CRACOW UNIVERSITY OF ECONOMICS

FOUNDATION OF THE CRACOW UNIVERSITY OF ECONOMICS

KNOWLEDGE ECONOMY SOCIETY

CHALLENGES AND TOOLS OF MODERN FINANCE AND INFORMATION TECHNOLOGY

Edited by
Paweł Ulman, Ryszard Węgrzyn, Piotr Wójtowicz

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Introduction

The undergoing processes of the liberalisation of business activity, deregulations of markets and the development of high technologies contribute to the progressing globalisation of the world economy and the integration of capital markets. Potential benefits and threats resulting from these processes pose new challenges to individual enterprises, markets and economies. The development of financial markets along with the risk being an inseparable element of any business activity have become the basis of the dynamic growth of modern finance, including financial risk management. Due to the global economic crisis we observe growth of risk related to the turbulences on financial markets and the increasing role of risk management. The importance of the measurement and reduction of risk and its interdisciplinary character is proven by the development of the tools of mathematics, statistics and econometrics in this respect.

The accelerated development of research into financial risk could be observed in the world literature as early as in the 1970s. Significant progress took also place in the following decades with the development of the techniques of collecting and processing data and the possibility of making complex computer computations. The dynamic development of information and communication technologies significantly supported undertaking economic decisions, but also contributed to the facilitation of numerous processes in various spheres of socio-economic life.

In the era of the increased level of risk, the interest in the risk management concept is growing not only among theoreticians but also practicians. For business entities, risk identification and assessment, as well as the ability to reduce its negative effects are becoming the crucial element. At present, the ability to manage risk is crucial in the financial sector, in banks and in insurance companies. The issues are the object of the intense attention of the Basel Committee on Banking Supervision, and they were reflected in Solvency II Directive. In the case of banks, in addition to standard risk measurement, more and more often attention is paid to risk connected with the ownership structure. The problems of systemic risk are still a great challenge, and in this context the problem of managing the portfolio of many kinds of risk, particularly the process of its aggregation.

Application of the proper instruments of risk reduction is an important issue. This application, however, is also connected with their availability. The development of the derivatives market or new kinds of insurance is in this case a condition of the effective reduction of various types of risk, particularly in the case of enterprises based on innovations and new technologies.

The efficient functioning of enterprises and their market assessment depend on the reliability and adequacy of information generated outside the accounting system. At the beginning of the 21st century, due to accounting scandals in the United States and in Europe, the reliability of information in this respect suffered a lot. However, it seems that accounting, especially earnings management (called sometimes "creative accounting"), stops to be perceived in bad light. A still current challenge for accounting, though not a new one, is the measurement of human capital and equitable payment. The history of labour accounting shows that the measurement system of labour value and adequate remuneration has existed in the economic life since the beginning of civilisation.

Recent changes undergoing in various spheres of socio-economic life were a result of the development of the new civilisation era in which knowledge is becoming the most valuable resource. A new model of knowledge based economy treats human capital as one of the dominating factors of growth. In recent years, fast development of technology and more and more common access to the Internet have brought about numerous applications of knowledge delivery systems. The process results in a considerable increase in data resources collected by institutions, enterprises and natural persons, which often constricts their use and constitutes great challenge in terms of the analysis of large data sets.

Recently, a dynamic development of content processing technologies in respect of information management systems has been marked. A new class of systems has arisen, called Enterprise Content Management (ECM), whose basic scope of applications is the circulation of documents and information concerning financial processes and related to personnel. Practical experiences proved the necessity of applying proper supervision over the circulation and reliability of financial documents in particular. ICT tools are applied in this respect, in connection with appropriate methods which enable efficient control and thus limiting the risk of internal entities.

The signalled research challenges and problems are reflected in this work whose basic aim is to point to management models, methods and tools, as well as analytical solutions ensuring the efficiency and effectiveness of the functioning of market entities. Within the framework of such an extensive problem area of research, the work focuses on the following main subject areas: risk management, accounting, information and communication technology in the analysis of entities' documentation, as well as the education process and activities aiming at the support of ICT applications.

We are handing over to the Readers the monograph being the effect of research works of academics, as well as students and doctoral students in the field of broadly understood finance and information technology. This monograph consists of two separate parts presenting issues related to the defined research areas.

Part One includes the problems of risk management, instruments of its reduction, and accounting. It presents the findings of the empirical research into the influence of the ownership structure on the results and risk of banks in the European Union, which may be significant for bank rating systems (*Antonio Fabio Forgione, Carlo Migliardo* and *Ivan Nania*); it discusses the problem which is important for the process of aggregation and quantitative definition of portfolio risk, namely the problem of estimating value at risk (VaR) in the situation of the lack of information or partial information about the structure of relations between random variables (*Stanisław Wanat, Ryszard Konieczny*); it identifies and analyses changes undergoing on the derivatives market in recent years, as well as the conditionings and factors influencing its development (*Ryszard Węgrzyn*); it presents the significance of insurance as one of most optimal methods of reducing operational risk of start-ups which are burdened with a high level of this risk on each stage of development and should treat risk management as a priority (*Ryszard Pukała*). The next part analyses changes in perceiving so-called creative accounting which only a few years ago was identified almost only with frauds (*Artur Hołda, Anna Staszel*), and presents the history of labour accounting as an activity resulting from the systematic solving of problems with harmonious work and adequate remuneration (*Jurij Renkas*).

Part Two of the monograph discusses the issues of information and communication technology in the analysis of entities' documentation and the process of education, as well as the problems of ICT applications. It presents the analysis of specialist software for control in financial report-

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[1] See: *Knowledge – Economy – Society. Challenges of the Contemporary World*, Edited by R. Oczkowska, B. Mikuła, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2011; *Knowledge – Economy – Society. Dilemmas of the Contemporary Management*, Edited by A. Malina, R. Oczkowska, T. Rojek, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2012; *Knowledge – Economy – Society. Transfer of Knowledge in the Contemporary Economy*, Edited by P. Lula, B. Mikuła, A. Jaki, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2012; *Knowledge – Economy – Society. Global and Regional Challenges of the 21st Century Economy*, Edited by P. Lula, B. Mikuła, A. Jaki, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2013; *Knowledge – Economy – Society. Challenges of the Contemporary Management*, Edited by A. Malina, R. Oczkowska, T. Rojek, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2013; *Knowledge – Economy – Society. Dilemmas of the Economic Resources Management*, Edited by R. Oczkowska, G. Śmigielska, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2014; *Knowledge – Economy – Society. Contemporary tools of Organizational Resources Management*, Edited by P. Lula, T. Rojek, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2014; *Knowledge – Economy – Society. Contemporary Organizations in the Process of Institutional Transformations*, Edited by A. Malina, R. Oczkowska, J. Plichta, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2014, *Knowledge – Economy – Society. Managing Organizations: Concepts and Their Applications*, Edited by A. Jaki, B. Mikuła, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2014; *Knowledge – Economy – Society. Problems of Management and Financing Economic Activity*, Edited by R. Oczkowska, G. Śmigielska, Faculty

This work inscribes into the series of publications under the common title *Knowledge – Economy – Society*, which constitute one of the effects of many years' cooperation between the academic environment of the Faculty of Management at the Cracow University of Economics and employees and doctoral students of other faculties of the University, with representatives of different Polish academic circles, as well as representatives of foreign academic circles.

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of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2014; *Knowledge – Economy – Society. Challenges and Development Trends of Modern Economy, Finance and Information Technology*, Edited by A. Malina, R. Oczkowska, J. Kaczmarek, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2015; *Knowledge – Economy – Society. Challenges of Contemporary Economies in the Face of Global Market Conditions*, Edited by R. Borowiecki, A. Jaki, P. Lula, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2015; *Knowledge – Economy – Society. Reorientation of Paradigms and Concepts of Management in the Contemporary Economy*, Edited by B. Mikuła, T. Rojek, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2015; *Knowledge – Economy – Society. Challenges for Enterprises in Knowledge-Based Economy*, Edited by R. Oczkowska, G. Śmigielska, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2015; *Knowledge – Economy – Society. Challenges and Development of Modern Finance and Information Technology in Changing Market Conditions*, Edited by A. Malina, R. Węgrzyn, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2016; *Knowledge – Economy – Society. Contemporary Aspects of Economic Transformations*, Edited by P. Lula, T. Rojek, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2016 and *Knowledge – Economy – Society. Strategies, Concepts and Instruments of Management*, Edited by R. Oczkowska, A. Jaki, B. Mikuła, Faculty of Management of the Cracow University of Economics – Foundation of the Cracow University of Economics, Cracow 2016.

PART I

CONTEMPORARY ISSUES AND TOOLS OF FINANCIAL RISK MANAGEMENT AND ACCOUNTING

Chapter 1

The Impact of Ownership Structure on Bank Performance and Risk in the European Union

Antonio Fabio Forgione, Carlo Migliardo, Ivan Nania

1. Introduction

According to the seminal study by Jensen and Meckling (1976), a conflict of interest between owners and managers arises when ownership is separated from control because managers might be reluctant to risk the advantages associated with their role. This reluctance could induce managers to choose less risky investments or operate with larger amounts of capital than owners would consider optimal, thus affecting firm's performance. However, the presence of shareholder control should mitigate this phenomenon because of the shareholders' ability and incentive to monitor managers (Shleifer & Vishny, 1997).

Numerous studies have analyzed the impact of ownership structure on bank performance (Iannotta et al., 2007; Aebi et al., 2012; Saghi-Zedek & Tarazi, 2015) and lending behavior (Micco & Panizza, 2006). Other studies have focused on the role of banks' corporate governance with regard to manager incentives (Fahlenbrach & Shulz, 2011), board composition (Berger et al., 2014), and board independence (Erkens et al., 2012).

The aforementioned literature has mainly focused on the nature of participation (government and public) and the ownership concentration (dispersed versus concentrated). In this paper, we empirically investigate the impact of ownership structure on bank performance in the European Union. In particular, we study how different types of shareholders affect bank performance in terms of income, profit, cost, and risk. Moreover, while earlier studies have used discrete data related to ownership structure, we adopt a set of continuous variables that exactly express the participation of each type of shareholder that we selected on the basis of business activity (government institutions, banks, mutual funds, and industrial companies). Therefore, our analysis allows us to obtain a better understanding of the actual effect of four shareholder types on the banks' profitability and risk, capturing the marginal effect of each type of shareholder on bank performance.

2. Data and Methodology

In this paper, we use a balanced dataset that includes 900 observations corresponding to 225 active banks from 28 countries in the European Union from 2011 to 2014. We constructed our

sample by collecting data from Bureau van Dijk Bankscope, following four criteria: first, we only included banks for which the dependent variables were available; second, we excluded banks that did not provide information on the percentage participation held by at least one shareholder; third, we excluded banks with a BvD independence indicator equal to *D* because of their role as branches of a controlling company; and fourth, in order to capture the shareholder's control effect on bank performance, we only included banks whose ownership structure did not change during the sample period.

We winsorized all continuous variables at the upper and lower 1% level to reduce the possible impact of outliers. Longitudinal data used in studies in this field are likely to foster the presence of the powers of unit root variables, cross-sectional dependence, and measurement errors (Ampenberger et al., 2013). These issues affect fixed-effects (FE) and random-effects (RE) estimators that could be biased and inconsistent, resulting in misleading inferences (Sarafidis & Robertson, 2009).

Moreover, bank ownership changes very little over time (Bertrand et al., 2002), and in our case, it did not vary at all; so, the FE estimator was not feasible[1]. Therefore, the best-performing panel data estimator is the between (BE) estimator (Hauk & Wacziarg, 2009). Averaging variable observations over time allowed us to mitigate the negative effects of nonsystematic measurement errors and cross-sectional dependence on the estimation process. In addition, Pesaran and Smith (1995) showed that the BE estimator should provide consistent estimates of the long-run relationship between variables. Finally, "between" estimates attenuate the concerns that arise when observations within the same sample are constant over time and independent from each other.

To avoid endogeneity, we also adopted an instrumental variable approach for the BE estimator (IV-BE).

Our general panel equation model follows the specification of Saghi-Zedek and Tarazi (2015); however, we used a different measure for ownership data. We estimated the following model:

$$P_{it} = \alpha + \sum_{j=1}^{5} \beta_j OS_{it} + \gamma Independence_i + \sum_{k=1}^{5} \delta_k C_{it} + \eta Listed_i + \varepsilon_{it} \quad (1)$$

where P_{it} is the observed performance for the i^{th} bank at time t and OS_{it} is the vector of the ownership structure variable that indicates the ownership of each type of shareholder in the i^{th} bank at time t.

We used the following performance measures: *Profit* is the ratio of operating profit to total assets, *Income* stands for the ratio of operating income to total assets, *Cost* is the ratio of operating costs to total assets, and *Risk* is the standard deviation of *ROA* (Iannotta et al., 2007).

We employed the following ownership structure characteristics as components of the OS_{it} vector: *Gob*, *Bao*, *Mpo*, and *Ico*. More specifically, these last covariates are a set of dummy variables equal to 1 if the shareholder is one of the following: national or local government institution, bank, mutual or pension fund, and industrial company, in that order, multiplied by *Share*; namely, the total sum of the percentage participation held in the i^{th} bank at time *t* by each type of shareholder[2].

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[1] The empirical literature shows that the ownership structure is rather stable over time, so the FE estimates would be driven by variations in a few bank-year observations (Lafontaine & Shaw, 2005; Benson & Davidson, 2009; Ampenberger, 2013).

[2] The *Share* variable, for each bank, contains the sum of percentage participation held by each type of shareholders.

The variable *Other* includes the percentage participation held by shareholders not included in one of the previous categories. *Independence* is the degree of bank independence from the ultimate shareholders (for detailed information, see the BvD independence indicator)[3].

Similar to Saghi-Zedek and Tarazi (2015) and Saghi-Zedek (2016), we use a set of control variables (C) affecting bank profitability and risk. In particular, *Loanloss* is the ratio of the loan loss provision to total loans. This covariate reflects the quality of bank loans, as well known it is the riskiest bank assets. *Ecap* is the ratio of equity to total assets, and it controls how bank capitalization impacts on bank profitability and risk, whereas its square ($Ecap^2$) allow us to investigate potential non-linear effect on bank performance. Indeed, a better bank capitalization enhances monitoring and good investment practices (Berger & Bouwman, 2013). Berger and Bonaccorsi (2006) show evidence of a hump-shaped effect of capital on profitability. *Loandeposits is* the ratio of loans to short-term deposits and it controls both funding policy and business model, at bank level. *NNII is* the ratio of non-interest operating income to operating income and it also controls for bank business model, from a profitability point of view. Finally, *Listed* is a dummy variable equal to one if the bank is listed in a stock market. It can affects bank's risk taking behavior (Iannotta et al., 2013).

3. Conclusion

In this section, we present and discuss the data and the empirical results.

Table 1. Summary statistics

Variable name	N of obs.	Mean	Standard deviation	Minimum	Maximum
Income	1112	7.152%	13.239	-7.692%	116.124%
Profit	1112	1.442%	4.955	-18.799%	26.936%
Cost	1054	4.709%	9.275	0.076%	72.145%
Risk	1144	1.784%	3.266	0.001%	15.362%
Gob_share	1248	1.760%	7.308	0%	90%
Bao_share	1248	38.865%	38.006	0%	100%
Mpo_share	1252	3.735%	7.140	0%	49.9%
Ico_share	1252	9.630%	20.498	0%	100%
Other_share	1248	6.755%	17.434	0%	100%
Independence	1252	2.089	0.992	1	4
Loanloss	843	0.018%	0.041	-0.119%	0.366%
Ecap	1114	0.205%	0.263	-0.010%	0.998%
$Ecap^2$	1114	0.069%	0.150	0%	0.654%
Loandeposits	924	2.974%	23.086	0.010%	387.981%
NNII	1107	0.493%	0.427	-1.626%	2.347%
Listed	1252	0.518	0.5	0	1

Source: own calculation based on Bureau van Dijk Bankscope.

[3] The BvD Independence Indicator has been transformed into a discrete variable, *Independence*, for decreasing independence from 1 (BvDII = A) to 4 (BvDII = U).

Table 1 reports the descriptive statistics of the variables. Even if the sample includes only active banks, some of these banks report negative performance to the point that it wears away their equity. It is worth noting that some banks follow almost risk-free strategies. Table 1 shows a relative low concentrated ownership structure. The less dispersed participation is for bank owner, whereas the most is for Government owner Table 2 reports the results for the BE and IV-BE estimators.

