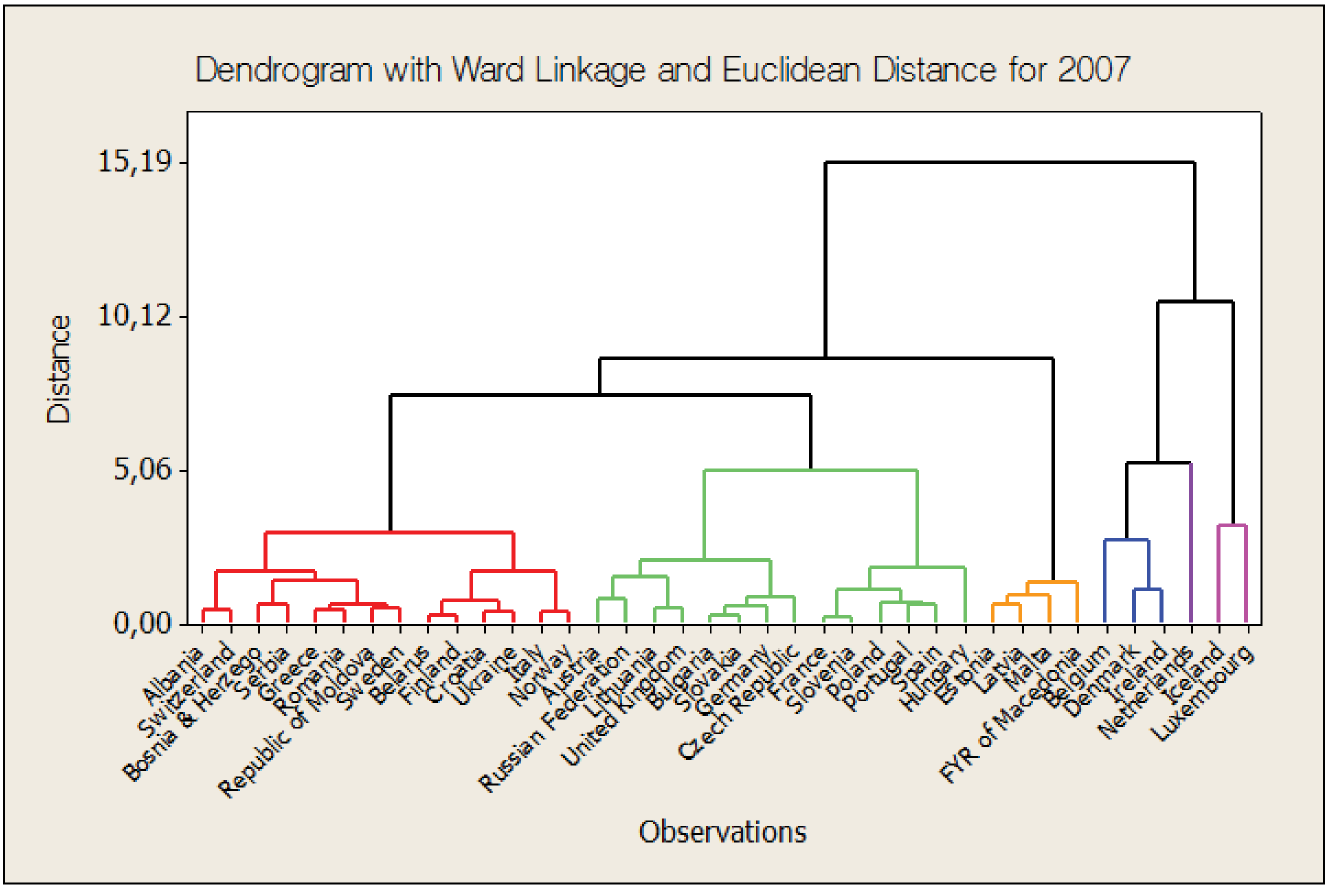

Figure 1: Dendrogram with six clusters created of 38 European countries based on four variables: production, export, import of poultry meat per capita and price of poultry meat in US $/t for 2007
Source: Author's creation 2012, Minitab 15

Table 3: Clustering of 38 European countries clustered into six clusters based on four variables for 2007: Production, Import of poultry meat, Export of poultry meat (all variables in kg/capita), and Producer price in US $/t.

Cluster	**No. of countries**	**Countries**
Cluster 1	14	Albania, Switzerland, Bosnia & Herzegovina, Serbia, Greece, Romania, Moldova, Sweden, Belarus, Finland, Croatia, Ukraine, Italy, Norway
Cluster 2	14	Austria, Russia Federation, Lithuania, United Kingdom, Bulgaria, Slovakia, Germany, Czech Republic, France, Slovenia, Poland, Portugal, Spain, Hungary
Cluster 3	4	Estonia, Latvia, Malta, FYR of Macedonia
Cluster 4	3	Belgium, Denmark, Ireland
Cluster 5	1	The Netherlands
Cluster 6	2	Iceland, Luxembourg

Source: Author's creation 2012, Minitab 15

Hungary and Poland. And, finally, there is Cluster 6, which includes only 2 countries and these are Belgium and The Netherlands. Countries comprising one cluster have got more or less similar

The Cluster 1 is comprised of 14 countries with exceptionally small amount of production, import and export, as well as with low producer prices of poultry meat. Low production is caused by the low price of work in those countries. The poultry meat production implies more physical work, so the price of work has a big impact on the producer prices. The exception is Switzerland, where the state gives producers big subventions from the import quotas (import levies) and this is the reason of low prices there. These countries are: Albania, Switzerland, Bosnia & Herzegovina, Serbia, Greece, Romania, Moldova, Sweden, Belarus, Finland, Croatia, Ukraine, Italy and Norway.

The Cluster 2 consists of 14 countries: Austria, Russian Federation, Lithuania, United Kingdom, Bulgaria, Slovakia, Germany, Czech Republic, France, Slovenia, Poland, Portugal, Spain, and Hungary. On average, these countries have similar values of production, import, export and prices. They have small standard deviations, which is also a one of the common factors that connect these countries.

The Cluster 3 is made of 4 countries: Estonia, Latvia, Malta and FYR of Macedonia. They have export, import and prices above the average. Moreover, they are characterized by extremely low production of poultry meat, which is caused by low population as well as non-intensive poultry meat production.

In Cluster 4 there are Belgium, Denmark and Ireland. These countries have connections between two pairs of economic features and dependent variables. The first pair is presented by production and producer prices. The countries in this Cluster are diametrical opposites. They have relatively high poultry meat production, while on the other hand the producer prices are low. The second feature of these countries is a positive difference of lower import and higher export (export surplus). This diametrical opposite provides them a competitive advantage and the possibility for higher GDP as well as the background for new investments and the industrial development.

Cluster 5 consists only one country, i.e. the Netherlands. Along with the Russian federation, it has the highest export (932.006.000 t) and it is on the fourth place in import (439.956.000 t) of the poultry meat. With the population of 16.443.000 people and its own production of 754.000t, it is placed seventh. Compared to other European countries, the export of poultry meat equals 439.956t, which is more than 349% above the average. The import of 932.006t is equal to import of Germany and France that are placed second and third respectively on the amount of the import of the poultry meat.

Finally, the Cluster 6 includes Iceland and Luxembourg that are characterized by the low poultry meat production. Luxembourg produces 476.000t of poultry meat and Iceland only 306.000t, thus holding the last place in Europe. Both countries also have low export and import. The reasons for such a situation in Iceland lie in low population density (3,2 people per km^2, EUROSTAT); low production as well as low export and import. On the other hand, Luxembourg has a high population density (185,6 people per km^2, EUROSTAT), but also does not have its own production, while export and import are far below the average in a relation to other European countries. However, both countries have the highest producer prices of poultry meat in Europe of 2150.44 US$/t. The price of poultry meat in Luxembourg equals 8607.60 US$/t, which is 400% above the European average, while in Iceland the price equals 5874.70 US$/t which is 273,2% above the average. The prices are high due to economic protection of domestic market, while both countries have high import duty EUR-Lex (2010).

3.3 Cluster analysis for 2009

Further, clustering is made for the same variables and same countries for 2009, using data from in Table 1. The dendrogram could be seen in Figure 2.

In Table 4 the clusters of countries are given according to the dendrogram given in Figure 2.

Some changes in clusters of countries in 2009 compared to 2007 are visible, as follows:

- Cluster 1 is created of 12 countries: Albania, Switzerland, Austria, Greece, Romania, Russian Federation, Italy, Norway, Bosnia & Herzegovina, Serbia, Croatia, Moldova. It happens that Austria and Russian Federation left their old Cluster 2 and joined this new Cluster 1. Austria increased its trade deficit, while the import was 3.496t higher than in 2007. Russia decreased its deficit by 329.774t and now it is equal to 966.831t. Comparing the differences in the deficit with the production, both countries are added to the Cluster of so called "average countries", i.e. in Cluster 1. The deficit calculations are based on the data in Table 1.
- Cluster 2 is comprised of 4 countries: Estonia, Latvia, Malta and FYR of Macedonia (in 2009 it was called Cluster 3). So, nothing changed in clusters of the mentioned countries.
- Cluster 3 covers only two countries. In 2009 Iceland and Luxembourg create a cluster of their own, and that is Cluster 3, just as before in 2007 (they were in old Cluster 6)
- Cluster 4 has 11 countries. Sweden and Finland left old Cluster 1 and joined new Cluster 4, so they are together with Belarus, Spain, Ukraine, Portugal, Bulgaria, Germany, Czech Republic, Lithuania, and Slovakia. Belarus and Ukraine left old Cluster 1 and moved to new Cluster 4. Almost the same production of poultry meat in 2009 was achieved by Sweden with 107.940t and Finland with 103.500t. They also have similar export that equals 12.173t for Sweden and 11.141t for Finland, as it can be seen in Table 1. These two characteristics have put Sweden and Finland in Cluster 4. From 2007 to 2009 Belarus and Ukraine increased their poultry meat production by 32,27% and 29,70%, respectively, moving them in Cluster 4. Such a growth deviates from the average growth of production, which equals 3,78% in Europe. The reason for that are preparations for economic union without the borders, which was formed in 2011 between Russia, Belarus, Ukraine and Moldova.
- Cluster 5 is created of 7 countries, and these are: Denmark, Ireland, United Kingdom, France, Slovenia, Hungary, and Poland. The main characteristic of this Cluster is export orientation on the markets of the European Union. These countries exported above the average export of poultry meat of 104.931t. The exceptions are Slovenia and Ireland, which have the amount production below the average, but have also relatively low import.
- Cluster 6 has got only two countries: Belgium, and The Netherlands. The Netherlands stays the biggest exporting country of poultry meat in Europe with 1.018.685t. Belgium is also included in this Cluster, while it exported 406.314t and had very high export surplus of 45.561t.

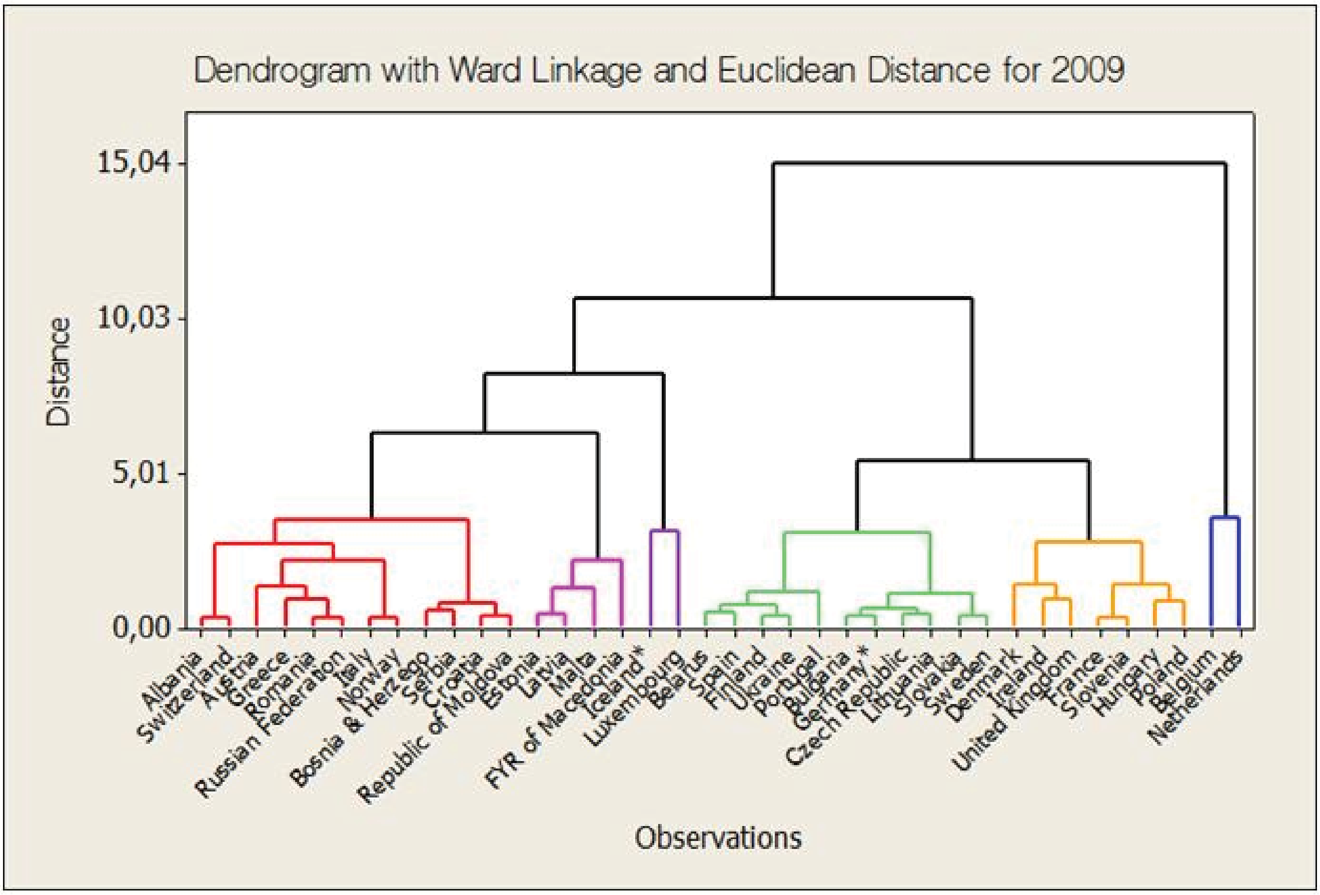

Figure 2: Dendrogram with six clusters created of 38 European countries based on four variables: production, export, import of poultry meat per capita and price of poultry meat in US $/t for 2009
Source: Author's creation 2012, Minitab 15

Table 4: Clustering of 38 European countries clustered into six clusters based on four variables for 2009: Production, Import of poultry meat, Export of poultry meat (all variables in kg/capita), and Producer price in US $/t

Cluster	No. of countries	Countries
Cluster 1	12	Albania, Switzerland, Austria, Greece, Romania, Russian Federation, Italy, Norway, Bosnia & Herzegovina, Serbia, Croatia, Moldova
Cluster 2	4	Estonia, Latvia, Malta, FYR of Macedonia
Cluster 3	2	Iceland*, Luxembourg
Cluster 4	11	Belarus, Spain, Finland, Ukraine, Portugal, Bulgaria, Germany*, Czech Republic, Lithuania, Slovakia, Sweden
Cluster 5	7	Denmark, Ireland, United Kingdom, France, Slovenia, Hungary, Poland
Cluster 6	2	Belgium, The Netherlands

**Since data Producers price of poultry meat are not available in Iceland and Germany for 2009 at the moment of publishing the paper, the average increase of the price of poultry meat in 2008 compared to 2007 is used for analysis.*

3.4 Correlation analysis

Correlation matrix consists of the coefficients of linear relation between variables of production, import and export of poultry meat given in kg per capita and is presented in Tables 5 and 6.