Table 2. Between and IV-Between Estimates

	Between				**IV-Between**
	Income	**Profit**	**Cost**	**Risk**	**Income**
Gob_share	0.0150	0.0050	-0.0017	0.0132	0.0327**
	(0.014)	(0.004)	(0.009)	(0.008)	(0.016)
Bao_share	0.0163***	0.0087***	0.0104**	-0.0053***	0.0194***
	(0.005)	(0.003)	(0.005)	(0.002)	(0.006)
Mpo_share	0.0706***	0.0339***	0.0437**	-0.0327***	0.0609**
	(0.025)	(0.010)	(0.019)	(0.006)	(0.028)
Ico_share	0.0479***	0.0036	0.0483***	0.0003	0.0473***
	(0.013)	(0.005)	(0.012)	(0.002)	(0.015)
Other_share	0.0063	-0.0014	0.0059	-0.0012	0.0168**
	(0.007)	(0.004)	(0.005)	(0.002)	(0.007)
Independence	-0.3545*	-0.3877***	-0.0750	0.2034***	-0.3644**
	(0.184)	(0.087)	(0.135)	(0.053)	(0.184)
Loanloss	54.265***	-7.347	38.586**	15.301***	57.293***
	(19.592)	(4.770)	(15.108)	(4.030)	(17.727)
Ecap	25.0968***	12.4691***	11.9631***	0.3848	29.6459***
	(3.019)	(1.938)	(2.224)	(0.849)	(3.743)
Ecap2	-56.498***	-33.746***	-19.764***	6.181*	-65.598***
	(7.462)	(5.052)	(4.834)	(3.209)	(8.465)
Loandeposits	0.0093*	-0.0652***	0.1242***	0.0373***	0.0081**
	(0.005)	(0.012)	(0.018)	(0.005)	(0.004)
NNII	2.7219***	-0.7601**	4.4301***	0.9233***	-3.3660**
	(0.722)	(0.326)	(0.697)	(0.171)	(1.628)
Listed	0.5184	-0.0089	0.2367	-0.0176	0.8575**
	(0.318)	(0.204)	(0.245)	(0.101)	(0.358)
Cons	0.1864	0.8650**	-1.1606***	-0.3660*	1.9009***
	(0.381)	(0.339)	(0.387)	(0.204)	(0.576)
D-W-H test					$\chi2$ (1)=21.278 p-value=0.00
Sargan test					$\chi2$ (2)=3.83 p-value=0.15
R2	0.3902	0.3306	0.4545	0.4619	0.2855
N	900	900	892	896	900

Notes: Robust standard errors in parenthesis; ***, **, * indicates statistical significant at the 1%, 5% and 10% level, respectively.

Source: own calculation based on Bureau van Dijk Bankscope.

Our results confirm that ownership structure matters in terms of bank performance. Indeed, bank profitability and risk are affected by the nature of its shareholders as a consequence of their institutional role and incentives. On the one hand, the associated coefficient for *Gob* is almost never significant because government institutions poorly consider both profitability and risk as the main goals. On the other hand, the estimated parameters for banks and mutual funds are always positive and significant. Simultaneously, banks with this ownership structure present a better risk-return relationship since they are more profitable and less risky. Further, the coefficient of *Mpo* is always the largest because profitability (in both the long run and the short run) is the main target for mutual funds. The coefficient estimated for *Ico* is only statistically significant for *Income* and *Cost* and not for *Risk* and *Profit.*

The other important determinant related to ownership structure is *Independence.* The greater the independence, the better is the bank performance both in terms of profitability and riskiness.

With regard to the *Cost* equation results, our evidence shows that banks with better performance (i.e., *Bao*, *Mpo*, and *Ico*) also bear greater operating expenses.

The other ownership variable (*Independence*) provides important insights on the effect of bank concentration on bank performance and risk. In fact, less dispersed owners are associated with worst risk-return profile.

Our findings related to the control variables are consistent with the existing literature. In particular, *Ecap* shows a nonlinear effect on bank performance. The coefficient of the capital ratio is positive and that of the squared term is negative, in term of bank performance. In this regard, following equation (1), the turning point is equal to $-\delta_2/2\delta_3$. In our estimation, by taking the value is equals, respectively, to 22.60%, 18.47%, 30.26%. The result is consistent with Berger and Bonaccorsi (2006), which analyzed the profitability of U.S. commercial bank.

As robust checks, Table 2 also reports the estimates of IV-BE, controlling for potential endogeneity problems. In particular, the Durbin-Wu-Hausman test for endogeneity suggests instrumenting *NNII*, which has been instrumented with *Loans, Deposits*, and *Specialization.* The validity of the set of instruments is confirmed by the results of the Sargan test. Overall, the IV-BE estimates do not diverge from the exogenous model. We report in Table 3 Ordinary Last Square (OLS) and Instrumental Variable (IV) regressions and the results are in line with the BE and IV-BE estimates.

Table 3. OLS and IV Estimates

	OLS				**IV**
	Income	**Profit**	**Cost**	**Risk**	**Income**
Gob_share	0.0159	0.0002	0.0029	0.0143	0.0309*
	(0.016)	(0.007)	(0.011)	(0.009)	(0.018)
Bao_share	0.0117**	0.0033	0.0105**	-0.0046***	0.0132**
	(0.005)	(0.003)	(0.005)	(0.002)	(0.006)
Mpo_share	0.0437*	0.0208**	0.0234	-0.0285***	0.0424
	(0.023)	(0.010)	(0.016)	(0.006)	(0.027)
Ico_share	0.0446***	-0.0045	0.0511***	0.0000	0.0441***
	(0.016)	(0.005)	(0.016)	(0.002)	(0.018)
Other_share	0.0147**	0.0011	0.0109**	-0.0029	0.0228***
	(0.006)	(0.004)	(0.004)	(0.002)	(0.006)

Independence	-0.0867 (0.175)	-0.2278*** (0.088)	0.0611 (0.113)	0.1631*** (0.052)	- 0.1102 (0.180)
Loanloss	21.3651* (11.754)	-21.3050*** (5.292)	13.0685** (6.146)	10.0304*** (2.692)	25.2270** (11.185)
Ecap	24.5496*** (3.397)	12.9756*** (2.179)	11.3582*** (2.285)	0.9889 (0.813)	28.4327*** (4.015)
$Ecap^2$	-47.0591*** (7.342)	-25.6251*** (7.296)	-18.3433*** (5.708)	0.4950 (3.294)	- 55.3593*** (8.933)
Loandeposit	0.0005 (0.004)	-0.0080 (0.010)	0.0313 (0.033)	0.0085 (0.007)	- 0.0018 (0.003)
NNII	3.4407*** (0.795)	0.3206 (0.354)	4.3733*** (0.976)	0.5664*** (0.195)	- 1.9715 (1.662)
Listed	0.1943 (0.294)	-0.1607 (0.187)	-0.0762 (0.199)	-0.1137 (0.096)	0.4282 (0.323)
Cons	-0.0268 (0.408)	0.4461 (0.337)	-0.8778* (0.466)	0.0173 (0.198)	1.5233*** (0.585)
D-W-H test					χ^2 (1)=11.605 p-value=0.00
Sargan test					χ^2 (2)=4.40 p-value=0.11
R^2	0.3261	0.2987	0.2912	0.3720	0.2124
N	825	825	816	824	825

Notes: Robust standard errors in parenthesis; ***, **, * indicates statistical significant at the 1%, 5% and 10% level, respectively.

Source: own calculation based on Bureau van Dijk Bankscope.

Finally, we checked for multicollinearity issues by computing VIF, in which the highest value was about 2.70, with its mean at approximately 1.40.

In this paper, we adopt a new approach to introduce ownership structure in bank performance literature, which should allow a wide application of econometrics methodologies. Our results have important policy implications for the bank rating system. Indeed, our evidences suggest that ownership structures heavily affect bank performance and risk.

Our evidence also denotes a non-monotonic effect of capitalization on bank profitability, i.e., the better the capitalization is, the greater the bank performance is, upon a certain threshold beyond which bank capitalization deteriorates the bank's financial results.

Further studies could extend our results within a theoretical framework.

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Chapter 2

Value-at-Risk Estimation under Dependence Uncertainty[1]

Stanisław Wanat, Ryszard Konieczny

1. Introduction

Nowadays there are many areas in which we must use the knowledge of risk. The ability to manage risk is extremely important in the financial sector, for example in banks and in insurance companies, where we have to set capital solvency requirements. These are the areas that The Basel Committee on Banking Supervision and the Solvency II Directive (effective from 1 January 2016 in the European Union) deal with.

The separate analysis of individual risks is a relatively simple task, however, most often insufficient. As an example we can indicate here the portfolio management of many risks. In this context, we usually need to carry out the aggregation process and quantify the total portfolio risk.

If we assume that the losses associated with the individual risks are modeled using random variables $X_1,...,X_n$, then the problem is reduced to define risk measure ϱ for $\psi(X_1,...,X_n)$, where ψ is an aggregating function. Next we assume that ψ is the add operator and the risk measure is the value at risk $(\rho \equiv VaR_\alpha)$ hence we focus on calculating the value $VaR_\alpha(X_1 + \cdots + X_n)$. We also assume that we know the cumulative distribution functions $F_1,...,F_n$ of variables $X_1,...,X_n$, respectively[2]. The main challenge in such a problem is to determine the cumulative distribution function (*cdf*) for the sum

$$S = X_1 + \cdots + X_n \tag{1}$$

This is a difficult task, because it depends on the knowledge we have (e.g. based on historical data) of the dependence structure between the variables $X_i (i = 1,...,n)$. We can distinguish three major cases: full knowledge, partial knowledge, lack of knowledge. In the first case, ideal but rarely seen in practice, the quantification of total risk, e.g. by *VaR*, is not a problem (see: e.g. Wanat, 2012).

[1] Publication was financed from the funds granted to the Faculty of Finance and Law at Cracow University of Economics, within the framework of the subsidy for the maintenance of research potential.

[2] In most cases we may estimate quite precisely the distribution of losses related to individual risks.

In other cases, we cannot carry out such quantification because we do not know the distribution of the aggregate variable. At most we are able to specify the bounds for *VaR* (upper and lower).

The main purpose of the paper is to discuss the problem of *VaR* estimation in the absence of information and partial information on the dependence structure between random variables $X_i (i = 1,...,n)$ and the presentation of the RA algorithm for estimating the lower and upper bounds of this measure. This problem is not well known in the Polish literature on the subject.

The paper is organized as follows. First part presents a method for estimating *VaR* boundaries for partial dependence information. Copulas were used for this purpose. The method described there can be also used to determine boundaries in the absence of dependency knowledge. The second part presents RA algorithm (proposed by Puccetti & Rüschendorf, 2012a; Embrechts et al., 2013), which can be used to estimate *VaR* boundaries in case of complete lack of dependence information. The third chapter contains a numerical example, and the fourth one contains conclusions.

2. VaR bounds in models with partial dependence information

Below (like before) we assume that the random variables $X_1,...,X_n$ have known cumulative distribution functions $F_1,...,F_n$, respectively. Then, the *cdf* of the sum $S = X_1 + \cdots + X_n$, and the value of $VaR_\alpha(S)$ depends only on the dependence structure of the vector $X_1,...,X_k$. Based on Sklar's Theorem, a copula *C* contains all information on it. Thus, *n-th* dimensional random vector with fixed marginals $F_1,...,F_n$ and dependence structure in the form of copula *C* will be designated by $(X_1^c,...,X_k^c)$.

If the dependence structure among $X_1,\ldots,X_n$ is not fully known, we are unable to determine the exact $VaR_\alpha(S)$, and it can only be assumed that it fulfills the following inequalities (see: e.g. Embrechts et al., 2013):

$$\underline{VaR_\alpha}(S) \le VaR_\alpha\left(X_1^C + \ldots + X_n^C\right) \le \overline{VaR_\alpha}(S), \tag{2}$$

where

$$\underline{VaR_\alpha}(S) = \inf_{C\in\mathcal{C}_n}\left\{VaR_\alpha\left(X_1^C + \ldots + X_n^C\right)\right\}, \tag{3}$$

$$\overline{VaR_\alpha}(S) = \sup_{C\in\mathcal{C}_n}\left\{VaR_\alpha\left(X_1^C + \ldots + X_n^C\right)\right\}, \tag{4}$$

whereas $\mathcal{C}_n$ denotes the class of all *n*-dimensional copulas.

The problem of searching for *VaR* bounds (3) and (4) is extremely important from the perspective of risk management and has a long history. The first results in this area (for the sum of two random variables) are presented in papers (Makarov, 1981) and independently in (Rüschendorf, 1982). In recent years, it has been discussed, for example, in (Kaas et al., 2000; Puccetti & Rüschendorf, 2012a, 2012b, 2014; Embrechts et al., 2013; Puccetti et al., 2013; Bernard et al., 2015, 2016).

It may be shown (e.g. Cossette et al., 2002; Embrechts et al., 2003; Embrechts & Puccetti, 2006), that in case of the dependence between random variables $X_1,\ldots,X_n$ is described by copula *C* for which there exist copulas C_0 and C_1 such that C_0 is the lower bound on *C*, i.e.

$$C(u_1,\ldots,u_n) \ge C_0(u_1,\ldots,u_n), \text{ for each } (u_1,\ldots,u_n) \in [0,1]^n, \tag{5}$$

while[3] C_1^d is the upper bound on C^d, i.e.

$$C^d\left(u_1,\ldots,u_n\right) \le C_1^d\left(u_1,\ldots,u_n\right), \text{ for each } \left(u_1,\ldots,u_n\right) \in \left[0,1\right]^n, \tag{6}$$

then the cumulative distribution function of the sum (1) has the bounds:

$$F_{min}^{C_0}\left(s\right) \le F_S\left(s\right) \le F_{max}^{C_1}\left(s\right), \text{ for each } s \in \mathbb{R} \tag{7}$$

where

$$F_{min}^{C_0}\left(s\right) = \sup_{\left(x_1,\ldots,x_{n-1}\right)\in\mathbb{R}^{n-1}} \left\{C_0\left(F_1\left(x_1\right),\ldots,F_{n-1}\left(x_{n-1}\right),F_n\left(s-\left(x_1+\ldots+x_{n-1}\right)\right)\right)\right\}, \tag{8}$$

$$F_{max}^{C_1}\left(s\right) = \inf_{\left(x_1,\ldots,x_{n-1}\right)\in\mathbb{R}^{n-1}} \left\{C_1^d\left(F_1\left(x_1\right),\ldots,F_{n-1}\left(x_{n-1}\right),F_n\left(s-\left(x_1+\ldots+x_{n-1}\right)\right)\right)\right\}. \tag{9}$$

Depending on the form of the copula C_0 and C_1, formulas (7)-(9) may be used to determine the bounds on the *cdf* of *S* for various dependence structures. In particular:

- if there is no knowledge on the dependence structure, it is assumed that $C_0 = C_W$ (where C_W designates the lower Fréchet bound[4]) and $C_1^d = \tilde{C}_W^d := min(1, \sum_{i=1}^{n} u_i)$.
- when variables $X_1,\ldots,X_n$ are positive orthant dependent[5], then $C_0\left(u_1,\ldots,u_n\right) = u_1 \cdot \ldots \cdot u_n$ and $C_1^d(u_1,\ldots,u_n) = 1-(1-u_1)\cdot\ldots\cdot(1-u_n)$.

The above considerations are simplified if $n = 2$. As for bivariate copulas the condition $C \ge C_0$ is equivalent to the condition $C^d \le C_0^d$, it can be assumed that $C_1 = C_0$. Then, conditions (5) and (6) are reduced to the necessity of such a copula C_0 that:

$$C\left(u_1,u_2\right) \ge C_0\left(u_1,u_2\right) \text{ for all } \left(u_1,u_2\right) \in \left[0,1\right]^2. \tag{10}$$

If condition (10) is fulfilled then the cumulative distribution function of the sum $S = X_1 + X_2$ has the following bounds:

$$F_{min}^{C_0}\left(s\right) \le F_S\left(s\right) \le F_{max}^{C_0}\left(s\right), \text{ for each } s \in \mathbb{R} \tag{11}$$

where

$$F_{min}^{C_0}\left(s\right) = \sup_{x_1\in\mathbb{R}} \left\{C_0\left(F_1\left(x_1\right),F_2(s-x_1)\right)\right\}, \tag{12}$$

$$F_{max}^{C_0}\left(s\right) = \inf_{x_1\in\mathbb{R}} \left\{C_0^d\left(F_1\left(x_1\right),F_2(s-x_1)\right)\right\}. \tag{13}$$

Therefore, it results from (11)-(13) that the specification of the lower bound on the cumulative distribution function of vector (X_1, X_2) determines lower and upper bounds of the cumulative

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[3] Symbol C^d denotes the dual of the copula *C*.

[4] For n > 3, the lower Fréchet bound C_w is not a copula. Nevertheless, with this lower and upper bound, formulas (8) and (9) are still applicable as their accuracy is proven only with the characteristic of C_0 and C_1^d where they are increasing for each argument.

[5] The definition and characteristics of this type of dependency are presented e.g. in (Esary et al., 1967; Joe, 2001; Denuit, 2005).

distribution function of the sum $(X_1 + X_2)$. Obviously, the lower Fréchet bound C_W is the natural bound which in the considered two-dimensional case is the copula. However, as it has been mentioned before, the acceptance of this bound means that the dependence structure is unspecified which leads to inaccurate estimation of F_s.

It turns out that some additional information on the dependence structure of vector (X_1, X_2) allows determining the copula for the lower bound thanks to the distribution function of the sum $S = X_1 + X_2$ may be better estimated. This situation occurs, inter alia, when we have the knowledge that variables X_1 and X_2 are positively quadrant dependent (PQD) or when we know the measures of associations between them. In the former case, the condition (10) is fulfilled by the independence copula $C_0(u_1, u_2) = u_1 u_2$. In case one of the association measures between variables X_1 and X_2: Kendall's tau (τ), Spearman's rho (ρ) or Blomqvist's beta (β) is known, lower bound may only be sought in the following copula family: $\{C(u_1, u_2) : MoA(C) = MoA(X_1, X_2)\}$, where MoA designates one of these measures (i.e. τ, ρ or β). The pointwise best-possible lower bounds for such families have been specified in by Nelsen et al. (2001) and Nelsen and Úbeda-Flores (2004). Depending on the type of measure, they take the following form:

$$C_0(u_1, u_2) = C_0^{\tau}(u_1, u_2) = max\left\{0; u_1 + u_2 - 1; \frac{1}{2}(u_1 + u_2 - \sqrt{(u_1 + u_2)^2 + 1 - \tau}\right\}, \quad (14)$$

$$C_0(u_1, u_2) = C_0^{\rho}(u_1, u_2) = max\left\{0; u_1 + u_2 - 1; \frac{1}{2}(u_1 + u_2 - \phi(u_1, u_2, \rho)\right\}, \quad (15)$$

where

$$\phi(u_1, u_2, \rho) = \frac{1}{3}\left(\left(9(1-\rho) + 3\sqrt{9(1-\rho)^2 - 3(u_1 - u_2)^6}\right)^{\frac{1}{3}} + \right.$$

$$\left. + \left(9(1-\rho) - 3\sqrt{9(1-\rho)^2 - 3(u_1 - u_2)^6}\right)^{\frac{1}{3}}\right)$$

and

$$C_0(u_1, u_2) = C_0^{\beta}(u_1, u_2) =$$

$$= max\left\{0; u_1 + u_2 - 1; \frac{\beta + 1}{4} - max\left(0; \frac{1}{2} - u_1\right) - max\left(0; \frac{1}{2} - u_2\right)\right\}. \quad (16)$$

In (Kaas et al., 2009) such bounds are provided in case when:

- two association measures τ or ρ and β are specified,
- variables X_1 and X_2 are positively quadrant dependent and one association measure, i.e. Kendall's tau (τ), Spearman's rho (ρ) or Blomqvist's beta (β), is specified.

3. VaR bounds without dependence information – rearrangement algorithm and its modifications

In the absence of information on the dependence structure among $X_1,\ldots,X_n$ the RA algorithm proposed by Puccetti and Rüschendorf (2012a) and Embrechts et al. (2013) can be used to determine boundaries (3) and (4). This is a numerical method in which Frechet limits are not used, as in the method described in the previous chapter. Below we will describe this algorithm in details. For this purpose, we assume that two vectors $\boldsymbol{a},\boldsymbol{b}\in\mathbb{R}^N$, are in opposite order if the inequality $\left(a_j-a_k\right)\left(b_j-b_k\right)\le 0$ holds for all $1\le j,k\le N$. In addition, for an $\boldsymbol{X}$ matrix with a dimension $N\times n$, we define two operators:

$$s\left(\boldsymbol{X}\right)=\min_{1\le i\le N}\sum_{j=1}^{n}x_{ij},\ t\left(\boldsymbol{X}\right)=\max_{1\le i\le N}\sum_{j=1}^{n}x_{ij}. \tag{17}$$

According to the algorithm RA, the upper estimate of $\overline{VaR_\alpha}\left(S\right)$ is determined as follows (Embrechts et al., 2013):

1. Fix a integer N and the required precision level ε.
2. Define matrices $\underline{\boldsymbol{X}}=\left(\underline{x}_{ij}\right)_{N\times n}$ and $\overline{\boldsymbol{X}}=\left(\overline{x}_{ij}\right)_{N\times n}$ as follows:
$$\underline{x}_{ij}=F_j^{-1}\left(\alpha+\frac{\left(1-\alpha\right)\left(i-1\right)}{N}\right),\ \overline{x}_{ij}=F_j^{-1}\left(\alpha+\frac{\left(1-\alpha\right)i}{N}\right)\ \text{for}\ 1\le i\le N,\ 1\le j\le n.$$
3. Permute randomly elements in each column of the matrix $\underline{\boldsymbol{X}}$ and $\overline{\boldsymbol{X}}$.
4. Iteratively rearrange the *j-th* column of the matrix $\underline{\boldsymbol{X}}$ so that it becomes oppositely ordered to the sum of the other columns $(1\le j\le n)$. A matrix $\underline{\boldsymbol{Y}}$ is found.
5. Repeat Step 4. until $s\left(\underline{\boldsymbol{Y}}\right)-s\left(\underline{\boldsymbol{X}}\right)<\varepsilon$.
A matrix $\underline{\boldsymbol{X}}^*$ is found.
6. Repeat Steps 4-5 to the matrix $\overline{\boldsymbol{X}}$ until a matrix $\overline{\boldsymbol{X}^*}$ is found.
7. Define:
$$\overline{s}_N=s(\overline{\boldsymbol{X}^*})\ \text{and}\ \underline{s}_N=s(\underline{\boldsymbol{X}}^*).$$
Then we have $\underline{s}_N<\overline{s}_N$ and in practice we find that
$$\underline{s}_N\underset{N\to\infty}{\simeq}\overline{s}_N\underset{N\to\infty}{\simeq}\overline{VaR_\alpha}\left(S\right). \tag{18}$$

In turn, the lower estimate $\underline{VaR_\alpha}\left(S\right)$ is estimated as follows:

1. Fix a integer N and the required precision level ε.
2. Define matrices $\underline{\boldsymbol{Z}}=\left(\underline{z}_{ij}\right)_{N\times n}$ and $\overline{\boldsymbol{Z}}=\left(\overline{z}_{ij}\right)_{N\times n}$ as follows:
$$\underline{z}_{ij}=F_j^{-1}\left(\frac{\alpha\left(i-1\right)}{N}\right),\ \overline{z}_{ij}=F_j^{-1}\left(\frac{\alpha i}{N}\right)\ \text{for}\ 1\le i\le N,\ 1\le j\le n.$$
3. Permute randomly elements in each column of the matrix $\underline{\boldsymbol{Z}}$ and $\overline{\boldsymbol{Z}}$.
4. Iteratively rearrange the *j-th* column of the matrix $\underline{\boldsymbol{Z}}$ so that it becomes oppositely ordered to the sum of the other columns $(1\le j\le n)$. A matrix $\underline{\boldsymbol{W}}$ is found.
5. Repeat Step 4. until $t\left(\underline{\boldsymbol{Z}}\right)-t\left(\underline{\boldsymbol{W}}\right)<\varepsilon$.

A matrix $\underline{\boldsymbol{Z}}^*$ is found.

6. Repeat Steps 4-5 to the matrix $\overline{\boldsymbol{Z}}$ until a matrix $\overline{\boldsymbol{Z}^*}$ is found.
7. Define

   $\underline{t}_N = t(\underline{\boldsymbol{Z}}^*)$ and $\overline{t}_N = (\overline{\boldsymbol{Z}^*})$.

   Then we have $\underline{t}_N < \overline{t}_N$ and in practice we find that

$$\underline{t}_N \underset{N\to\infty}{\simeq} \overline{t}_N \underset{N\to\infty}{\simeq} \underline{VaR_\alpha}(S). \tag{19}$$

In subsequent years, various modifications have been made to this algorithm. The modification known as ARA (*Adaptive Rearrangement Algorithm*), was proposed by Hofert et al. (2017). The main impulse for the creation of the algorithm was a huge (even if the use of computers is taken into account) number of operations which needed to be performed with the use of RA algorithm in case of a large number of variables L_i. Bernard et al. (2015) constructed ERA algorithm (*Extended Rearrangement Algorithm*) also on the basis of RA algorithm. In relation to RA algorithm, the extension involves determining minimum elements of the distribution of a sum of random variables in the sense of convex order, in the upper and lower part of the distribution separated by the given α with the limitation of variance taken into account. ERA algorithm aims at making the distribution of *S* as flat as possible on the upper and lower part by applying the RA algorithm on both parts and by moving through the domains in a systematic way in order to satisfy the variance constraint. The examples presented by the authors prove that ERA algorithm works well and an additional condition of limited variance leads to better (as compared to RA algorithm) estimations of *VaR* boundaries. On the basis of ERA algorithm, the authors prove that models used by participants and regulators of the capital market can underestimate *VaR* whereas values-at-risk designated in this manner may be incomparable. They additionally claim that the determination of capital requirements at a high confidence level, e.g. 99.5%, is justified.

4. Influence of the dependence structure on the VaR – numerical example

The influence of the dependence structures on the Value-at-Risk will be illustrated with the example in which two risks X_1 and X_2 modelled with the same normal distribution $N(1,1)$ are subject to aggregation. The following dependence structures are considered:

- **NoInf:** No information about the dependence structure. In this case, bounds (3) and (4) are estimated using the method outlined in Chapter 2 as well as by the RA algorithm.
- **PQD:** Positively quadrant dependent risk $(C_0(u_1,u_2) = C_1(u_1,u_2) = u_1u_2)$.
- **PartInf:** Partial information about the dependence structure. Lower bound is the Clayton copula with the parameter $\theta^{Cl} = 6$ while the upper bound is the Gumbel survival copula with the parameter $\theta^{Gu} = 4$ (in both cases, parameters are selected in such a way that Kendall's τ coefficient between aggregated risks is equal to 0.75).
- **Com:** Risks are comonotonic.
- **Indep:** Risks are independent.
- **Gauss:** Risks X_1 and X_2 have a two-dimensional normal distribution with Kendall's coefficient τ equals 0.75 (Pearson's linear correlation coefficient is 0.924). In this case *VaR* is determined by the most commonly used variance-covariance method.

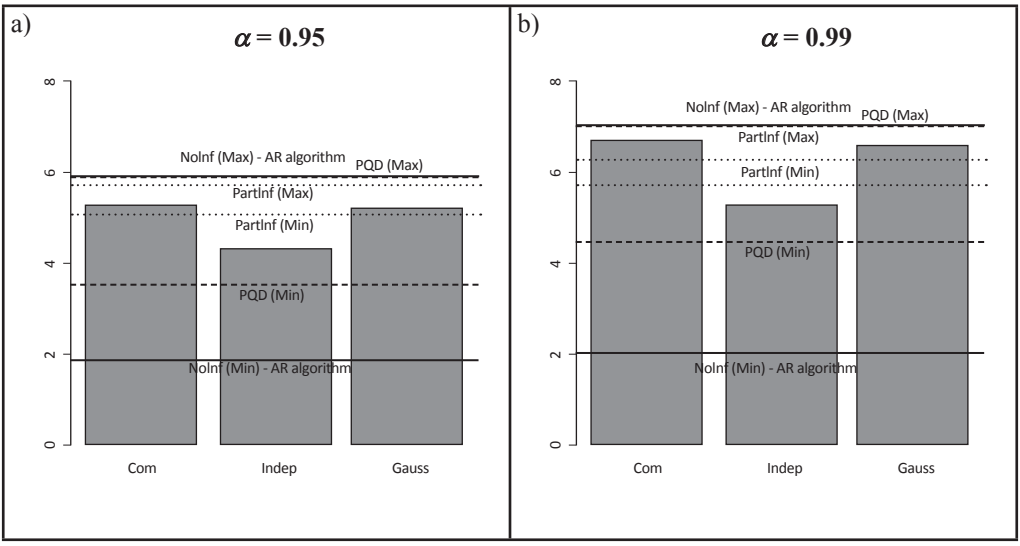
The Williamson-Downson's algorithm (see, e.g. Williamson & Downs, 1990; Wanat, 2012) was used to determine *VaR* bounds for the **PartInf**, **PQD**, and **NoInf**[6] structures. In turn, the *VaR* for the **Com**, **Indep** and **Gauss** structures was analytically calculated. Calculations were made using the R package. The RA function from the package qrmtools in the R program was used to calculate the *VaR* bounds. The results for $\alpha = 0.95$ and $\alpha = 0.99$ are shown in Table 1 and in Figures 1a and 1b.

Table 1. *VaR* depending on the dependence structure for selected risk tolerance level

Dependence structure	$\alpha = 0.95$		$\alpha = 0.99$	
	$\underline{VaR}_\alpha$	$\overline{VaR}_\alpha$	$\underline{VaR}_\alpha$	$\overline{VaR}_\alpha$
NoInf (copula)	1.8721	5.9031	1.9724	7.0880
NoInf (AR)	1.8652	5.9233	1.9652	7.1544
PQD	3.5053	5.8918	4.5084	7.0859
PartInf	5.0723	5.7153	6.3466	7.0500
	VaR_α			
Com	5.2897		6.6527	
Indep	4.3262		5.2900	
Gauss	5.2265		6.5633	

Source: own calculation.

Figure 1. *VaR* depending on the considered dependence structures



Source: own elaboration.

[6] Method described in part 2.

This simple example shows the impact of the dependence structure on one of the most commonly used risk measures i.e. *VaR*. It also indicates the fact which might have been expected and which may be generally proven (cf. e.g. Denuit et al., 1999) that additional knowledge about the dependence structure (such as positive dependency) "limits the field" in which the *cdf* of *S* is located, which further narrows down the range of possible *VaRs*.

This example also shows that a comonotonic dependence structure assumption, that in practice is considered to be the safest, does not guarantee the highest value of *VaR*. For example, in the process of estimating solvency capital requirements (e.g. in Solvency II) this may result in their underestimation, because worse (in *VaR* sense) scenarios for realizing aggregated risks may occur. In the analyzed example, if the requirements were equal *VaR*, the underestimation would be 0.633574 for $\alpha = 0.95$ and 0.501674 for $\alpha = 0.99$. Similar conclusions can be drawn having regard to the very often applied variance-covariance method.

Looking from the numerical side to the presented problem of estimating the *VaR* bounds under conditions of complete lack of information on the dependence structure it can be stated that methods based on the copulas and the RA algorithm gave similar results. However, from a numerical point of view, the RA algorithm is simpler.

5. Conclusion

In the aggregation process, a desired and ideal case occurs when the dependence structure of risks $X_1,\ldots,X_n$ is specified. However, in practice in most cases there occurs the problem of too little statistical data allowing for a reliable estimation of it. In these situations, risk aggregation takes place in the conditions of unspecified or partially specified dependence structure. Thus, as a result we do not obtain the exact cumulative distribution function of aggregate risk but only the lower and upper bound. From the practical perspective, estimations with the "narrowest area possible" of the occurrence of the proper *cdf* of *S* are desired.

Calculating the bounds, using methods discussed in this paper, shows that the more information about the dependence structure was taken into account in the design, the narrower the area is. Shown results have been intuitively expected. Therefore, research on the development of risk aggregation methods should focus on developing tools to obtain as much information as possible on the dependence structure based on scarce statistical data, and tools to effectively use this information in determining the distribution of aggregated risk.