Correlation coefficients show that positive linear correlation exists between any two variables considered for 2007 and 2009. Variables Export (kg/capita) and Production (kg/capita) are highly positively correlated with correlation of r=0,756 in 2007 and r=0,766 in 2009. Also, variables Export (kg/capita)

Table 5: Correlation matrix of variable production, export and import of poultry meat data in 38 European countries in 2007 variables in kg/capita

	Production (kg/capita)	Import (kg/capita)	Export (kg/capita)
Production (kg/capita)	1,000		
Import (kg/capita)	0,267	1,000	
Export (kg/capita)	0,756	0 ,599	1,000

Source: Author's creation 2012, Megastat

Table 6: Correlation matrix of variable production, export and import of poultry meat data in 38 European countries in 2009 variables in kg/capita

	Production (kg/capita)	Import (kg/capita)	Export (kg/capita)
Production (kg/capita)	1,000		
Import (kg/capita)	0,236	1,000	
Export (kg/capita)	0,766	0 ,684	1,000

Source: Author's creation 2012, Megastat

and Import (kg/capita) are moderately positively correlated with correlation of r=0,599 in 2007 and r=0,684 in 2009. Only variables Production (kg/capita) and Import (kg/capita) are weakly positively correlated with correlation of only r=0,267 in 2007 and r=0,236 in 2009, which seems to be completely logical.

4 Discussion

4.1 Multiple regression model for poultry meat production

With a purpose to test the second research hypotheses H2, that there is at least one variable that is statistically significant for an explanation of poultry meat production in kg/capita, the following multiple linear regression model for the population is analyzed:

$$\text{Production\_pc}_i = \beta_0 + \beta_1 \cdot \cdot \text{Export\_pc}_i + \beta_2 \cdot \text{Import\_pc}_i + e_i, \quad i=1,...,n,$$

with appropriate model for the sample:

$$\widehat{\text{Production}}\text{\_pc}_i = \hat{\beta}_0 + \hat{\beta}_1 \times \text{Export\_pc}_i + \hat{\beta}_2 \times \text{Import\_pc}_i, \quad i=1,...,38.$$

Estimates are calculated using an ordinary least squares method (OLS).

4.2.1 Multiple regression model estimated for the year 2007

With concrete estimates the model for 38 countries for 2007 is:

$$\widehat{\text{Production}}\text{\_pc}_i\,(2007) = \underset{(1,6558)}{16,9499} - \underset{(0,2176)}{0,4910} \cdot \text{Export\_pc}_i + \underset{(0,1217)}{0,8774} \cdot \text{Import\_pc}_i;$$

$\hat{\sigma}$=6,3828

R^2=0,6264

$\bar{R}^2$=0,6051

R=0,7914

DW=1,709

n=38

The regression coefficient of the regressor variable Export_pc is negative and statistically significant at 5% significance level, as the test value t-statistic is -2,2562 with p-value= 0,0304. Based on the estimated equation, remaining Import unchanged, a one unit increase in Export (kg/capita) decreases Production of poultry meat on average by 0,491 kg/capita. Based on the estimated equation, remaining Export unchanged, a one unit increase in Import (kg/capita) increases Production of poultry meat on average by 0,8774 kg/capita. The value of the coefficient of determination of R^2=0, 6264 means that 62,24% of the variation in Production of poultry meat is explained by both Import and Export of the same kind of meat. For conducting the overall test of significance of the multiple regression the test value of Fisher's F is 29,3434 with p-value=0,0000 indicates that two independent variables Export and Import per capita are statistically significant for explanation of Production of poultry meat per capita in 38 countries. The regression standard error is 6,3828 kg/capita and regression coefficient of variation is 34,97%, meaning the model is moderately representative.

Regression diagnostics for evaluating multiple regression model for 2007 assumptions was conducted, too. Diagnostics techniques, described in Dougherty (2011), Gujarati & Porter (2009), Maddala (2010), Pfajfar (2012), Dumičić, Čeh Časni & Palić (2011) and Asteriou & Hall (2007), were applied using Eviews 7 and Megastat. The following tests were applied: the Jarque Bera test for normality of the residuals; the Durbin-Watson test for autocorrelation; the Breusch-Pagan-Godfrey test for heteroskedasticity; as well as the Variance Inflation Factor criteria for examining multicollinearity were applied.

Firstly, the Jarque-Bera test of normality for residuals was applied. With the JB test statistics that equals 0,9607, and the p-value=0,6248, the null-hypotheses that the residuals are normally distributed may not be rejected at significance level of 5%.

Secondly, the regression model assumes that autocorrelation, i.e. correlation between error terms ordered in time does not exist. Since the test value for *Durbin Watson test* is $DW = 1{,}709$, so that $0 < DW < 2$, the test for positive autocorrelation of residuals was conducted. The computed DW is larger than the table value $d_U = 1{,}398$, so the test indicates that there is no positive autocorrelation of the first order.

Further, Breusch-Pagan-Godfrey heteroskedasticity test examines whether the residual variance in a regression model is constant or not. The test value LM=Obs*R-sq=0,3601 and p-value=0,8352, at any reasonable significance level, the null-hypotheses of the test may not be rejected, so there is no statistically significant heteroskedasticity.

When independent variables are highly correlated, it is difficult to distinguish their separate influence on the dependent variable. So, finally, the multicollinearity test using Variance Inflation Factor (VIF) criteria is conducted. Since the value of VIF is 1,5604 and it is smaller than 5, there is no problem of that kind.

4.2.2 Multiple regression model estimated for the year 2009

With concrete estimates the multiple regression model for 38 countries for 2009 is:

$$\widehat{\text{Production\_pc}}_i(2009) = \underset{(1{,}4790)}{19{,}2531} - \underset{(0{,}1919)}{0{,}8825} \cdot \text{Export\_pc}_i + \underset{(0{,}1108)}{1{,}0703} \cdot \text{Import\_pc}_i;$$

$\hat{\sigma} = 5{,}7666$

$R^2 = 0{,}7424$

$\bar{R}^2 = 0{,}7276$

$R = 0{,}8616$

$n = 38$

The regression coefficient of the regressor variable Export_pc is negative and statistically significant at 5% significance level, as the test value t-statistic is -4,5993 with p-value= 0,0001. Based on the estimated equation, remaining Import (kg/capita) unchanged, a one unit increase in Export (kg/capita) decreases Production of poultry meat on average by 0,8825 kg/capita. Based on the estimated equation, having Export unchanged, a one unit increase in Import (kg/capita) increases Production of poultry meat on average by 1,0703 kg/capita. The value of the coefficient of determination of $R^2=0{,}7424$ means that 74,24% of the variation in Production of poultry meat is explained by both Import and Export of the same kind of meat. In conducting the overall test of significance of the multiple regression the test value F is 50,423 with p-value=0,0000, which indicates that two independent variables Export and Import in kg/capita are statistically significant for explanation of Production of poultry meat in kg/capita in 38 countries. The regression standard error is 5,7666 kg/capita and regression coefficient of variation is 30,41%, which means the regression model is quite representative.

Regression diagnostics for the multiple regression model for 2009 was conducted using Eviews 7, too.

With the Jarque-Bera JB test statistics that equals 0,6949, and the p-value=0,7065, the null-hypotheses that the residuals are normally distributed may not be rejected at significance level of 5%.

Since the test value for the *Durbin Watson test* is $DW = 2{,}02$, so that $DW > 2$, considering autocorrelation between random error terms ordered in time, the test for negative autocorrelation of residuals was conducted. The computed DW is larger than the value $(4-d_U)=2{,}6015$, taken for the 1% significance level, so the test indicates that there is no negative autocorrelation of the first order.

The Breusch-Pagan-Godfrey heteroskedasticity test gave the test value LM=Obs*R-sq=3,3446 and p-value=0,6470, at any reasonable significance level, the null-hypotheses of the test may not be rejected, so there is no statistically significant heteroskedasticity.