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Chapter 3

The Development of the World Derivatives Exchange Market[1]

Ryszard Węgrzyn

1. Introduction

The turbulent development of the world derivatives market began in the 1970s when, after the collapse of the Bretton Woods system, there was a considerable increase in the volatility of exchange rates, interest rates and stock prices. In that period, successive innovations occurred quickly in respect of the instruments themselves, as well as specialised derivatives exchange markets emerged.

The data from recent years concerning the world derivatives exchange market may, however, cause some concern related to its further development. And so in 2012 there was a slowdown, and in the case of some types of derivatives a downward trend was marked. In that year, for the first time since 2004, the global number of derivatives transactions on exchange markets went down, and the decline concerned all classes of derivatives except for commodity derivatives, and all regions of the world.

The aim of the paper is to identify and analyse changes undergoing on the derivatives exchange market in recent years, as well as the conditionings and factors influencing its development. In addition to statistical data concerning the derivatives trading volume, the attention is also paid to the specificity of the world derivatives stock exchanges.

2. The conditionings of the derivatives market development

The basic economic function of the derivatives market is to create conditions for the effective risk transfer by entities showing aversion to risk to entities inclined to take over the risk in the hope of making profits. This risk transfer to other entities is defined as hedging (Tarczyński, 2003). Generally, the development of derivatives is related exactly to their extraordinary usefulness

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in risk management. To corporations or financial institutions which want to manage currency risk, financing costs or credit exposure, derivatives give invaluable opportunities, which to a great extent accounts for the dynamic growth of this market connected with the progressing globalisation.

The application of derivatives, especially to a great scale, is related, however, to some potential risk. The risk arises from the interaction of three factors which create a potentially dangerous combination if the risk is not properly understood and managed (Sundaram, 2012). Leverage is the first of the factors. The leverage effect results from the fact that by means of a much lower capital contribution, with a beneficial change of the price of the underlying instrument, a much higher rate of return is obtained than from the purchase of the underlying instrument itself. It is connected with the fact that with the change of the underlying instrument price, the percentage change of the derivative price is higher than the percentage change of this instrument price. On the one hand, leverage makes a derivative attractive for speculators. Speculators considerably raise liquidity, and by taking opposite positions they make it easier for hedgers to take hedging positions. On the other hand, leverage increases the change price effect, which means that a very unfavourable change in the underlying instrument price may relatively easily cause a disaster for the derivatives portfolio. The second factor is volatility linked to the leverage effect. With the growth in the volatility of the underlying instrument and an unexpectedly big change of the price, the impact of leverage deepens, which leads to potentially greater losses. The third factor is liquidity, or rather the lack of it, which may occur on the market. The period of turbulences on the market is often accompanied not only by greater volatility, but also by a dramatic drop in liquidity. It precludes the liquidation of the adopted strategies bringing losses (and even hedging derivatives by means of the underlying instrument), thus increasing the risk of the maintained positions with regard to derivatives.

In the history of finance we can find a lot of examples of corporations and financial institutions which collapsed when the worsening of the market conditions brought about mass losses in the derivatives portfolio (see: Sundaram & Das, 2010). In particular, a potentially dangerous combination of the leverage effect and volatility makes it so important for the users to fully understand risk related to instruments and for the institutions regulating the market – the systemic influence of the fluctuations of volatility. The regulation of the derivatives markets has been for a long time a controversial area and a challenge at the same time. On the one hand, the market enables risk transfer which is always regarded a factor of economic development by economists. On the other hand, the trade of derivatives (particularly on the OTC market) has created concentrated risk groups within financial institutions, which, as the recent crisis showed, in the event of the interaction between the financial leverage and volatility may threaten not only individual institutions, but the whole financial system. A special challenge for the regulations are non-transparent OTC markets and the rising sophistication of the derivatives applied (Sundaram, 2012).

The development of the derivatives exchange market depends on the supply and demand factors, which include (see: Gastineau & Margolis, 1994):

- demand for derivatives in risk management,
- demand for asymmetric income profiles (asymmetric returns),
- demand for derivatives in asset allocation and liability management – to a great extent it concerns institutional investors optimising their portfolios,
- regulations stimulating demand, e.g. concerning tax burdens,
- cost reduction on the exchange market, especially in comparison with the over-the-counter market,

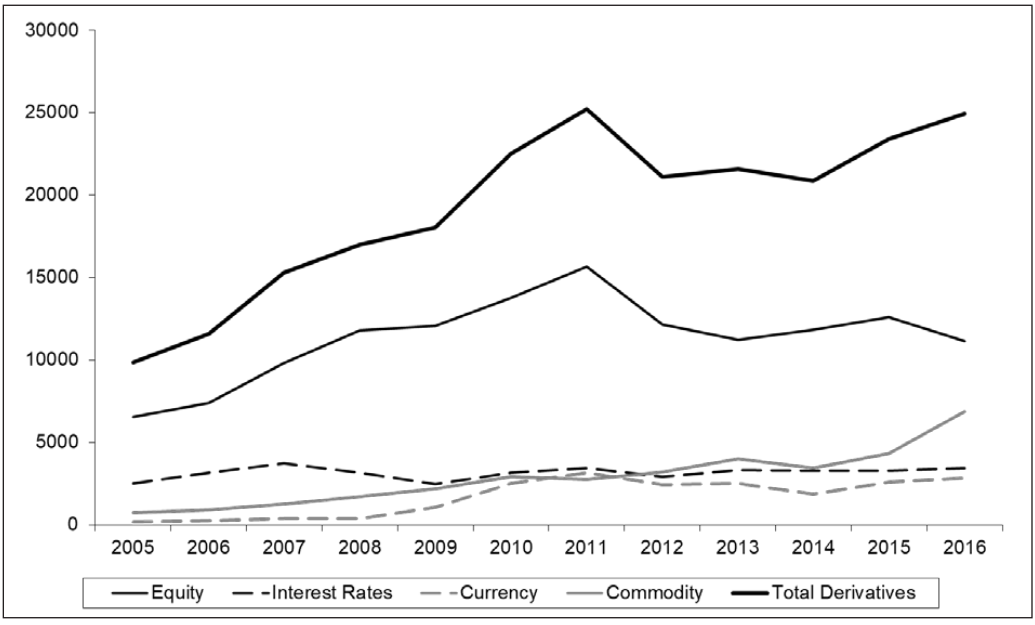
- competition in the area of supply and the struggle for a market position, leading to the market concentration,
- regulations concerning supply, e.g. granting a marketing authorisation to specific innovations.

The factors have specific impact on the development of the market, and their shaping is a result of the behaviours of market participants and institutions regulating the market.

3. The analysis of changes on the derivatives exchange market

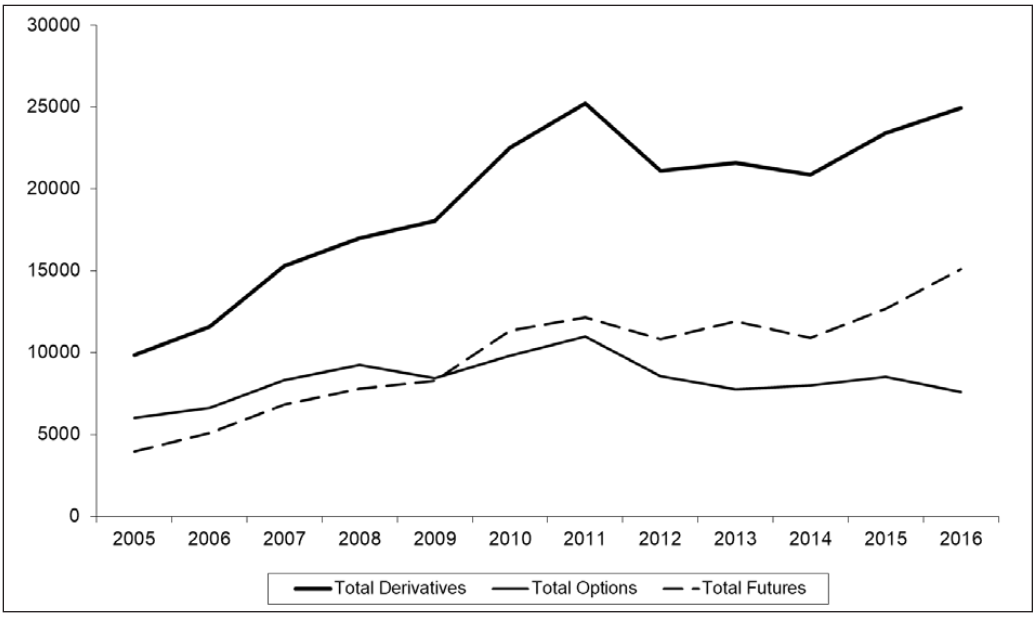
For many years, the derivatives market has been developing fast and even the recent economic crisis did not cause general collapse in the form of the drop of trading volume (see: Fig. 1). In 2009, 16.6 billion derivatives transactions were concluded in comparison with 16.4 billion contracts in 2008 (*WFE/IOMA*…, 2010). Thus, there was a slowdown of the growth, but the overall upward trend was maintained. However, after 2009 there was a characteristic change on the derivatives exchange markets – options in respect of trading volumes gave way to futures contracts (see: Fig. 2). What is more, as we can observe in Figure 2, the advantage of futures contracts over options in respect of trading volumes strengthened considerably.

Figure 1. Trading volumes of exchange-traded derivatives (in mln)



Source: own work based on (*WFE/IOMA*..., 2006-2017).

Figure 2. Trading volumes of exchange-traded futures contracts and options (in mln)



Source: own work based on (*WFE/IOMA*..., 2006-2017).

In 2012, 21 billion derivatives contracts were concluded on stock exchanges worldwide (10 billion of options and 11 billion of futures), in comparison with 25 billion of contracts in 2011. It meant that for the first time since 2004 the global number of concluded derivatives contracts on stock exchanges dropped. Moreover, the drop in the volume was substantial (-15%) and concerned all classes of derivatives except for commodity derivatives, and all regions of the world. The biggest decline (-23%) was experienced by the currency derivatives segment. The interest rate derivatives trading volume decreased by 15%. The low interest rate environment, the lack of economic growth and the lack of credit expansion, among others, were considered the factors generally perceived in that period as unfavourable for interest rate derivatives and able to explain this decrease (Devai & Naacke, 2013).

The only derivatives market segment which in 2012 marked an increase (+18%) was the commodity derivatives market. To a great extent, Chinese continental exchanges and the ICE in the US contributed to this growth. With regard to the number of concluded contracts, the segment outstripped the currency and interest rate derivatives market, and in the following years it became the second biggest segment following the equity derivatives segment (see: Fig. 1).

As to equity derivatives, the drop in trading volume in 2012 was 19.5%. What greatly contributed to the drop was a rapid decrease in the number of index options listed on the Korea Stock Exchange, as a result of a five-fold increase in the number of newly-listed KOSPI 200 index contracts from March 2012. Excluding KOSPI 200 options, a decline in equity derivatives was 7.5%. The share of equity derivatives in the total number of derivatives contracts in trade remained dominant but it decreased to 58% in comparison with 61% in 2011 and 67% in 2009. This decline in the equity derivatives volumes was associated with a drop in the value of equity spots and a significant drop

in volatility observed in 2012. Volatility indices in 2012 decreased considerably: S&P 500 Volatility (VIX) drooped by 23%, EURO STOXX 50 Volatility – by 33.6%, and FTSE100 Volatility Index – by 19.7%. The results of the observations of monthly volumes in the United States and in Europe in comparison with the number of transactions on spot markets show that the activity on spot markets is one of the major driving forces of equity derivatives trading volume. The shaping of volumes on equity derivatives markets is also strongly correlated with the volatility of stock prices. The relations seem to explain the drop in equity derivatives trading volume, however, in the first quarter 2013 the volumes seemed to regain their levels, whereas volatility on stock markets kept going down. It indicates that the influence of the spot market on derivatives volume is greater than the influence of volatility (Devai & Naacke, 2013).

The factor which could also have a considerable influence on the shaping of the situation on the derivatives market, particularly on the European market, was a formal presentation of the plan of introducing a new financial transaction tax by the President of the European Commission in September 2011. The President pointed out that the financial sector received a lot of aid from the EU member states during the crisis and indicated the tax as a measure "so that the financial sector made its fair contribution". The effect of this policy was a gradual introduction of the financial transaction tax in subsequent countries and now it is applied in 10 Euro-zone states.

Some hope for further development of derivatives market was only brought by the year 2015 when trading volume was 23.4 billion of concluded transactions (10.3 billion with options and 13.1 billion with futures) and increased by 12% in comparison with 2014 (see: Fig. 1). However, it is the Asia-Pacific region where the volume went up by 36% in comparison with the previous year which was responsible for a great part of this growth. An increase in trading volume took place in almost all groups of derivatives. In general, equity derivatives still remained the most actively traded group of exchange-traded derivatives although their share in trading volume went down to about 55% of the total volume. The equity derivatives volume in 2015 increased by 6%, mainly due to the growth of the index options volume (+19%) and index futures volume (+17%) (*WFE/IOMA*…, 2016). Out of derivatives, those groups were the subject of the most active trade in 2015 and they constitute just more than a half of all equity derivatives and about 28% of all exchange-traded derivatives.

However, the greatest growth of volume in 2015 was marked by currency and commodity derivatives. Currency derivatives, reversing the 2014 trend, in 2015 marked a rapid increase by 37%. And the growth of currency derivatives was marked in all regions of the world. The volume of commodity derivatives in 2015 was still going up, reaching 4.3 billion of contracts, which constituted an increase by 26%. Within this group, the volume of option contracts rose by 6% and of futures – by 28%. Commodity futures outstripped stock options in terms of volume and became the most actively traded contract in 2015.

A slight drop in volume (-0.1%) was marked in 2015 only in the case of interest rate derivatives, mainly due to a decline in the volume of short-term interest rate futures. The trading volume of instruments belonging to the category "other derivatives", which includes, among others, volatility index options, exotic options and futures contracts, dividend derivatives and on dividend index derivatives in 2015 went up by 58%, although still from a relatively low base (*WFE/IOMA*…, 2016).

In 2016, there was further growth of trading volume by 2.2%, reaching the total number of 24.9 billion derivatives transactions (9.4 billion of options and 15.5 billion of futures contracts). In respect of individual regions, there was an increase in volumes in both Americas and the EMEA region (by 6.7% and 7.8%, respectively) and a decline in volumes in the Asia-Pacific region by

5.5%. The overall growth of trading volume took place mainly owing to both Americas which constitute 41% of the total volume, with an increase in the trading volume of index futures, as well as interest rate, currency and commodity derivatives. In EMEA (23% of the totality), the volume increased by 7.8%, as a result of an increase in the volume of mainly index futures, interest rate and commodity derivatives. In the Asia-Pacific region (36% of the total volume) a drop by 5.5% was marked, mostly because of a drop in the volume of single stock and index derivatives.

The growth of trading volume took place in 2016 for commodity, currency and interest rate derivatives. On the other hand, the volumes of equity derivatives and "other derivatives" decreased by 11% and 1.1%, respectively. The volume of commodity derivatives went up in 2016 by 27.5% compared to 2015. In 2016, commodity futures constituted 27% of the total trading volume. The EMEA region, which accounts for 16.1% of the total commodity derivatives trading volume, marked a huge growth of trading volume by 57%. The Asia-Pacific region (which constitutes 63.9% of commodity derivatives volume) increased by 27%, whereas Americas (20% of the total volume) marked a 13% growth of trading volume in comparison with 2015. The volume of currency derivatives, constituting 11% of the total trading volume of derivatives, increased by 10.4% in comparison with 2015. Both Americas and the Asia-Pacific region, which jointly constitute 61.6% of the total trading volume, marked the growth of volume by 14% and 23.2%, respectively. On the other hand, the EMEA region (38.4% of the total trading volume) marked a decrease in trading volume by 3.2%. The interest rate derivatives volume, which constituted 14% of the total derivatives trading volume in 2016, went up in 2016 by 5.5%, as opposed to the drops in the years 2014-2015. Americas and the EMEA region, which jointly constitute 94% of all interest rate derivatives, marked an increase in trading by 5.5% and 6.5% in comparison with 2015. The volume in the Asia-Pacific region, which constitutes only 6% of the total volume, increased by 0.4%.

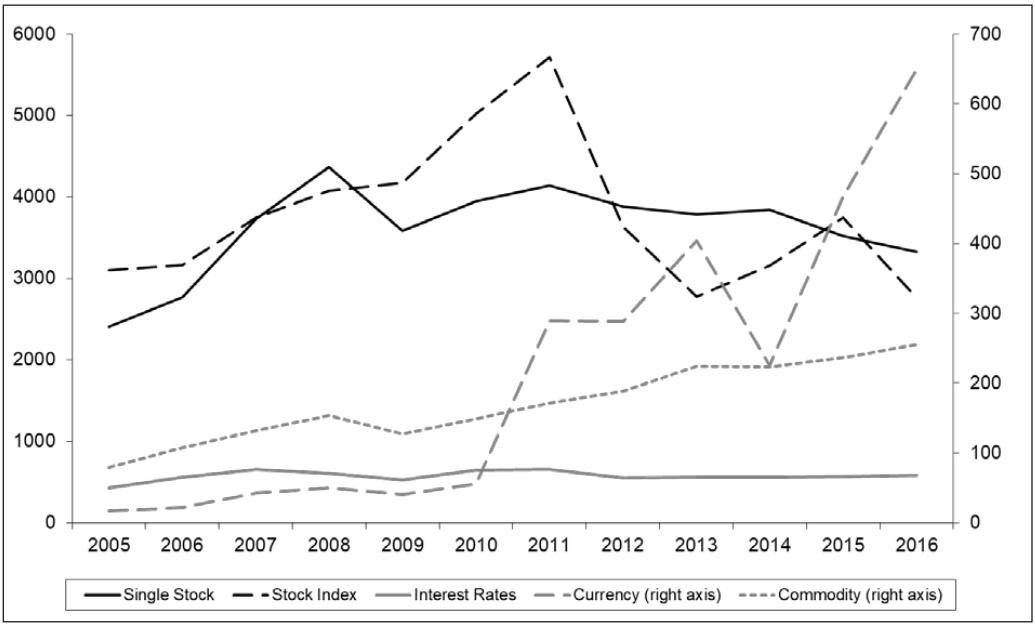
Generally, equity derivatives are still the most actively exchange-traded derivates, although in 2016, for the first time, their share in the total trading volume dropped to the level below 50% (to be exact, to 45%). Compared to 2015, the volume decreased by 11%, and the drops were marked in respect to almost all types of equity derivatives. Stock options trading volume went down by 4.9%, and the trading volumes of index options and futures dropped by 26.1% and 7.3%, respectively. In spite of the decrease in their volumes, they were still among most active derivatives in 2016, constituting more than 75% of all equity derivatives and 34% of all exchange-traded derivatives. While EMEA and Asia-Pacific regions (together constituting 47.5% of equity derivatives) marked in 2016 a decrease in volumes by 20.7% and 26.1%, respectively, both Americas marked an increase by 5.5% in comparison with 2015. In "other derivatives" category, trading volume in 2016 decreased by 1.1%, and the drop resulted mainly from a decrease in trading volume on Johannesburg Stock Exchange and Japan Exchange Group (*WFE/IOMA*…, 2017).

In the case of the division of derivatives into options and futures contracts, it is worth mentioning that in 2016 options constituted 38% of the total trading volume, and futures 62%. It is a significant change in comparison with the period before 2009 (see: Fig. 2) but also in comparison with 2015 when options constituted 42% of the world trading volume. In general, in 2016 the volume went down by 8%, whereas the number of futures increased by 10% in comparison with 2015.

Figure 3 presents the shaping of trading volume for individual types of options in the years 2005-2016. On its basis we can say that single stock options and index options are still distinctly prevailing options in terms of trading volume on the exchange market. However, while in the case of single stock options in 2009 there was a distinct decrease, index options marked further increases, until 2011. In 2012, a decline in the index option volume was really dramatic and deepened

in the next year. In spite of a deep drop in the years 2012-2013, in the years 2014-2015 the index option trading volume was going up again, which could bring expectations for further growth. However, in 2013 there was another decline (see: Fig. 3). The situation related to single stock options does not look optimistic, either, as after 2011 we can observe a slight downward trend.

Figure 3. Exchange-trading options volume (in mln)

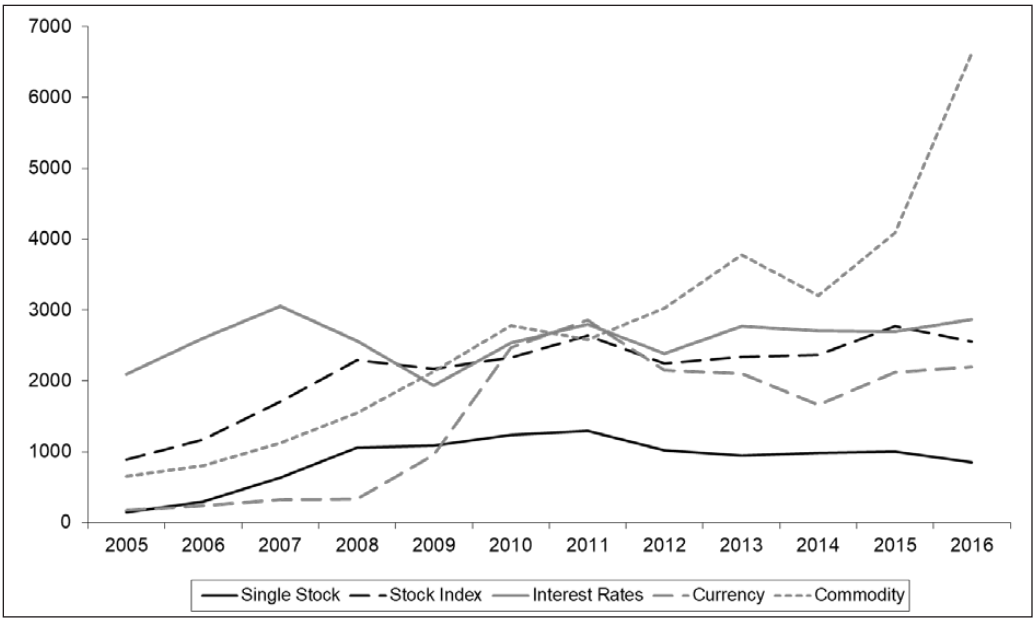


Source: own work based on (*WFE/IOMA*…, 2006-2017).

In the case of commodity options, trading volume, although still on the lowest level, was growing systematically, which was connected with the overall increase in commodity derivatives. Likewise, particularly since 2011, the trading volume of currency options was going up, but the increase was very unstable (see: Fig. 3).

On the other hand, Figure 4 presents the shaping of the trading volume of individual futures contracts in the years 2005-2016. On the basis of this Figure, we can observe a very strong upward trend of the trading volume of commodity futures, which by far dominated futures trading. Interest rate and index futures, placing on the second and third position, respectively, in recent years have had a relatively stable volume level, whereas currency futures volume, after the dynamic growth in the years 2009-2011 and decreases in the years 2012-2014, have gone up again in recent years. Single stock futures, for which after 2011 a drop and some stagnation, if not a downward trend, were observed, have the lowest level of volume (see: Fig. 4).

Figure 4. Futures trading volume (in mln)



Source: own work based on (*WFE/IOMA…*, 2006-2017).

4. The characteristics of the largest derivatives exchanges

In the years 1998-2008, an increase in the derivatives exchange trading was substantial. Trading volume in that period increased 7, 8 times, which constituted a bigger growth than of volume on spot markets. Over those ten years, a lot of mergers and acquisitions concerning the largest stock exchanges took places, new stock exchanges were also established, successfully competing with those already functioning (Davydoff & Naacke, 2009). In total, in the years 1998-2008, 9 new stock exchanges were established, which influenced greatly the shaping of the structure of the whole market.

Tables 1-5 present the largest stock exchanges in the world in terms of derivatives trading volume in 2016. In the case of the single stock options market, stock exchanges in the United States dominate, although on the first position there is Brazilian BM&FBOVESPA. On the single stock futures market, the greatest trading volume was marked by Moscow Exchange followed by Indian, Korean, German Eurex and the European part of Intercontinental Exchange (see: Tab. 1). With regard to Moscow Exchange, it should be observed that in spite of the first position by volume, the estimated trading volume for the Exchange was on a relatively low level.

Table 1. The largest exchanges in terms of trading volume of single stock options and single stock futures in 2016

Single Stock Options		**Single Stock Futures**	
Exchange	**Volume**	**Exchange**	**Volume**
BM&FBOVESPA	692 006 943	Moscow Exchange	254 711 570
NASDAQ (US)	512 237 363	National Stock Exchange of India	172 712 809
NYSE Derivatives	368 820 227	Korea Exchange	172 120 372
Chicago Board Options Exchange	364 374 899	Eurex	101 032 613
International Securities Exchange (ISE)	268 857 090	ICE Futures Europe	41 588 273

Source: own work based on (*WFE/IOMA…*, 2017).

Table 2. The largest exchanges in terms of trading volume of stock index options and stock index futures in 2016

Stock Index Options		**Stock Index Futures**	
Exchange	**Volume**	**Exchange**	**Volume**
National Stock Exchange of India	1 034 997 570	CME Group	609 691 636
Chicago Board Options Exchange	433 316 741	Eurex	498 173 245
Eurex	388 839 391	Japan Exchange Group	293 749 363
Korea Exchange	359 036 315	Moscow Exchange	236 104 126
TAIFEX	167 732 568	BM&FBOVESPA	170 157 338

Source: own work based on (*WFE/IOMA…*, 2017).

In the case of stock index options, among the first five there is only one American exchange – Chicago Board Options Exchange, and apart from that – the Indian exchange, Eurex, the Korean exchange and the Taiwan exchange (see: Tab. 2). It should be emphasised that with regard to the estimated trading per value of these options, Chicago Board Options Exchange and Korea Exchange were by far the largest. On the index futures market, among five largest ones there was the American, German, Japanese, Russian and Brazilian exchanges.

The interest rate derivatives market is divided into short-term interest rate derivatives and long-term interest rate derivatives. On both markets in the first five by trading volume there were the following stock exchanges: Chicago CME, European part of ICE and the Australian Securities Exchange. In addition to them, in respect of short-term interest rate derivatives, the largest ones include Brazilian BM&FBOVESPA and Montréal Exchange, and with regard to long-term interest rate derivatives – Eurex and Korea Exchange (see: Tab. 3). On the currency derivatives market, the first five include: the exchange in Moscow, two exchanges in Bombay, the exchange in Chicago and in Sao Paulo, whereas on the commodity derivatives market Chinese stock exchanges are by far predominant, and along with them there is only CME and Moscow Exchange (see: Tab. 4).

It should be pointed out that in spite of high trading volume of Moscow Exchange and Dalian Commodity Exchange, these exchanges are characterised by definitely low value of trading.

Table 3. The largest exchanges in respect of trading volume of short-term interest rate derivatives and long-term interest rate derivatives in 2016

Short-Term Interest Rate Derivatives		**Long-Term Interest Rate Derivatives**	
Exchange	**Volume**	**Exchange**	**Volume**
CME Group	997 144 436	CME Group	897 049 242
ICE Futures Europe	358 235 728	Eurex	526 379 512
BM&FBOVESPA	337 490 505	Australian Securities Exchange	93 976 347
Australian Securities Exchange	35 373 406	ICE Futures Europe	53 765 296
Montréal Exchange (TMX Group)	26 999 784	Korea Exchange	38 824 185

Source: own work based on (*WFE/IOMA*..., 2017).

Table 4. The largest exchanges in respect of trading volume of currency derivatives and commodity derivatives in 2016

Currency Derivatives		**Commodity Derivatives**	
Exchange	**Volume**	**Exchange**	**Volume**
Moscow Exchange	961 622 037	Shanghai Futures Exchange	1 680 771 301
National Stock Exchange of India	748 063 626	Dalian Commodity Exchange	1 537 479 768
BSE Limited	530 133 841	CME Group	1 062 584 545
CME Group	215 091 017	Zhengzhou Commodity Exchange	901 240 809
BM&FBOVESPA	171 278 493	Moscow Exchange	471 384 517

Source: own work based on (*WFE/IOMA*..., 2017).

Table 5. The largest exchanges in respect of trading volume of so-called other derivatives in 2016

Exchange	**Volume**
Johannesburg Stock Exchange	377 590 039
Chicago Board Options Exchange	148 253 619
CBOE Futures Exchange (CFE)	60 177 810
Eurex	26 093 021
ICE Futures Europe	6 087 528

Source: own work based on (*WFE/IOMA*..., 2017).

Table 5 presents the largest exchanges with regard to trading volume of so-called "other derivatives". However, with regard to derivatives they trade, they can be called the largest innovators on the derivatives market. "Other derivatives" category includes, as it was mentioned before, volatility index options, exotic options and futures, dividend derivatives and dividend index derivatives, among others. These innovations do not occur on all exchanges, only on those specialised in it. In this case, it is worth pointing out that Johannesburg Stock Exchange, by far the largest in terms of volume, is at the same time the smallest exchange with regard to the value of trading of the mentioned exchanges, in turn, ICE Futures Europe – the biggest one in terms of the value of trading.

When comparing the largest exchanges in 2016 with the largest exchanges in the past, we can say that almost the same exchanges were among the largest ones in, for example, 2009. Moscow Exchange is an exception here, as it did not occur in those rankings before. The other exchanges simply changed their positions in volume rankings. Thus, we can say that for some time the situation in the structure of the derivatives exchange market has not changed much.

5. Conclusion

In general, increases in trading volumes marked till 2011 were, according to some analysts, a result of some turbulences on the markets in previous years, from which the global derivatives exchange market benefited. In 2012 the situation changed – low volatility and low interest rates, as well as the transfer of some activity from equity derivatives to commodity derivatives caused specific changes on that market.

However, from the perspective of 2016 we can say that after a deep decline in 2012, the overall volume of derivatives trading "made up for losses" and that happened by means of futures contracts. In the case of options it was much worse. "Making up for losses" took place mainly due to the growth of the trading volume of commodity derivatives and currency options, in spite of equity derivatives, in the case of which we can talk about some stagnation or even a downward trend, perhaps with the exception of index futures.

Due to the formed structure from the supply point of view, the future development of derivatives market will be particularly influenced by the shaping of demand factors. In this respect, it is particularly appropriate to implement necessary regulatory measures, among others to eliminate non-transparent transactions related to derivatives, as well as to raise the safety of the market participants. Under favourable conditions of the environment, we can predict a renewed interest of the market participants in derivatives and their further development, also in terms of trading volume.

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Chapter 4

Financing the Operational Risk of Start-ups through Insurance

Ryszard Pukała

1. Introduction

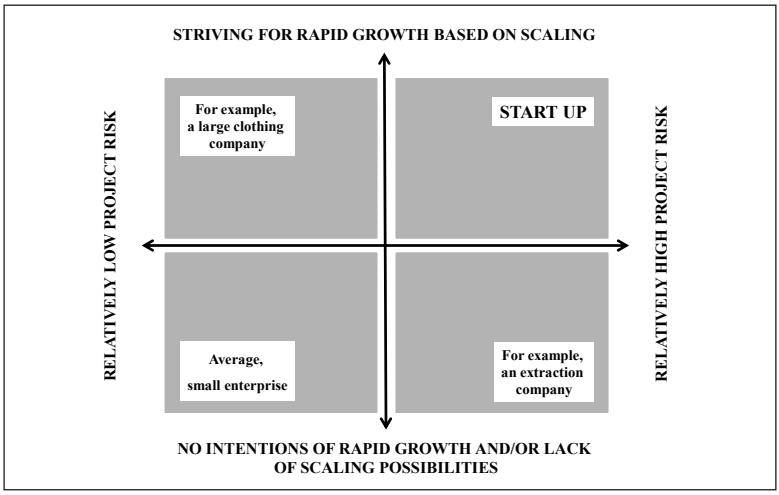
The contemporary economy would be unable to develop steadily and sustainably without rapidly growing enterprises based on new technologies and innovations. These enterprises include start-ups. This business activity relies on a particular idea and methods of bringing it to life. However, due to the specificity of starting up and conducting the activity as well as frequent testing of business solutions until they become scalable and take on a form of a business model, this type of activity is burdened with a considerable level of risk. In each stage of start-up life the operational risk spectrum varies and is often changeable over time. This means that start-ups should give priority to risk management processes and making use of risk financing tools. Insurance is one of such tools and – owing to its efficiency, cost and additional benefits it offers – it is one of the most optimal operational risk financing methods under volatile external business conditions and a fluctuating market environment. The study is devoted to this very issue and it aims at presenting the possibilities of using insurance in limiting start-up operational risks.