When independent variables are highly correlated, it is difficult to distinguish their separate influence on the dependent variable. So, finally, the multicollinearity test using Variance Inflation Factor (VIF) criteria is conducted. Since the value of VIF is 1,8806 and it is smaller than 5, there is no problem of that kind.

5 Conclusion

This paper studies the relationship between variables concerning poultry meat and sales in European countries by using heuristic, as well as descriptive statistics, cluster, correlation and regression analysis.

Concerning the first research hypothesis (H1), which says that clusters of countries considering four variables on poultry meat: production, export and import per capita, as well as the price of that kind of meat per quantity unit, may be recognized, a cluster analysis of standardized variables, using Ward linkage method and Euclidean distances was conducted. Six different clusters of countries are recognized. In 2009 the Cluster 1 is comprised of 12 countries, as follows: Albania, Switzerland, Austria, Greece, Romania, Russian Federation, Italy, Norway, Bosnia and Herzegovina, Serbia, Croatia and Moldova. Cluster 2 is consisted of 4 countries: Estonia, Latvia, Malta and FRY of Macedonia. Cluster 3 is made by 2 countries: Iceland and Luxembourg. Cluster 4 is consisted of 11 countries, which are similar considering clustering variable, and these are: Belarus, Spain, Finland, Ukraine, Portugal, Bulgaria, Germany, Czech Republic, Lithuania, Slovakia and Sweden. A separate Cluster 5 covers: Denmark, Ireland, United Kingdom, France, Slovenia, Hungary and Poland. And, finally, there is Cluster 6, which includes only 2 countries and these are Belgium and The Netherlands. Countries comprising one cluster have got more or less similar characteristics considering all four variables on poultry meat, so, the research hypothesis H1 is proved.

Based on the obtained results it can be concluded that the European countries, which are export oriented and invest in the growth of production, have the economic benefits, as well as qualitative conditions for further investments in the development of technology and the growth of production. According to the forecasts (FAOSTAT, 2012), demand for poultry meat is higher than the supply; therefore is necessary to invest in the quality of product in order to obtain corresponding prices, which could give good financial results.

The data analysis shows that the countries from the Cluster 5 are the most important for the Slovenian producers. Furthermore, with well-prepared marketing strategy the countries from Cluster 4 are also very important, while they are attractive thanks to its size and high producer prices, which increase producers' competitive advantage in a relation to the domestic producers. Countries covered with the Clusters 3,4 and 5 are atypical and extreme putting them in a situation where much more investments are needed, which is quite hard to secure during the recession.

Concerning the second research hypothesis (*H2*), which states that there is at least one variable that is statistically significant for an explanation of poultry meat production per capita, the multiple regression model was set for each of two years considered, 2007 and 2009.

When comparing and evaluating two multiple regression models in analyzing Production of poultry meat depending on two regressors, Export and Import, in 38 European countries for 2007 and 2009, it may be concluded that both models are good. For the multiple regression model for 2009, the regression coefficient of the regressor variable Export_pc is negative and statistically significant at 1% significance level. Based on the estimated equation, leaving Import (kg/capita) unchanged, a one unit increase in Export (kg/capita) decreases the regression value for Production of poultry meat by 0,8825 (kg/capita). This estimated value of the regression coefficient is higher than it was in the multiple regression model for 2007, where it was estimated with 0,491 kg/capita. Based on the estimated equation, having Export unchanged, a one unit increase in Import (kg/capita) increases Production of poultry meat on average by 1,0703 kg/capita This regression coefficient has got the lower value in 2007, and it was 0,8774 kg/capita. The value of coefficient of multiple determination for the regression model in 2009 is R^2=0,7424 so 74,24% of the variation in Production of poultry meat is explained by both Import and Export of the same kind of meat. In the model for 2007 only 62,24% of the variation was explained, but this is still good enough concerning the quality of the model. In conducting the overall test of significance of the multiple regression using F-test, both multiple regression models, for 2007 and 2009, show that two independent variables Export and Import in kg/capita are statistically significant for explanation of Production of poultry meat in kg/capita in 38 countries. Regression standard error for the model for 2009 equals 5,7666 kg/capita, with a regression coefficient of variation of 30,41%. For the model for 2007 regression standard error equals 6,3828 kg/capita, and regression coefficient of variation is 34,97%. So, it may be concluded that both multiple regression models, for 2007 and 2009 are moderately representative. Both regression models have got all model assumptions fulfilled, so, they may be used for predictions. Finally, it should be stated, that both multiple regression models' proof the research hypothesis H1, because a production of poultry meat depends statistically significantly on Import and Export of that kind of meat.

6 Further research

This work has some obstacles. One of the problems is that the data from the FAOSTAT database are not updated. The data are only available for a couple of years back (in 2012 the data have been published in 2009). New data are going to be released in 2014 so the researchers are going to be able to continue its work on the relationship between variables connected with the supply of poultry meat in Europe.

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Miro Simonič is a Key account Manager in Export department of poultry production company and a lecturer of Product design and technological process at the Business School Murska Sobota. At the Faculty of Commerce and Business Sciences is finalizing Ph. D. study in the field of consumer supply and marketing. He has published a several papers at conferences with research on consumer behavior and marketing.

Ksenija Dumicic is a Full Professor of statistics at the Department of Statistics, Faculty of Economics and Business, University of Zagreb, Croatia. She specialized in statistical sampling and survey research methods. She has authored and co-authored more than 100 papers and 3 books in statistical research methodology.

Gabrijel Devetak is an associate professor of Marketing at the Faculty of Commerce Business Sciences. His research includes the fields of innovation and marketing. He has published over 1100 bibliographies units.

Regresijska analiza varijabel ki opisujejo oskrbo s perutninskim mesom v evropskih državah

V dokumentu, ki temelji na analizi uradnih podatkov Faostat-a in Eurostat-a za perutninsko meso 38 evropskih držav, zajetih za leti 2007 in 2009, sta bili proučevani dve hipotezi. V prvi, ki obravnava štiri spremenljivke, ki se nanašajo na proizvodnjo, izvoz, uvoz perutninskega mesa v kg/prebivalca, kot tudi na proizvodno ceno, izraženo v US $/t, so bile raziskovane navedene države z uporabo deskriptivne in klaster analize. Hipoteza, da lahko te države razvrstimo po skladnosti v klasterje, je bila potrjena. Kot rezultat analize, so države po skladnosti spremenljivk razvrščene v šest klasterjev. Druga, ki na osnovi multiple regresijske analize raziskuje, da v tem dokumentu obstaja statistično signifikantno razmerje med proizvodnjo, izvozom in uvozom perutninskega mesa, merjeno v kg/prebivalca. Ugotovljeno je, da obstaja visoka korelacija med proizvodnjo, kot odvisno spremenljivko in med vsako od neodvisnih spremenljivk.

Ključne besede: perutninsko meso, strategija trženja, klaster analiza, korelacija, multipla regresija

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Why European Subordinates Trust their Managers

Jon Aarum Andersen[1], Jure Kovač[2]

[1]Lillehammer University College, N-2604 Lillehammer, PO Box 952, Norway, Jon.Andersen@hil.no
[2]University of Maribor, Faculty of Organizational Sciences, Kidričeva cesta 55a, 4000 Kranj, Slovenia, Jure.Kovac@fov.uni-mb.si

This article addresses the problem of why subordinates trust their managers based on the responses from 108 subordinates of seven Slovenian managers and from 138 subordinates of eight Swedish managers. The subordinates of these managers responded to a 20-item instrument tested for reliability and validity. In both samples the managers enjoyed different degrees of trust. The level of trust vested in Slovenian managers was higher than in Swedish ones. The kinds of managers' actions that enhanced trust were similar amongst Swedish and Slovenian subordinates. Different socio-cultural contexts may theoretically explain why some other kinds of actions had contrasting effects between the samples. On the whole, the actions of managers explain trust in both countries. Subordinates' trust in managers declines with the increasing hierarchical distance in both national samples. Managers need to show in action that they trust their subordinates, promote their interests, demonstrate appreciation of their subordinates, and solve problems.

Key words: Trust, managers, subordinates, societal factors, hierarchy

1 Introduction

This comparative study addresses the problem of why subordinates trust their managers. It specifically addresses the questions of how trust can be developed, but not the consequences of trust and distrust. On the basis of a review of contemporary research on trust, Rousseau et al. (1998) have defined trust as a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intention or action of another. This present study has applied this definition. Dirks and Ferrin (2002) make a distinction between trust in a direct leader (manager) and trust in organizational leadership (management). This study is only concerned with trust in a direct manager, that is, the superior person of the subordinates.

The literature review shows that few studies have addressed the reasons for trust between subordinates and managers, and empirical studies on this relationship are scant. Ferrin and Gillespie (2010) have claimed that it is critical and timely to consider whether and how national or societal culture influences interpersonal trust. We also need to understand whether socio-cultural characteristics influence the trust that managers enjoy from their subordinates. This comparative study with data from Sweden and Slovenia indicates that Swedish subordinates do not trust their managers as much as their Slovenian counterparts do. A degree of similarity was found regarding what kinds of managers' actions enhanced trust in Sweden and Slovenia. The different socio-cultural contexts may theoretically explain why some other kinds of actions had contrasting effects on the subordinates. The term socio-cultural context refers here primarily to the cultural dimensions of Hofstede (1991) especially the dimensions of power-distance and uncertainty-avoidance. Trust is induced through actions, but the reasons for trust may vary owing to socio-cultural factors. Subordinates' trust in managers declines with increasing hierarchical distance.

2 Theories on trust in managers

Few studies have actually addressed the reasons for trust between subordinates and managers. The question of the reasons for trust is distinct both from the consequences of trust (e.g., Poon, 2006) and from the effects of trust violation and erosion (Elangovan et al., 2007). The present study also differs from the work of Atkinson and Butcher (2003) on the development of trust in the context of managerial relationships and the political realities of organizational life.

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The role of trust between managers and their subordinates has been the subject of research from numerous different disciplines. Trust is a crucial element in the behaviour effective leadership (Fleishman and Harris, 1962; Bass, 1990). Other researchers have shown that managers' efforts to build trust involve key mechanisms for enhancing organizational effectiveness (Barney and Hansen, 1994; Dirks, 2000; Dirks and Ferrin, 2002; Morgan and Zeffane, 2003; Bijlsma et al., 2008). Furthermore, Bijlsma-Frankema et al. (2008) have concluded that trust in supervisors is an important factor in promoting team performance. Drawing from these observations, we may conclude that trust in superiors is advantageous for both individuals and organizations.

A number of scholars have insisted on the need to appreciate the role of actions and behaviours in order to understand the phenomenon of trust (Sitkin and Roth, 1993; Gambetta, 1988; Luhmann, 1988; Coleman, 1990; Sheppard and Sherman, 1998). Bhattacharya et al. (1998) have concluded that trust is not only dependent on actions but also on outcomes and consequences. Trust, then, is a condition for interaction between individuals (Seligman, 1997). Whitener et al. (1998) have identified a series of managerial behaviours that may affect employees' trust in managers. Dirks (2000) has also studied how trust can be built through the actions of the managers. Biljsma and van de Bunt (2003) have found four managerial actions which generate trust amongst subordinates.

Additionally, globalization introduces a need to understand the role of socio-cultural contexts of trust in workplaces. With this consideration in mind, this study concentrates on subordinates' trust in managers and asks whether subordinate-manager relationships vary with societal and national characteristics. In order to address this question, this study has sought to compare the data from a Swedish study (Andersen, 2005) with data from another country, and preferably one with markedly different socio-cultural characteristics for testing the robustness of the conclusions. Data from a Slovenian organization, therefore, appeared to be apposite for this comparative study.

The Swedish study has shown that managers enjoyed different degrees of trust. Additionally, the managers' actions and support create trust, and explain the subordinates' trust in them. Two specific problems addressed here are (1) whether these conclusions on trust in managers based on a Swedish study are valid for Slovenian managers, and (2) whether aspects of trust are dependent on societal characteristics.

3 Hypotheses

Andersen (2005) has found that Swedish managers enjoyed different degrees of trust from their subordinates. It was imperative, then, to establish whether or not this is the case for managers in Slovenia. If managers from the two countries enjoy the same degree of trust as each other, then the issue of trust is inconsequential.

H1: Managers enjoy different degrees of trust.

Bijlsma-Frankema (2000) has suggested 38 explanations for subordinates' trust in their managers. Dirks and Skarlicki (2004) have also noted that trust in leadership appears to be associated with a well-established set of leadership actions and behaviours. "Leaders generate and sustain trust […] through the behavior of the leader", according to Joseph and Winston (2005, p. 7). Dirks and Ferrin (2002, p. 614) claim that individuals observe leaders' actions and draw inferences about the nature of the relationship with the leaders or the character of the leader, or both. The analyses performed by Andersen (2005) have indicated that managers' actions as perceived by the subordinates create trust. One purpose of the present study is to explore the validity of this explanation in Slovenia.

Processes of globalization have, moreover, accelerated the introduction of comparable managerial practices into different environments. Ferrin and Gillespie (2010) have claimed that it is critical and timely to consider whether and how national or societal culture influences interpersonal trust. We also need to understand whether socio-cultural characteristics influence the trust that managers enjoy from their subordinates. Globalization draws attention to the need to understand what socio-cultural influences there may be on trust in organizations, and whether the trust that managers enjoy from their subordinates depends on these factors. Lämsä and Pucetaite (2006) have pointed out that little research has been done to understand this relationship. There may be significant differences in values and work cultures across nations. Work morale, for instance, is an important factor in the development of trust amongst employees in some societies (Wicks and Berman, 2004).

Doney et al. (1998) have proposed a conceptual framework for studying trust in which Hofstede's cultural dimensions were included. The formulation of the second hypothesis has also taken into account Hofstede's theoretical concept, which links the characteristics of managerial styles with the cultural environment (Hofstede, 1991; Wade, 2003). The purpose of testing the second hypothesis is to find out whether Andersen's conclusion (2005) that trust in managers has it basis on managers' behaviour is valid in a Slovenian company or not. Consequently, the second hypothesis is:

H2: The reasons for subordinates' trust in managers are independent of socio-cultural contexts.

Trust is based on information and personal judgement (Mayer et al., 1995). More specifically, information on the personal qualities and social limitations of others is vital (Gambetta, 1988). Bigley and Pearce (1998) have pointed out that problems also arise in interactions between actors acquainted with each other in an ongoing relation. Subordinates' trust in their managers is partly a product of their ability to judge their managers' reliability (Sheppard and Sherman, 1998). It is assumed that some subordinates have a better basis for judging the reliability of their managers owing to daily and close contact. Other subordinates will not have the same knowledge of their manager and his or her behaviour. Dirks and Ferrin (2002) also emphasize the effect of the hierarchical distance.

Andersen (2005) has found that trust in managers is significantly higher for those subordinates with closer proximity to the manager. It is worthwhile, then, to explore this relationship with data from a Slovenian sample, as neither theoretical arguments nor empirical studies indicate that socio-cultural factors influence this relationship. In this regard, data from House et al. (2004) on power distance may be relevant. Slovenia ranked higher than Sweden, band A and band B, respectively. This result is in line with data from Hofstede and Hofstede (2004), who also reported that the power distance is higher in Slovenia than in Sweden. The purpose of testing the third hypothesis is to find out whether the finding of Andersen (2005) that trust in managers differs according to the subordinates' hierarchical level is independent of societal factors.

H3: Subordinates' trust in managers declines with increasing hierarchical distance.

4 Empirical study of trust in managers in Sweden and Slovenia

Sample

The Slovenian and the Swedish companies were almost identical with respect to such parameters as the number of hierarchical levels and the number of organizational units. Additionally, the position of the managers in this study was virtually identical, most being production managers. Both were manufacturing companies and part of large groups of companies. The Slovenian company employed 781 people who were organized into five large production units. The Swedish and Slovenian companies differed in the number of managers on the secondary level: the Swedish company had eight managers, whilst the Slovenian company had seven. No data had been collected on the age and sex of the respondents and their managers. All managers were male and very few of the subordinates were female.