2. The essence of start-up activity

Contemporary knowledge-based economy is characterised by high dynamics of changes and the quest for new solutions that engender tangible benefits and enable enterprises to activate innovative business solutions. Their development, based on new and often unique technologies, contributes to providing durable and sustainable economic development. We can classify start-ups, defined in various ways, to this group. Through their innovative undertakings aimed at seeking unique paths of development they can quickly start playing a dominating role on domestic and global markets. Mature enterprises are usually characterised by a clearly defined objective and specificity of operation. They execute a plan aimed at winning new clients and generating revenues. Start-ups, on the other hand, only seek a scalable and repeatable business model that would enable them to stay on the market and continue their development (Blank & Dorf, 2012). Here,

scalability means a relatively proportional increase in the market share. We can also assume that a start-up is an organisation that creates products and services under conditions of extreme uncertainty (Ries, 2012). Therefore, a start-up is an entity that looks for a business model that describes how value added is created, safeguards the achievement of this value and provides benefits arising therefrom (Osterwalder, 2013). Start-ups belong to high-risk entities and thus require particular financial protection, including as regards an insurable and non-insurable risk. When analysing risks a start-up is exposed to, we can identify their broad spectrum – see Figure 1 below.

Figure 1. Position of start-ups on the business activity risk and scale map



Source: (Deloitte Polska, 2016).

We need to emphasize that start-ups are mainly associated with modern technologies. This applies mostly to web portals, services and mobile applications. However, the business model used by this group can be used virtually by any other industry. In this case, the area of activity is not the most important thing – it is the sole business model and operating methods that gain prominence, therefore start-ups do not have to be linked directly to modern technology. Contrary to the so-called routine business activity, a start-up is a temporary organisation aimed at testing a new business model. Only when it succeeds, can the entity move on to regular operation. Such entities are often associated with a high degree of innovation. Therefore, as part of the governmental work on the so-called Small Innovation Act, start-ups have been defined as newly established enterprises conducting research and development activities. In practice, though, the specificity of start-ups results mainly from their focusing on the application of information technology and the Internet – aspects whose contribution to the development of the contemporary economy is invaluable. The most important categories of socio-economic influence exercised by start-ups include:

1. Creating value added in economy – the innovative character of start-up activity makes them contribute creatively to the production process, which leads to generating value added. The dynamic development of start-up activity can therefore efficiently contribute to GDP growth.
2. Creating valuable jobs – start-ups usually start their activity as small enterprises employing several people. However, those that reach maturity and successfully go through the scaling

phase usually transform into important employers. They create jobs mostly addressed to young people, which is particularly significant in the context of high unemployment levels among the youngest groups on the labour market.

3. Generating household income – by providing valuable jobs, start-ups contribute to the increased disposable income, which allows increasing consumption and savings of persons working for start-ups and members of their families.
4. Contribution to the public finance – through taxes the start-ups have impact on the situation of the public finance, thus contributing to financing budgetary tasks.
5. Increasing human capital – jobs generated by start-ups usually require high qualifications in dynamically developing areas such as IT, nanotechnology, robotics, creative industry or e-commerce. These areas are of key importance in a developing, knowledge-based economy. Therefore, start-ups play an important role as standard creators – they build perspectives for persons beginning their education in the field of innovation and on faculties that offer promising perspectives for the development of the entire economy.
6. Enhancing social capital – the specificity of start-up activity requires interpersonal skills, collaboration and trust. Persons involved in developing a start-up must therefore develop competences in those fields, so that the enterprise was able to go through subsequent maturity stages. We are dealing with mutual influence here: the social capital contributes to the start-up's success, while the start-up's success has a social impact. In this manner the start-up activity contributes to the popularisation of attitudes and behaviours that constitute an expression of high social capital.
7. Positive spillover effects – start-ups create innovative solutions that are used by other business entities and can become the basis for creating a new generation of services and products. Even if solutions created by start-ups are protected by patents or another form of know-how safeguard, they indicate a profitable and promising development direction for other enterprises anyway.
8. The influence of products and services created by start-ups – start-ups generate innovative solutions that influence the quality of human lives. Many of them enhance the quality of life, open new communication channels and broaden the access to various forms of entertainment. Thus, these qualitative effects that are hard to evaluate have an important impact on the socio-economic reality.

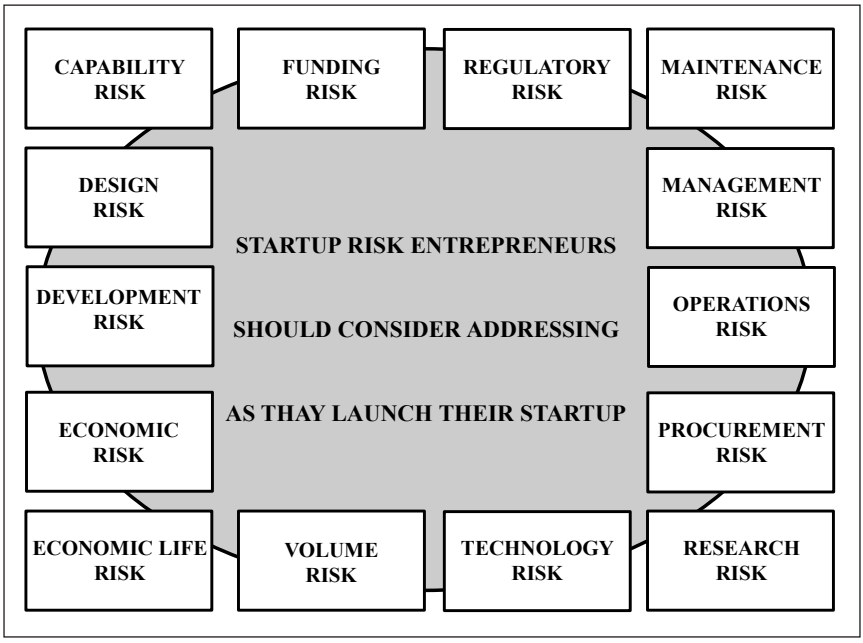
Therefore, promoting start-up initiatives will be one of the main directions of support as part of the Polish economy in the years to come. The issue of start-up survival in a turbulent market environment and working out solutions and business models that allow durable development and market success gains particular significance in this context.

3. Start-up activity risk

Risk is an inseparable element of each activity. In general, risk means uncertainty, a threat to assumed objectives and an activity with unknown results. It is also defined as a possibility of success or failure. When acting in conditions of risk that is highly exposed in start-up operations, one needs to take account of a possibility that an initiated undertaking might fail. On this plane the risk is defined as a possibility of an event that will adversely influence the execution of assumed objectives. On the other hand, taking a risk is also connected with possible benefits.

Start-ups belong to high-risk entities and thus require particular financial protection, including in the scope of insurable and non-insurable risk. When analysing risks a start-up is exposed to, we can identify their broad spectrum – see Figure 2 below.

Figure 2. Risks related to start-up launching and operation



Source: own study based on http://fundingsage.com/14-startup-risks-entrepreneurs-should-consider/. Retrieved on 17/05/2017.

A broad assortment of risks that influence start-ups adds particular significance to the use of risk management tools that can limit the operational risk. We have to stress that risk management is a process in which an enterprise solves associated risk-related problems in an organised way, so that the operation could bring about durable benefits, both in particular areas and as a whole (Sitek, 2009, p. 29).

Corporate risk management usually consists of several subsequent stages (Frame, 2003, p. 18):

- risk planning,
- risk identification,
- risk influence assessment, both quantitative and qualitative,
- working out a response strategy,
- risk monitoring and control.

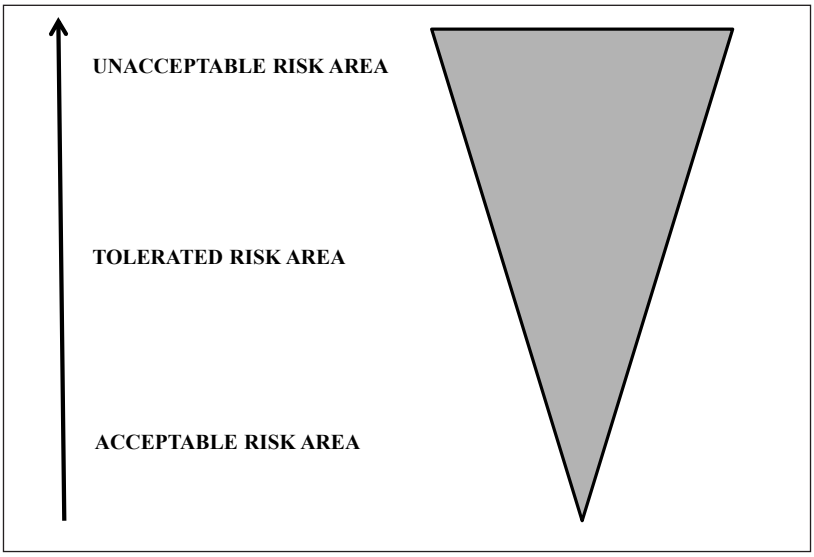
In order for the risk management process to function properly, it should be coupled with other processes taking place at an enterprise, regardless of whether in a small, medium-sized or a large company (Korombel, 2013, p. 45).

In the case of start-ups, which are usually newly established enterprises, it is hard to talk about formalised approach to risk management. Such entities often undertake risk-limiting activities only if the entity starts facing a direct impact of the risk. It is characteristic of the so-called silo

approach to risk management, which is unique for the fact that risk management is not included in the corporate strategy and does not take account of the impact of risk on business objectives. The organisation performs reactive risk management – when a crisis appears – focusing mainly on selected measurable risks. Unfortunately, such approach makes it impossible to take account of links taking place between all corporate risks present (Korombel, 2013, p. 45). Frequent dispersal of employee responsibility for the risk management process and low risk identification efficiency also constitute important problems. It is particularly unfavourable in the case when efficient implementation of the risk management process should be based on accurate identification of risks occurring at a company. Correct risk establishment requires analysing the company as a whole and determining all possible sources of risk that have effects on an entity, taking account of features of each risk (Szczerbak, 2009, p. 44). Risk identification is aimed at defining types of risk a given enterprises is exposed to (Jajuga, 2009, p. 15).

The lack of a comprehensive approach to risk identification in start-ups considerably limits the risk prevention opportunities and precludes an accurate assessment of its size and ensuing threats that can destabilise the entity's operations. Therefore, it seems legitimate for start-ups to use a simplified version of the ALARP (As Low As Reasonably Practicable) concept, which claims that the risk level should be as low as possible in practice. The framework diagram of the ALARP concept is presented in Figure 3.

Figure 3. The ALARP concept



Source: (Korombel, 2013, p. 134).

Although the ALARP concept was elaborated to specify appetite for professional risk related to a given activity, e.g. a risk of accident, its main idea can be related to the operation of the entire enterprise (including, in particular, start-ups) and risk management tools it utilizes.

It should be noted that currently the perception of corporate operational risk is changing in the context of optimised corporate operation and managerial decisions, due to the fact that risk:

- is an independent product that can become an object of commercial transaction,
- can be transferred,
- has impact on the enterprise's market value,
- is an element of a comprehensive corporate management system,
- offers an opportunity to use formalised methods of supporting decisions, owing to an increasingly detailed parameterisation.

In the case of start-ups, financing the risk can take place in a number of ways:

- risk deterrence by means of own financial resources (own funds, possibility of taking out a loan, etc.)
- transfer of risk:
  - for a non-insurable risk (possibility of using hedging transactions, such as options, futures, forward, etc.);
  - insurance (insurance system, either the whole pool of risks or only selected ones, insurance sums, the value according to which the insurance has been concluded, amount of franchise, amount of own share, exclusions, who acted as an intermediary in the process of concluding an agreement, etc.).

Competitiveness of insurance compared to other risk management methods can be evaluated through the prism of criteria of significance to the assessment and selection of risk management methods. From the practical point of view, we can indicate the following criteria:

1. Efficiency – insurance belongs to compensatory methods, i.e. those that aim at providing a financial compensation for a loss that arose from risk materialisation. Obviously, efficiency in this regard will be determined by the scope and reliability of compensation for the incurred losses, which results from the scope and feasibility of insurance coverage.
2. Cost – in terms of price, insurance ranks as a very attractive tool of providing protection related to corporate risk transfer. It is also worth emphasizing that it allows decreasing tax liabilities through including an insurance premium in deductible depreciation.
3. Additional benefits – apart from a risk transfer method, insurance can bring about additional benefits to an entrepreneur, when seen on two levels:
   - additional (apart from compensatory) insurer benefits that can be helpful in conducting a business activity (e.g. assistance),
   - benefits that derive from holding an insurance policy, other than the right to obtain compensation or benefit (the feeling of safety makes entrepreneurs more inclined to make non-standard business decisions).

The listed criteria are particularly important for start-ups, which experience high volatility of risk over time, therefore adjustment of extra-insurance, risk-limiting tools might be quite problematic and cost-intensive. This project is devoted to this very issue of the use of insurance as an operational risk management tool among start-ups.

4. The use of insurance as a start-up risk-limiting tool

The scope of insurance coverage used by an enterprise is a derivative of numerous factors. The most important ones include:

- size of a business entity,
- area of operation,

- development status,
- volume of financial resources,
- risk management tools used,
- possibility of transferring risk onto clients and suppliers.

Each enterprise operates under changing internal and external conditions, therefore it is very important to optimally adjust the insurance coverage to corporate needs. It is particularly complicated for start-ups, since their operational specificity and in many cases a long period of reaching scalability lead to a situation where insurance needs are very often ignored or underestimated. It also has to be stressed that the spectrum and size of risk a given start-up is exposed to depend to a great extent on the development stage of an entity – Table 1.

Table 1. Risk level and insurance coverage depending on start-up lifecycle

Start-up lifecycle stage	Risk level and type	Insurance coverage
Conceptualisation	very low, non-insurable	none
Vision	very low, non-insurable	none
Forming	low, insurable to a small extent	none or selected products to a limited extent
Validation	high, insurable to a small extent	selected products to a limited extent
Scalability	high, insurable to a medium extent	selected products in a broadened scope
Maturity	high, comprehensively insurable	comprehensive

Source: own study.

When selecting insurance products to protect the start-up activity, it must be emphasized that there is no single product or a group of products that would protect corporate assets, future profits and potential client or contractor claims in a comprehensive manner and would additionally be appropriate for every enterprise. This results from the specificity of business activity conducted by a start-up. Therefore, this specificity gives rise to a situation where in spite of an enterprise holding an insurance policy not all potential risks are covered. Each start-up should adjust the insurance coverage to individual needs. We can distinguish several key products in the broad spectrum of products offered by insurance companies. They include[1]:

1. Personal Property Insurance provides the holder of the policy protection against the financial risk of damage or loss of personal property due to fire, theft and certain weather perils.

[1] own study based on http://fundingsage.com/8-insurances-to-mitigate-startup-risks/. Retrieved on 17/05/2017.

2. Real Estate Title Insurance provides the holder of the policy protection against financial loss due to defects in a title to real property and from the unenforceability or invalidity of mortgage loans. Its purpose is to protect the property owner or lender from losses due to title defects, liens or other similar issues.
3. General Liability Insurance provides the holder of the policy protection from liabilities which may occur from the imposition of lawsuits or other similar claims. In general, it provides protection against third party claims, excluding damages caused intentionally or liabilities which are contractual in nature.
4. Product Liability Insurance provides the holder of the policy protection against financial loss of property due to issues arising from or related to the property, in a manner similar to General Liability Insurance.
5. Directors and Officers Insurance (D&O) is a liability insurance which provides financial protection, (indemnifies) the insured director or officer of a company, or the company itself for losses or costs of legal defense suffered as a result of legal action brought against the parties for alleged wrongful acts.
6. Errors and Omissions Insurance (E&O) is a form of liability insurance which protects professionals, consultants and companies engaged in providing professional advice as a service against the financial losses which may occur due to the need to defend against negligence claims made by clients and resulting damages which may be awarded as a result of civil lawsuits. Specifically, the coverage is directed to provide protection against financial loss caused by errors or omissions in the service provided.
7. Workers Compensation Insurance protects employees by providing wage replacement and medical benefits to employees injured in the course of employment.
8. Key Man Insurance is a form of business insurance. It is an insurance policy executed by the business to provide financial compensation to the business as protection against financial losses that may arise in the event of the death or extended incapacity of a critical member of the business.
9. Computer Crime Policy, which covers risks related to electronic collection, storage, processing and transferring information, the loss of which would be able to cause corporate losses.

When selecting products that provide optimal protection of start-up activity from risks, one needs to focus not only on the scope, but also on the cost. Some insurances can constitute a significant financial burden for a start-up, therefore in such case one needs to consider other risk financing tools or use other risk limiting methods. Regardless of an approach, though, a start-up should make maximum efforts to make the operational risk as small as possible and to make the risk financing tools optimal for individual needs.

5. Conclusion

The emergence in recent years of new, innovative enterprises that include start-ups should currently be treated as a challenge to stand up to in the context of the development of the Polish and global economy and efficient competition of newly established enterprises on the European and global market. Their rapid growth and the quickest possible achievement of an optimal business model are the sole guarantee of their market success and can become a significant incentive for economic growth. The start-up activities largely influence the social and economic life. The unique

character of such undertakings results in the fact that only a small number of them become mature enterprises that exert significant impact on the economy.

Start-ups are burdened with a high level of operational risk in each development stage. Therefore, the use of risk financing tools is gaining importance. Insurance is the most optimal one. A broad spectrum of products offered by insurers results in start-ups being protected in a manner that is tailored to their individual needs. This is particularly important given the operational risk volatility, whereas the use of an optimal insurance coverage of the business activity can certainly become one of the preconditions of a market success achieved by this type of enterprises.

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Chapter 5

Creative Accounting – The Ordinary Perception of the Concept on the Internet[1]

Artur Hołda, Anna Staszel

1. Introduction

Determining the meaning of creative accounting and the approach of the accounting environment to the area of accounting freedom is the basis for further consideration of the place of fair value accounting, accounting ethics or the application of the principle of true and fair view in various accounting systems. The efficient functioning of market systems uniformly depends on the reliability and adequacy of information generated by the accounting system, which became evident at the beginning of the 21st century in the wake of the global effects of accounting scandals in both the US and Europe. A clear distinction between which accounting practices are permissible (as well as indicating why they are allowed) and which should be considered as completely impermissible, is of particular importance.

However, the way in which the concept of creative accounting functions in ordinary language determines the public perception of accounting as a whole, e.g. by strengthening the conviction that accountancy can be manipulated, which, in turn, may undermine the confidence of potential investors, thus affecting the perception of the entire market system.

The authors conducted a three-stage study to examine how the concept of creative accounting functions in everyday language and in what sense the term is used by the public. They verified how this concept is used on the internet and in what sense it is used by journalists. The research was first conducted in 2014 and then repeated in 2017. It revealed that as a consequence of a large number of scientific papers on the positive aspects of creative accounting published between 2014 and 2016 to promote the understanding of this concept as an ambiguous phenomenon, the public perception of what creative accounting is had changed.

[1] This publication was funded out of the fi nancial resources of the Polish Ministry of Science and Higher Education granted to the Cracow University of Economics' Department of Management towards the research of young scientists and Ph.D. students.

2. The perception of creative accounting in various parts of the world and in Poland – aggregate information

The concept of creative accounting was evident in professional literature as early as the 1970s, especially in publications on bankruptcy of business entities. Starting with the journalist Ian Griffiths who popularised the concept of creative accounting, English authors have defined creative accounting as manipulation, misleading the users of financial reporting, legal but morally dubious fraud (Griffiths, 1986, p. 1), and following in their footsteps, American, Australian, New Zealand and some South American authors identified creative accounting with fraud, often lawful but morally doubtful (Jameson, 1988, pp. 7-8; Jones, 2011, chapter 1.1; Cosenza & Grateron, 2004). Interestingly, it is authors from counties of Anglo-Saxon accounting where the principle of true and fair view in accounting is strongly emphasised that define creative accounting as a negative phenomenon (Hołda & Staszel, 2014, p. 330).

Creative accounting, whose origins can be traced back to English-language literature, has long been a research subject in France (since 1992) and Spain (since 1991). In France, a large group authors emphasised the negative aspect of creative accounting, treating it as manipulation (Felaga & Malciu, 2002; Breton & Stolowy, 2000). However, an equally large group of authors opposed such an authoritative definition of creative accounting (Raybaud-Turillo & Teller, 1997), pointing out that creative accounting is, first and foremost, a technique that, by and large, shows the best possible picture of the entity (which in itself may be misleading), but also offers a benefit to investors by improving the external perception of their companies, and secondly, it can be used not only for bad ends, such as data manipulation, but for good ones as well by painting a true and fair picture of the economic reality in accounting books (Hołda & Staszel, 2016b).

Positive aspects of creative accounting are emphasised even more strongly by Spanish authors. In 1992, Giner (1992, p. 4) wrote that there are areas of accounting that even demand individual judgment and estimation, i.e. accounting creativity. Likewise, Gabas (1991, pp. 115-116) pointed out that normative accounting does not exist, and creative accounting is simply a way of choosing between the different solutions when there are no clearly defined mathematical rules.

Spanish scientists have started a trend under which creative accounting is defined as a choice between different valuation methods or the presentation of economic events where the law does not prescribe a clear solution to the problem. This trend became particularly evident in some Balkan states, in Central and Eastern Europe and in Russia. Authors from these countries came to oppose the original definition of creative accounting, which treats the practice solely as a scam. Authors who promote a positive definition of creative accounting maintain that creative accounting is the result of an accounting policy that reflects an entity's situation in the absence of a clearly defined method. Creative accounting is therefore identified with accounting innovation, a perception which completely deprives it of its negative overtones (Hołda & Staszel, 2015a).

Most Polish authors point out that creative accounting is an unclear phenomenon: it consists in a presentation of economic events that is both legal and in line with appropriately interpreted accounting principles, and which is not explicitly indicated in the law (Gut, 2006, p. 11; Hołda & Staszel, 2015b). As with any type of freedom, the freedom may be used either lawfully, expressing an attempt to paint a fair and clear view of the entity in the financial statements and it may be used unlawfully to deliberately mislead the users of financial statements.

Also CIMA notes that creative accounting is not always an adverse thing (*Creative…*, 2005) it simply implies solving accounting problems requiring the choice of the valuation method,

the recognition of transactions in a creative, non-stereotyped way. The same opinion is shared by most authors from Poland, Ukraine, Croatia, the Czech Republic and Slovakia, who thus put themselves in opposition to American, English and Balkan authors (Hołda & Staszel, 2016a).

3. Research into the functioning of the concept of creative accounting in common language

In order to test how the concept of creative accounting functions in colloquial language, the authors conducted a two-way study. As a first step, in 2014, they analysed newspaper articles from eight of the most frequently read (as of December 2014) periodicals (newspapers, weeklies and biweeklies) in 2001-2013. The study revealed that journalists used the phrase 'creative accounting' very often, more often than expressions such as 'aggressive accounting' 'accounting tricks', 'falsification of financial statements', or even 'accounting fraud'. Unfortunately, the term 'creative accounting' penetrated the media lexicon as a neat and catchy synonym of dishonest practices, and consequently also entered the public domain as a mild name for fraud, manipulation and falsification of accounting data. In 2001-2013, the phrase 'creative accounting' appeared in the daily press as many as 715 times in the negative sense, and in only 11 cases did journalists use the word in a positive sense (in articles explaining that creative accounting must not be identified with fraud). The aggregate data is presented in Table 1.

Table 1. Contextual meaning of phrases relating to creative accounting and related phrases in 2001-2013 in Poland

Phrase used:	**Number of occurrences in newspaper articles (2001-2013)**
Creative accounting	715 times with a negative meaning, 11 times with a positive meaning
Aggressive accounting	13 times with a negative meaning, 3 times with a positive meaning
Accounting tricks	35 times with a negative meaning
Falsification of financial statements	105 times with a negative meaning
Accounting fraud	93 times with a negative meaning

Source: (Hołda, 2016, p. 49).

The results of the 2014 analysis of the content of press articles containing the phrase 'creative accounting' indicate that as a result of journalists' use of the term 'creative accounting' in solely such a negative context, the phrase entered the common language with the negative overtones.

The second stage of the authors' research aimed to verify how the concept of creative accounting functions on the Internet – the authors came up with the premise that the person who wanted to check what creative accounting was without having access to professional literature would probably check the meaning of this concept on the internet. Hence, the way in which creative accounting is defined by popular online portals and the content of the web pages that appear first after the term is entered in the search engines will also determine the manner in which creative accounting is construed in everyday language.

Analysis of the concept of creative accounting on the Internet was conducted twice, with a more than two-year time gap: in December 2014 and in March 2017. The purpose of the second analysis was to examine how information on creative accounting had changed on various web portals, in particular due to the fact that the number of scientific papers on creative accounting showed a significant increase throughout the 2014-2016 period. The papers increasingly emphasised the positive aspects of creative accounting. Bazekon's database of scientific papers from the 2000-2013 period features a mere 23 articles on creative accounting. In turn, during the 2014-2016 study period, as many as 11 scientific papers on creative accounting can be found that indicate its positive aspects, and clearly contradict the notion that creative accounting is fraudulent accounting. The purpose of the authors' second review of internet content relating to creative accounting was to ascertain whether the increase in the number of scientific articles promoting positive aspects of creative accounting would also translate into a change in the perception of creative accounting and put an end to its sole identification by the public as fraud.

4. Results of the 2014 research into the functioning of the concept of creative accounting on the internet

In their first study in December 2014, the authors analysed the first four pages returning the term 'creative accounting' in the most popular search engines, i.e. Google, WP, Yahoo, Onet, Interia, and Ask.com. The aggregate results are shown in Table 2. The numbers in parentheses show the number of occurrences on the first page of the search (out of a maximum of 10 results on the first page of search results), the numbers outside the parentheses are the search results from the first four search pages (up to 40 results). The authors ignored results that did not carry any content (e.g. advertisement of an accountant's office with the word "creative" in the office's name, training information that also covered creative accounting, translation of the phrase into English, or an offer of assistance in the writing of a diploma thesis with the term 'creative accounting' in the title).

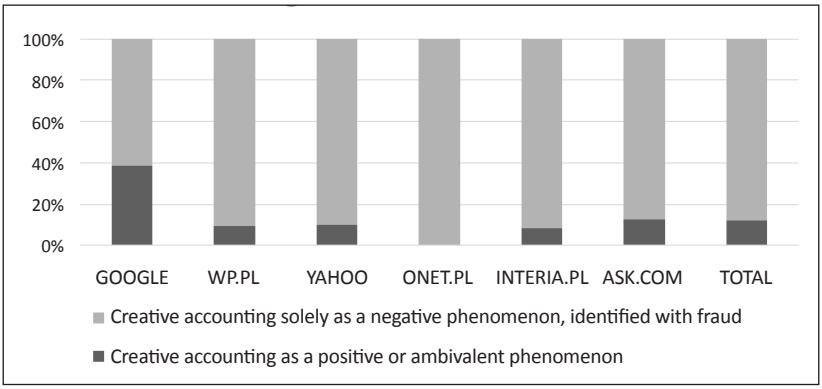
Table 2. The aggregate results of the 2014 survey

	GOOGLE	WP.PL	YAHOO	ONET.PL	INTERIA.PL	ASK.COM	TOTAL
Creative accounting as an exclusively positive or ambivalent phenomenon	10 (8)	3 (2)	2 (1)	0 (0)	3 (2)	4 (4)	21 (18)
Creative accounting as a negative phenomenon identified with fraud	16 (2)	29 (6)	18 (5)	31 (11)	32 (7)	28 (5)	154 (36)

Source: own work.

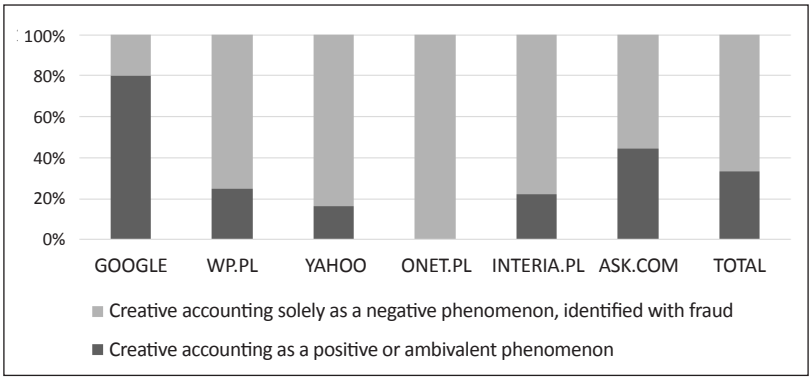
Definitions of creative accounting that focus on its positive aspects as well as those that present creative accounting as an ambiguous phenomenon dominate the first page of search results (Fig. 1); on the other hand, the results on the subsequent pages associate creative accounting with fraud or use the term to refer to accounting scandals or manipulation of deficit and public debt (Fig. 2).

Figure 1. Results of search for the term 'creative accounting' – first 40 search results



Source: own work.

Figure 2. Results of search for the term 'creative accounting' – first 10 search results



Source: own work.

It should be noted that the search results on the most popular search engine, google.com coincide with how the concept of creative accounting is defined in professional literature where the notion of creative accounting is largely considered by the authors to evoke negative connotations. The results of the search for the term 'creative accounting' on other portals will indicate to Internet users that creative accounting is a smart name for accounting fraud.

One of the most popular portals, Wikipedia (2017), used by internet browsers to extend their knowledge, referring to the works of E. Mączyńska and P. Gut and the etymology of the word 'creative' aptly pointed to the positive aspect of creative accounting and emphasised that there is no agreement as to how to define creative accounting in Polish literature. Likewise, the Mfiles.pl portal correctly cited the definition of creative accounting given by S. Surdykowska. On the other

hand, most online sources unequivocally considered the concept of creative accounting to stand for manipulation and fraud. The first pages of search results for the term 'creative accounting' in the most popular Internet search engines are dominated by articles identifying creative accounting with fraud, e.g. articles referring to fraudulent economic practices titled "Creative accounting in Polish companies (*Korupcja i*…, 2013)" or other articles with much-telling titles, e.g. "How General Motors conjured $30 billion (Wróbel, 2010)". Numerous search results contain references to press articles on various types of financial scandals, which use the phrase 'creative accounting' in the title. Also specialist portals, such as the Monitor Rachunkowości i Finansów (Accounting and Finance Monitor), the Polska Akademia Rachunkowości (Polish Academy of Sciences) portal, bankier.pl, forbes.pl and Gazeta Bankowa (Banking Gazette) all defined creative accounting as an illegal, unethical, improper and fraudulent activity. For example, the bankier.pl posted statements from companies (e.g. Hydrotol S.A or LG Petro Bank S.A) stressing that the "financial data provided is true and fair and does not contain any elements of creative accounting".

5. Results of the 2017 study into the functioning of the concept of creative accounting on the internet

The March 2017 study was based on the same methodology as the previous research – the authors searched for occurrences of the term 'creative accounting' on the first four pages of search results (which yielded a maximum of 40 results per webpage) in the most popular search engines. The 2017 study did not include Yahoo because it was no longer available in the Polish language. As in the previous study, the authors ignored results that did not contain any relevant content e.g. advertising by offices of accountants.

The March 2017 analysis showed that there were a lot of articles on the Internet indicating the need to differentiate creative accounting from accounting scam, and additionally internet content advises that in order to refer to negative phenomena the term "aggressive accounting" should be used rather than creative accounting. Well-known Internet portals, such as Wikipedia, infor, Stowarzyszenie Inwestorów Indywidualnych (Individual Investors Association), bankier.pl, warn that creative accounting should be distinguished from accounting scam, pointing out, in accordance with a definition provided by theoreticians and accounting experts, that creative accounting is an ambiguous phenomenon. These ideas practically did not appear on the websites in 2014, suggesting that the change in internet information on creative accounting was caused by a significant number of scientific papers on creative accounting published in 2014-2016 to highlight its positive aspects and clearly differentiate between creative accounting and accounting fraud.