Response

The number of respondents in Sweden in 2003 was 138, and in Slovenia 108. In Sweden, 44 people were in a directly subordinate position (closest subordinates of the managers), and 94 were classified as other employees. Some subordinates have a better basis for judging the trustworthiness of their managers because of their daily and close contact with the managers. In this study "closeness between subordinates and managers" refers to staff personnel who directly report to the managers and meet, see, and work with the managers on a daily basis as well as with next-level managers who also frequently interact with the managers in question. In Slovenia, 51 of the surveyed people were directly subordinate (25 of those were close co-workers), and 57 were other employees. In the Swedish research, the response rate varied between 50 per cent and 92 per cent. The response rate in Slovenia varied between 70 per cent and 100 per cent. Table 2 shows the main features of the two samples.

Instrument

Andersen (2005) has performed a study of trust in managers in a Swedish manufacturing company with 590 employees that focused on trust in eight managers, including the managing director. The investigations were carried out in 2002 and 2003. The study in 2002 utilized a questionnaire that was hypothesized to explain the degree of trust with 38 items of independent variables. An exploratory factor analysis showed that the 38 items formed three factors with a total of 20 items, which showed a high degree of internal consistency. The study was replicated in 2003 with the same eight managers and their closest subordinates, as well as all subordinates of one of the production managers. The study performed in 2003 used a refined version of the questionnaire with 21 items (including the dependent-variable item). In both the Swedish and Slovenian studies, the subordinates received the questionnaire at their home address, and they returned it directly to the researchers.

Reliability and validity of instrument applied

A questionnaire, based on previous research measured trust and its hypothesized causes, used a five-point Likert scale for all items (Andersen, 2005). The questionnaires used in the Swedish investigation in 2003 and in Slovenia in 2006 were identical. The original items in English were translated into Swedish and Slovenian and subjected to back-translations.

Reliability – Cronbach's alpha

To assess the reliability of the respondents' choice of individual statements, this study applied a Cronbach's alpha test. Table 1 summarizes the answers of the 44 respondents directly subordinated to all managers and the 94 other employees in the Swedish study, and the 51 respondents directly subordinated to all managers (of which 25 were close co-workers), and the 57 other employees in the Slovenian study. In the Swedish and Slovenian studies all three factors showed a very high degree of internal consistency according to Cronbach's alpha. It is a generally agreed that a value higher

Table 1. Cronbach's a per factor - Sweden (N = 138) and Slovenia (N = 108)

	No. of items		α		Standardized item α	
Factor	Sweden	Slovenia	Sweden	Slovenia	Sweden	Slovenia
1: Improvements	8	5	0.87	0.84	0.87	0.83
2: Managers' actions	8	8	0.94	0.83	0.94	0.89
3: Goals	4	4	0.79	0.80	0.79	0.80

Table 2. Overview of samples and response rates

Sample characteristics	Sweden	Slovenia
Number of managers	8	7
All managers - No. of closest subordinates	44	25
All managers - No. of subordinates reporting directly	NA	26
All managers - No. of remote subordinates	NA	57
One manager - No. of remote employees	94	NA
Total number of respondents	138	108
Response rate (average)	80 %	82 %
Total number of employees	590	781

than 0.70 is necessary to affirm reliability with Cronbach's alpha (Bagozzi, 1994; Nunally, 1978).

Validity

The studies of Bijlsma-Frankema (2000, 2002) have provided a theoretical basis for each affirmative statement on the questionnaire. The questionnaire items were generated from interviews with managers and subordinates. The performed factor analysis has revealed both discriminate and convergent validity.

These studies regarded trust as a quantitative variable, and they measured trust rather than distrust. The affirmative statement of "I trust my manager" measured the dependent variable of trust (item no. 4). In order to perform a more demanding statistical analysis, an assessment of whether the dependent variable trust has a normal distribution was necessary. The average values of the dependent variable and its standard deviation (with skewness and kurtosis- values less than one) for both the Swedish and Slovenian samples made it reasonable to regard trust as having a normal distribution (table 3). The variable had close to normal distribution. The requirements for performing the statistical analyses were met, therefore. The analysis showed that trust is a matter of degree. It appeared reasonable, then, to treat trust as a quantitative, continuous variable.

5 Analyses

Testing hypothesis one: Managers enjoy different degrees of trust.

At the outset, both the Swedish and the Slovenian data show that managers enjoy different degrees of trust from their subordinates. Table 3 supports the first hypothesis. Trust vested in Slovenian managers was higher than trust given to Swedish managers by their subordinates. A t-test of the two samples informed that the difference between the average trust was significant, with $t = 4.633$, $p<0.05$.

These findings of the average degree of trust (mean) and standard deviation in Sweden and Slovenia can be compared with the findings of Elangovan et al. (2007), who reported 4.43 and 0.61 (N = 120) with samples from Austria and Germany, and Poon (2006), who with data from Malaysia reported 3.38 and 0.71 (N = 106) by using different instruments. Ferrin and Gillespie (2010) have concluded that there is robust support for the view that there are meaningful differences across countries in the average level of generalized trust.

Data on socio-cultural factors and national characteristics has not been collected. What has been done is to refer to other scholars' work, particularly Hofstede (1991) and Hofstede and Hofstede (2004). These factors are used to explain our findings theoretically, not to show that they empirically do so.

Table 3. Mean degree of trust per manager – Sweden (N = 138) vs. Slovenia (N = 108)

Trust mean	Manager no.							
	1	2	3	4	5	6	7	8
Sweden = 3.25 (1.24)	4.5	4.3	3.8	3.6	3.4	2.7	2.4	2.0
Slovenia = 3.93 (1.09)	4.1	4.1	4.1	3.9	3.9	3.3	3.3	

Note: Standard deviation in brackets.

What may be the theoretically explanation for the significant difference in trust between Slovenian and Swedish managers?

In both Sweden (population 9.5 million) and Slovenia (population 2 million) the manufacturing industry is the most important. It is quite common to group Sweden as a Northern European or Nordic country. Placing Slovenia in the Eastern European cluster is, however, quite imprecise. Even when it was a part of the former Yugoslavia, Slovenia was the least influenced by the communist regime and was the most affluent and industrialized part.

Data from the European Values Survey (1999-2000) (Halman, 2003) have shown that work is more important to Slovenians than to Swedes. The power-distance index measures the extent to which the less powerful employees of organizations accept and expect the unequal distribution of power (Hofstede, 1991). It suggests that the followers endorse a society's level of inequality as much as the leaders do. The uncertainty-avoidance index indicates the degree to which people feel threatened by ambiguity or unknown situations. Slovenia ranked 15th and Sweden ranked 70th on this variable (Hofstede and Hofstede, 2004). If trust is a solution to countering uncertainty and risk, then differences in the degree of uncertainty avoidance between the two countries may account for differences in the degree of trust given to superiors. Previous studies suggest that the general level of trust is higher in Slovenia than in Sweden (Hofstede and Hofstede, 2004; Rus and Iglič, 2005; van Deth et al., 2007). According to the Edelman Trust Barometer (2009), the Slovenians' trust in management is higher than the Swedes'. If trust is a solution to countering uncertainty and risk, then differences in the higher degree of uncertainty avoidance in Slovenia may account for a higher degree of trust given to Slovenian superiors. This may explain why the trust vested in Slovenian managers was higher than the trust given to Swedish managers.

Testing hypothesis two: The reasons for subordinates' trust in managers are independent of socio-cultural contexts.

Factor analyses

The factor analyses included all 20 independent variables from the Swedish study and the same items from the Slovenian study. The result of the factor analyses of both studies is shown in table 1. Both the Swedish and Slovenian factor analyses yielded three factors: (1) improvements, working conditions, and atmosphere; (2) managers' actions and support; and (3) goals, development, and achievements. The items resulting from the factor analyses are shown in tables 4, 5, and 6.

The importance of mutual trust captured by item 2 (I feel that the manager trusts me) is also emphasized by Atkinson (2004), who stresses that there is an element of interdependence between subordinates' trust in their managers and sub-

Table 4. Factor 1: Improvements, working conditions, and atmosphere

Sweden (2003)	Slovenia (2006)
Item 11: The manager provides for conditions that make the goals set for my team/, unit/, department/, company attainable. (0.67)	*Item 11: The manager provides for conditions that make the goals set for my team/, unit/, department/, company attainable. (0.76)*
Item 14: Responsibilities are clearly demarcated in this department/, company. (0.67)	*Item 14: Responsibilities are clearly demarcated in this department/, company. (0.68)*
Item 20: There are enough resources at my disposal to fulfil my tasks. (0.78)	*Item 20: There are enough resources at my disposal to fulfil my tasks. (0.76)*
Item 1: Ideas and suggestions for improvement of work processes are quickly implemented in this department, company. (0.71)	*Item 9: My manager offers help and guidance to improve my performance. (0.67)*
Item 5: Differences of opinion between people are cleared up in an open and honest way around here. (0.70)	*Item 10: I am carefully informed about developments within the company that are relevant to my work. (0.73)*
Item 8: In this department/ company, employees are treated with care. (0.69)	
Item 16: My manager quickly implements our ideas for the improvement of work processes. (0.63)	
Item 18: Most decisions taken around here are based on a thorough reflection of possible solutions. (0.63)	

Table 5. Factor 2: Manager's actions and support

Sweden (2003)	Slovenia (2006)
Item 21: The manager solves problems in an adequate way. (0.56)	*Item 21: The manager solves problems in an adequate way. (0.80)*
Item 2: I feel that the manager trusts me. (0.85)	*Item 2: I feel that the manager trusts me. (0.79)*
Item 12: My manager ably promotes the interests of my department/, team within the company. (0.71)	*Item 12: My manager ably promotes the interests of my department/ team within the company. (0.78)*
Item 15: The manager shows appreciation if I perform a good job. (0.74)	*Item 15: The manager shows appreciation if I perform a good job. (0.79)*
Item 17: The manager will always support me in cases of problems with others. (0.70)	*Item 17: The manager will always support me in cases of problems with others. (0.79)*
Item 6: My manager is well aware of whether I perform as expected or not. (0.77)	*Item 5: Differences of opinion between people are cleared up in an open and honest way around here. (0.73)*
Item 9: My manager offers help and guidance to improve my performance. (0.75)	*Item 8: In this department, company, employees are treated with care. (0.73)*
Item 19: If I do a good job, appreciation is clearly shown. (0.62)	*Item 16: My manager quickly implements our ideas for improvement of work processes. (0.81)*

ordinates' perception of their managers' trust in them. The reasons for the differences in Factor 2 (Managers' action and support) between the Swedish and the Slovenian samples (five out of eight items were identical) are not empirically investigated, but may be due to socio-cultural factors.

Table 7 presents data generated from the three factors on the mean value and standard deviation for the Swedish and Slovenian samples. The content analysis of the formed factors revealed a similarity in Factor 2 between the Swedish and the Slovenian samples. Furthermore, the weight values were similar.

Regression analysis

A regression analysis was used to explore the relation between the obtained factors and dependent variable (trust). By using factor values, this study produced the following linear model (table 8).

The coefficient of determination, R^2, is statistically important. Subordinates' trust in managers can statistically be explained by the actions of the managers (table 7). For a deeper understanding of whether the generated factors, with the help of factor analysis, showed a causal connection between trust and management, this study carried out a regression analysis. Table 8 shows that in the Swedish study, factor 2 explained 76 per cent degree of the trust in managers ($p<0.001$). Factors 1 and 3 were insignificant. The regression analysis confirmed that managerial actions and support fostered trust. This result was also in agreement with the findings of the regression analysis of the Slovenian study, in which fac-

Table 6. Factor 3: Goals, development and achievements

Sweden (2003)	Slovenia (2006)
Item 3: I am well aware of the goals of my department/, team. (0.81)	*Item 3: I am well aware of the goals of my department/, team. (0.84)*
Item 7: I agree with the goals of my department/, team. (0.81)	*Item 7: I agree with the goals of my department/, team. (0.83)*
Item 10: I am carefully informed about developments within the company that are relevant to my work. (0.67)	*Item 1: Ideas and suggestions for improvement of work processes are quickly implemented in this department/, company. (0.64)*
Item 13: I feel at ease in criticising the performance of my colleagues in a constructive way. (0.64)	*Item 18: Most decisions taken around here are based on thorough reflection of possible solutions. (0.62)*

Table 7. Descriptive statistics for the factors according to the factor analyses Sweden (N = 138) and Slovenia (N = 108)

Factors	Mean		Standard deviation	
	Sweden	Slovenia	Sweden	Slovenia
	2003	2006	2003	2006
Factor 1: Improvements	2.85	3.97	0.77	0.87
Factor 2: Managers' actions	2.79	3.81	0.95	0.84
Factor 3: Goals	3.40	4.03	0.83	0.96

Table 8. Regression analyses – Sweden (N = 138) and Slovenia (N = 108)

Model	B		B (SE)		ß		Significance	
Country	Swed	Slov	Swed	Slov	Swed	Slov	Swed	Slov
(constant)	- .69	4.02	0.24	0.09			0.004	0.000
Factor 1: Improvements	0.20	0.04	0.16	0.15	0.12	0.72	0.219	0.754
Factor 2: Manager's actions	0.95	1.03	0.13	0.11	0.72	0.89	0.000**	0.000**
Factor 3: Goals	0.08	- 0.15	0.11	0.13	0.05	- 0.08	0.497	0.261
Control variable: Management group	0.06	1.27	0.23	0.42	0.02	1.27	0.788	0.031
Control variable: Other employees	0.30	1.01	0.12	0.13	0.11	0.96	0.016*	0.00

Note on Sweden 2003:
R^2 = 0.760; Adjusted R^2 = 0.754; F = 141.164
*** = p<0.001*
** = p<0.05*
Note on Slovenia 2006:
R^2 = 0.826; Adjusted R^2 = 0.813; F = 61.755
*** = p<.0.001*

tor 2, managerial actions, explained 82 per cent of the degree of trust in managers (p<0.001).

Factors 1 and 3 were insignificant in both studies. The results from the Swedish and Slovenian studies were similar and confirmed the second hypothesis. Employees' trust is due to the actions of the manager. However, this factor of managers' actions is not identical in the two samples.

These results support the framework of initiating trustworthy behaviour that Whitener et al. (1998) have suggested. They have identified five managerial behaviours that may affect employees' trust in managers: *(1) behavioural consistency,* which refers to regularity over time and across situations. Tables 5 and 6 show that these aspects are implied in items nos. 1 and 17; *(2) acting with integrity*, which refers to attributions that affect employees' trust and implied in items nos. 2, 5, and 6; *(3) sharing and delegation of control,* refers to participation in decision-making, which may be associated with item no. 3; *(4) openness of communication* refers to the provision of accurate information, explanations for decisions, and openness, which are found in items nos. 8, 9, 12, 15, and 19; and finally *(5) demonstrations of concern,* which refers to the consideration for employees' needs and interests, actions that protect employees' interests, and the unwillingness to exploit others for the sake of self-interest. This study provides empirical support to Whitener et al. (1998), who suggest that managers who engage in these behaviours will increase the likelihood that their employees will trust them.

Biljsma and van de Bunt (2003) have identified five managerial actions that elicit trust in managers by subordinates: *(1) monitoring performance*. Table 5 shows that this aspect is implied in item no. 6; *(2) guidance to improve individual performance*, which is found in item no. 9; *(3) support in case of trouble with others,* which is found in item no. 9; *(4) openness to ideas of subordinates and co-operation-related problem solving,* which are aspects found in items nos. 5, 16, and 21. Appreciation of good work, however, was not significantly related to trust in managers in Biljsma and van de Bunt's (2003) study. In this present study, this kind of behaviour was related to trust and items no. 15 and 19 were part of the factor 2, which explained trust in Sweden and Slovenia.

Item no. 21 (The manager solves problems in an adequate way) had the strongest correlation with the degree of trust (+ 0.82) in the Swedish sample and (+ 0.86) in the Slovenian one. Dirks and Ferrin (2002, p. 615) have stressed that "at present, research has not explored which practices have the strongest effect on trust". They (2002, p. 622) have also stated: "Given this pattern of results, one might speculate that future research and practice might have greater success by focusing on leader behaviours and practices". The reasons for subordinates' trust in managers were quite similar. However, socio-cultural contexts appeared to influence what kinds of actions enhanced subordinates' trust in managers. This investigation has shown that Swedish and Slovenian managers' behaviours explain why subordinates trust them. Ferrin and Gillespie (2010) have also concluded that there is a considerable support for the view that there are both culturally specific and universally applicable determinants of trust.

Testing hypothesis 3: Trust in managers differs between the closest subordinates and other employees.

Table 9 shows the degree of trust per managerial group of 2003 in Sweden. It is evident that the closest subordinates had a higher degree of trust in their managers than all other employees had for one manager (average scores 3.3 versus 2.6). The closest subordinates of this manager also had more trust in the manager than all other subordinates had for the same manager. In the regression analysis for 2003 (table 8), a control was carried out to see if different managerial positions had an impact on the degree of trust. One group consisted of the closest subordinates of all eight managers (N = 44), whilst the other group consisted of the other subordinates of one manager (N = 94). A t-test showed that there was a significant difference in the degree of trust vested in the managers by their closest subordinates compared to the trust that other subordinates had, with $t = 3.118$, $p<0.05$. In the Swedish sample the closest subordinates' trust in managers was higher than other employees'.

The hypothesis also received support from the analysis of the Slovenian sample. On the basis of the answers of 51 respondents directly subordinate to all managers (of which there were 25 close co-workers) and 57 other employees (108 respondents) in the Slovenian study, the following results refer to the statements connected to the individual factors originating from the factor analysis (table 7). The high degree of trust in Slovenian managers can be attributed to the respondents' proximity to the managerial level. In the Slovenian study, these respondents were the closest co-workers of the managers. In the Swedish case, however, respondents were more dispersed. This finding indicates that the degree of trust in managers declines as the hierarchical distance from the manager increases.

The Slovenian sample also throws some additional light on the importance of distance between the trust in managers and their subordinates (table 9). The Slovenian sample provides data on three levels whilst the Swedish sample provides two (i.e., the closest subordinates and other subordinates). A t-test on the average degree of trust between the 25 closest subordinates to the managers and the 57 most remote subordinates (lowest level) showed that this difference was significant, with $t = 4.106$, $p<0.05$. Testing the average degree of trust between the 25 closest subordinates to the managers compared to the degree of trust of the 26 other subordinates reporting directly to the managers showed that this difference is insignificant, with $t = 0.405$, $p>0.10$. Finally, a t-test of the differences in trust between the 26 subordinates reporting directly to the managers and the 57 other subordinates showed that this difference was significant, with $t = 2.569$, $p<0.01$. The Slovenian study confirmed the result from Sweden: the more removed subordinates were from managers, the less they trusted them, a finding that supports the third hypothesis. These findings thus suggest that societal factors do not exert a strong influence.

6 Conclusions

Both of these studies show that managers enjoy different degrees of trust from their subordinates. The first hypothesis was supported. The level of trust vested in Slovenian manag-

Table 9. Descriptive statistics - Trust variables Sweden and Slovenia

	Respondents (N)		Average		Standard deviation	
	Sweden	Slovenia	Sweden	Slovenia	Sweden	Slovenia
All managers – closest subordinates	44	25	3.25	4.4	1.241	0.666
All managers – subordinates reporting directly	NA	26	NA	4.29	NA	1.210
All managers - remote Subordinates	NA	57	NA	3.56	NA	1.180
One manager - remote employees (Sweden only)	94	NA	2.60	NA	1.212	NA

ers by their subordinates is significantly higher than what is vested in Swedish managers. This study did not explore the reasons for this difference, but it may be due to the greater remoteness to power in Sweden.

The analysis revealed a degree of similarity regarding the managers' actions and support between the Swedish and the Slovenian samples, as five out of eight items were identical. Socio-cultural contexts may explain why the items in the factor "managers' actions and support" were not identical. The second hypothesis was partly supported. The actions of managers were decisive for the development of trust.

The actions and support of Swedish managers explained 76 per cent of the degree of trust that the subordinates had in them. This result is also in agreement with the findings of the Slovenian study, where managerial actions explained 82 per cent of the degree of subordinates' trust. These results may imply that both Swedish and Slovenian subordinates perceived leadership through managerial actions. Trust was strongly associated with such terms as "the manager has confidence in me", "the manager promotes our interests", "the manager shows me appreciation", "the manager supports me", and "the manager solves problems". In both these national samples the other two factors were insignificantly related to trust.

Trust in managers differed between the closest subordinates and other employees. The Swedish study supported the third hypothesis, since the closest subordinates had a significantly higher degree of trust in their manager than more remote subordinates. The Slovenian data also supported this conclusion. Theoretical explanations for these empirical outcomes in both the Swedish and Slovenian samples are hard to find.

Implications for managers

The development and maintenance of trust are especially important to managerial and organizational effectiveness, as several scholars (e.g., Atkinson, 2004) have emphasized. This comparative study of why Swedish and Slovenian subordinates trusted their managers informs managers on how to establish, maintain or increase the trust of their subordinates. The answer points to the subordinates' perception of their managers' actions. The manager needs to show in action that he or she trusts his or her subordinates, promotes the interests of the subordinates, demonstrates an appreciation of his or her subordinates, and solves problems in an adequate way. The comparative study also indicates that it is more difficult for managers to gain the trust of the more remote subordinates than of those who are closer.

Implications for trust theory

This comparative study of subordinates' reasons for trusting their managers in Sweden and Slovenia addresses four theoretical aspects of trust relations between managers and subordinates. It supports previous research and the assumptions that: (1) managers enjoy different degrees of trust; (2) trust is induced through actions; and (3) trust in managers differs between the closest subordinates and other employees. A strong association was found between the actions of managers and the degree of subordinates' trust in managers. The kind of leadership that generates trust is leadership by actions, or what are perceived as actions by the subordinates. Trust in managers is a promising way of enhancing organizational performance.

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Jon Aarum Andersen is professor of Business Administration (management) at Linnaeus University, Sweden (partly leave of absence) and full time professor of Organization and Leadership at Lillehammer University College, Norway.

Jure Kovač is a Professor of Organization and Management at Faculty of Organizational Sciences, University of Maribor. His research interests are organization theory, organization design and management development.

Zakaj evropski podrejeni zaupajo svojim menedžerjem - primerjalna študija slovenskega in švedskega podjetja

Članek skuša odgovoriti na vprašanje, zakaj podrejeni zaupajo svojim menedžerjem, in sicer na podlagi odgovorov 108 ljudi, ki so podrejeni sedmim slovenskim menedžerjem in 138 ljudi, ki so podrejeni osmim švedskim menedžerjem. Menedžerji so uživali različne stopnje zaupanja. Stopnja zaupanja v slovenske menedžerje je višja od švedskih. Vrste dejanj menedžerjev, ki so poviševala zaupanje švedskih in slovenskih podrejenih so bila podobna, različen socio-kulturni kontekst pa morda lahko pojasni, zakaj imajo druge vrste dejanj nasproten učinek med skupinama. Na splošno pa dejanja menedžerjev pojasnijo zaupanje v obeh državah. Pri obeh vzorcih se zaupanje podrejenih v menedžerje zmanjša z večjo razdaljo v hierarhiji. Menedžerji morajo z dejanji pokazati, da zaupajo svojim podrejenim, da podpirajo njihove interese, da pokažejo, da jih cenijo in da težave rešujejo zadovoljivo, da bi vzpostavili, vzdrževali ali povišali zaupanje svojih podrejenih.

Ključne besede: zaupanje, menedžerji, podrejeni, družbeni dejavniki, hierarhija

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