However, some portals, such as Forsal, blog.parkiet.pl, gazeta prawna (legal gazette), still unequivocally identify creative accounting with falsification of financial data, giving e.g. the following information: "Creative accounting involves the use of loopholes, weaknesses and flexibility of accounting standards, e.g. to report better than actual results. It can therefore be described as a mild form of falsification (cooking) of accounting books" (Forsal.pl).

The aggregate results of the 2017 survey are shown in Table 3. The numbers in parentheses represent the number of search results on the first page of search results, the numbers outside the parentheses are the search results from the first four search pages (up to 40 results).

Table 3. The aggregate results of the 2017 survey

	GOOGLE	WP.PL	YAHOO	ONET.PL	INTERIA.PL	ASK.COM	TOTAL
Creative accounting as a solely positive or ambivalent phenomenon	18 (9), including on the 1st page 4 scientific papers	20 (9), including 5 scientific papers on the 1st 1 page	Currently the engine is not available in Polish	18(9) Search engine shows results of google search	18(9) Search engine shows results of google search	12 (8) including 3 scientific papers on the 1st page	86 (44)
Creative accounting as a solely negative phenomenon identified with fraud	13 (2)	10 (1)		13(2)	13(2)	9 (2)	58 (9)

Source: own work.

It should be emphasised that research papers on creative accounting such as papers from Universities' proprietary publications, post-conference monographs and the "Zeszyty Teoretyczne Rachunkowości" (Theoretical Accounting Booklet) appear on the first pages of the search (as pdf files or references to relevant pages). During the previous research conducted in 2014, only 3 scientific results appeared in the search results, and they were only listed on the third and fourth search pages.

Comparing the results of the 2017 study to the results of the 2014 research, one notices a dramatic change in the structure of search results. In 2014, the search results for all web browsers indicated that that creative accounting was positive or ambivalent in a mere 12% of the cases, as opposed to 88% of search results suggesting that creative accounting was a term used to refer to fraud, counterfeiting and even embezzlement. Undeniably however, this structure was different on the first page of search results alone – here one third of the searched pages pointed to positive aspects of creative accounting, as opposed to two thirds of the search results focusing on the negative aspects of creative accounting alone.

By 2017 the situation had changed considerably – among the results of the search for the term 'creative accounting', half of them (51%) implied that creative accounting should not at all be construed as fraud, and the searched webpages provided relevant definitions of creative accounting (taken from scientific papers) and suggested that creative accounting should be viewed as an ambivalent, indeed, positive phenomenon. Moreover, as much as 73% of the results on the first search page (and it can be easily assumed that an internet browser searching for quick feedback will limit himself to just the first page) defines creative accounting as an ambiguous practice and points to its positive aspects. Wikipedia, which in each of the surveyed search engines comes top after the phrase 'creative accounting' is entered gives a correct definition of creative accounting taking it from the works of such authors as Gut, Mączyńska, Hołda and Staszel. Tables 4, 5, 6 show the structure of the 2014 and 2017 search results and the dynamics of change over the two years studied.

Table 4. Structure of results of search for the term 'creative accounting' on the first four pages of the search results in the different search engines in 2014 and 2017

	Google		WP.pl		Yahoo		Onet		Interia		Ask.com	
	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017
Positive	63%	58%	9%	90%	10%	Brak	0	58%	9%	58%	13%	57%
Negative	37%	42%	91%	10%	90%	brak	100%	42%	81%	42%	87%	43%

Source: own work.

Table 5. Structure of results of search for the term creative accounting on the first four pages of the search results in the different search engines in 2014 and 2017

	Google		WP.pl		Yahoo		Onet		Interia		Ask.com	
	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017	2015	2017
Positive	80%	81%	25%	90%	17%	Brak	0%	81%	22%	81%	44%	83%
Negative	20%	19%	75%	10%	83%	Brak	100%	19%	78%	19%	56%	17%

Source: own work.

Table 6. Overall dynamics of change

	Google	WP.pl	Onet	Interia	Ask.com
Positive	180% (113%)	1000% (450%)	100% (100%)	900% (450%)	300% (200%)
Negative	81% (13%)	34% (3%)	42% (6%)	41% (6%)	32% (7%)

Source: own work.

6. Conclusion

In order for information provided by the accounting system to be useful, it should be reliable and at the same time best reflect the economic reality. However, the measurement process in accounting is marked by subjectivity and by its very nature subject to the influence of individual judgments. The fact that accounting measurement is never entirely objective is crucial in understanding the essence of creative accounting.

The authors suggest that creative accounting should be construed as a choice made both within the law and in accordance with one's judgement between different approaches in situations where appropriate patterns or standards do not furnish a direct solution to a problem or indicate the possibility of alternative approaches. In this sense, creative accounting always implies actions in line with the broadly defined law (i.e. criminal, civil, economic, and especially detailed accounting regulations) and consequently is not in itself a judgmental concept. Moreover, creative accounting in the above definition assumes the satisfaction of the criterion of reliability of economic information, in particular with regard to its qualitative features such as reliability, neutrality and completeness.

It is worth emphasising that the definition given by the authors is consistent with the definition of creative accounting provided by many researchers around the world who view it as completely legal acts, and additionally this definition combines several different positions, indicating that the connotation of this phenomenon can be either positive or negative depending on how the degree of accounting freedom is used.

Analysis of the results of the search for the term 'creative accounting' in internet search engines shows that the concept of creative accounting functions on the Internet in line with its theoretical meaning, and internet portals point to the correct definitions of this concept (provided by most accounting theoreticians) and do not identify it solely with fraud, which was commonplace even 3 years ago. It may be inferred that the change in the approach to the use of the concept of creative accounting (where previously the expression was misused to describe any manner of accounting scandals, embezzlement, scams, accounting frauds, etc.), and the increasing reference on websites to definitions sourced from professional literature (e.g. scientific journals) reflect the significant increase in often freely available on the Internet scientific publications covering the essence of the concept of creative accounting.

The 2014 study indicated that the concept of creative accounting had only negative connotations in colloquial usage: it was used by journalists in that sense and functioned on portals in that way. The 2017 analysis shows how much the perception of the concept of creative accounting by the public had changed, as can be evidenced by the fact that information on creative accounting on the Internet increasingly overlaps with its meaning in professional literature. Numerous internet portals point to the positive aspects of creative accounting, relying on professional literature and making reference to the authors of this very paper.

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Chapter 6

Outline of the History of Work Accounting[1]

Jurij Renkas

1. Introdaction

The value of an individual employee's human capital increases in the period from birth to the end of the work activity. Its size determine the necessary expenditure, as the cost of living and education expenses, and expenses incurred in the course of work (for example, post-graduate studies). Furthermore, the capital increases employee as a result of the increase in work experience. This is a positive side effect of the work. Identification of these expenditures, and determine the function of capital growth as a result of the acquired experience, leads to the already known and repeatedly verified human capital model presented in many previous studies, like (Dobija, 2009; Koziol, 2007; Kurek, 2004; Stando-Gorowska, 2015, 2016; Renkas, 2016).

Developing a model of measuring human capital and fair wages associated with research in the field of accounting and labour economics. A short sketch concerning accounting of wage notes that at the time of the original agrarian civilization (the city-states of Mesopotamia) work accounting was the basis of economic relations and the basis for determining the appropriate remuneration.

2. The origins of work accounting

In the history of accounting, scholars focus their attention mainly on the event, which is published in 1494, the main work of L. Paciole "Summa de Arithmetica, Geometria, Proportioni et Proportionalita". This work has indeed become the beginning of contemporary theory and practice of accounting. However, it is worth paying attention to the earlier period in the history of accounting, which falls on millennia of agrarian civilization, before the city-states (around 3200 BC). It was a period of interest from the point of view of labor accounting, as the measurement and record of working time served as the main instrument for organizing the economic life of society.

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First and foremost, let us note that the contemporary societies had to solve the problem of cooperation very important to their existence. This applies to every society at all stages of its development, but at the beginning of civilization the issue was of the utmost importance. The problem is that in order for the public to achieve greater results, resulting from the joint work of many specialized workers, there is a need to organize work together. An important factor that aroused and motivated was the search and creation of a common measure that helped to determine the personal contribution of each participant to work together, and to share the results of that work in a proportionate way. Note that the problem of adequate remuneration for work also exists today.

The research conducted (Dobija & Jędrzejczyk, 2011) shows that the first traces of accounting appear in the scope of registration of work-related operations. The large-scale work organization is found in ancient Mesopotamia where irrigation systems were built for agriculture. It is here that among the large number of pictograms we find signs of units of work that were used in those times.

As we know, accounting requires the existence of a number system. Without abstract numbers, not only accounting would be created, but also civilization itself. Georges Ifrah in his work "The History of Numbers, or the History of the Great Inventory" (1990) shows that the development of numbers and their use is directly related to economic records. The development of numbers has progressed along with the improvement of economic records. For these purposes, there was no need a zero. As Charles Seife writes in his work "Zero – Dangerous Idea" (2002, p. 9): "The origins of mathematical thinking have come from the need to record property and the passage of time". The invention of numbers is attributed to enumerators from city-statesmen of Uruk. They brought about revolutionary changes in the method of calculating and trading data. Accountants introduced two types of characters: numbers (symbols, denoting abstract numbers) and pictographs (signs, characterizing individual items).

The archaeologist at the University of Texas D. Schmandt-Besserat (2007) was the first person to address the issue of accounting in ancient times. It is a scholar who over the years has been exploring small clay works called tokens discovered during the excavations in the Middle East. She first understood that she was investigating artifacts that had a direct bearing on the calculation and subsequent writing.

Beginning in 1974, D. Schmandt-Besserat published a number of articles on the importance of tokens in the development of writing and accounting. An essay entitled "Accounting in Prehistoric Times", given in 1988 at the 5th World Congress of Accountants in Sydney, is particularly important for accounting. This article contained basic questions about the place of tokens in the economy of those times. It is inspirational that a trained archaeologist, investigating small clay works, was able to recognize the basic features of the accounting system.

In most cases, tokens meant different products and their metrics. As M. Dobija and M. Jędżejczyk (2011) interpreted it, an employee received a suitable token for his work, which gave him the right to receive the right amount of a certain product. However, tetrahedral tokens deserve special attention. They were distinguished among others by the fact that they meant work units. This clearly demonstrates the fact that at this time units of work were used to measure the work done. The tokens system was using for both job records and payment for work.

Although we do not know the details of the calculation and valuation of the products according to which they were assigned the appropriate number of units of work, however, it can be stated that the system was based on the standard quantities for the measurement of work and remuneration. Analysis of information in the sphere of economy and accounting, organized in ancient cities-

states (founded in Mesopotamia, Egypt and Syria), leads to the conclusion about the existence (at the beginning of the civilization) of the economy, based on the account of work.

3. The use of abstract unit of work in antiquity

There are many confirmations that as early as the third millennium BC, when the tokens were converted into tablets, the abstract work unit was used to settle the work. It must be emphasized that the wedge letter, invented in Mesopotamia at the end of the third millennium BC, was extremely efficient. In those times, the palm-sized plaque contained as much information as can fit on the contemporary A4 paper of the printed text (Dobija & Jędrzejczyk, 2011, p. 22). There were city-states organizations, such as Lagas or Ur. At Ur, there was a textile factory with about 6,000 employees. A detailed and practical accounting system was introduced at this factory. So the question is about the nature and organization of that system that existed and worked in those days. There is a lot of evidence that accounting, the traces left on clay tablets, are the continuation of work accounts that were carried out using tokens.

M. Dobija and M. Jędżejczyk (2011) write that sumerologists have come across the concept of "daily rate" as the primary unit of account in the third millennium BC.W. Struwe (1969), after examining the tablets from the archives of the city-state Umma (23rd century BC), came to the conclusion that:

Tablets contain records of the number of employees (men and women) who do the work in farms under the guidance of a supervisor. Time assigned to perform the desired operation is expressed in days or months, but in most cases the records indicate one day (a certain number of employees for one day). […] Comparative analysis of these records with aggregate documents leads to the conclusion that the writers recorded on the plate the number of workers, and further placed the product of that number and 360 days a year. As a result, they received the number of workers working for one day. From this it was concluded that the Sumerian accountants used the notion of man-day and the sum of labor added in these units (p. 128).

The cited author also gives a very important detail that allows us to infer the nature of the accounting and the economics of these times. W. Struwe (1969) states that:

The introduction of the concept of "daily rate" in the accounting records was undoubtedly motivated by the desire to simplify the calculations of the product secreted due to staff as remuneration for their work. In addition to the daily rate as a unit of work accountants distinguish coefficients, such as 5/6, 2/3, 1/2 etc., which express part of the daily rate. Workers whose labor productivity was estimated at 2/5, 2/3, 1/2 etc. unit of work, receive grain rations reduced accordingly (p. 128).

These fractional coefficients determine the level of productivity attributed to individual employees, with one representing the highest productivity. In modern systems, providing appropriate remuneration apply similar solutions. To justify this, it is enough to divide the remuneration of a particular employee by the size of the largest salary in the enterprise. Then we obtained numerical fractional power coefficients. In turn, by multiplying the productivity factor corresponding to a separate worker, by the number of hours worked, we get the value of the work done.

The above-mentioned considerations indicate that, regardless of the period of time in the accounting systems, there was always measurement and reflection of the work performed, i.e. the measurement of labor costs and the issue of remuneration according to the value of the work done. This guaranteed to some extent the state of balance in the economy. This means that in the labor

accounts from the 3rd millennium BC there were productivity ratios expressing the power attributed to the employee. Even in those days it was possible to aggregate values using the category "daily rate". This makes it possible to talk about accounting, which system requires aggregation of values. At present, this role is full of money, and then it was a standard working day. According to research (Dobija & Jędrzejczyk, 2011), the differences between the present and the old system are not too great.

4. Organization of ancient accounting

Archaeological and historical research also reveal elements of former accounting. In the years 1924-1925 the British-American expedition made the greatest discovery in the field of accounting research in ancient Mesopotamia (Dobija & Jędrzejczyk, 2011, p. 29). They have discovered the archive of the last king from about 2025 BC. The archive contained plaques that presented the methods of contemporary economic governance and the temple. The texts of these tablets were published in 1947. It follows from this that in Ur city existed the oldest and most extensive factory accounting system, which was responsible for recording the various stages of production and tracking the costs incurred. All accounting entries reflected in the only fixed unit of measurement.

Thus, from the 3rd and 2nd millennia BC, there are many testimonies of the existence of economic registers. The excavations, conducted in Egypt, the Middle East and in modern Greece, confirm that the registration was systematic and concerned mainly the records of the work done. In turn, this is confirmed by the fact that work was the factor that involved the activities of enumerators. The rulers (Dobija & Jędrzejczyk, 2011, p. 36), through the administrators and writers, set tasks to be performed and sent people to work. Managers supervised the work process, its productivity and efficiency, and the writers paid the employees due to pay the right coefficients of productivity. A factor of 1 was characterized by maximum productivity. Other fractions meant less productivity. The system provided that the worker could receive the products only within the limits of the payouts due to him, recorded on his personal account. Therefore, there was a need to register every measure of oil or wine that a worker received, as well as every issue of goods from the warehouse.

Pictograms and other ancient and even prehistoric records deserve special attention. We meet here not only with ordinary, maintainable memory records, but with a well thought out accounting system. These systems did not need money in the form of banknotes or coins. In the ancient city-states, the administrative authority ran accounts for all citizens in the sphere of ownership, liabilities and dues for their work (Oppenheim, 1957, p. 21). The work of the individual citizen was precisely recorded and anyone could receive from the warehouse the goods for an amount that did not exceed the size reflected on his or her personal payroll account, calculated for the work performed. In this way the city authorities could guarantee that everyone would spend no more than he earned or saved.

It can therefore be stated that the labor account system and the fair payment for the work performed were the foundation of economic life since the dawn of civilization. Archaeological excavations have allowed the curtain to be set aside for the organization of work in ancient cities-states where the measure of the unit of work as a unit of value was widely used in everyday work. This guaranteed the stability of economic relations and the steady growth of socio-economic life.

M. Dobija (2011) points out that the importance of work was perceived and emphasized by early economists. In A. Smith's work there is a key assertion about the economic importance of work. This economist points out (1904) that:

Labour was the first price, the original purchase-money that was paid for all things. It was not by gold or by silver, but by labour, that all the wealth of the world was originally purchased; and its value, to those who possess it, and who want to exchange it for some new production, is precisely equal to the quantity of labour which it can enable them to purchase or command (…)" (Book I, Ch. V, 1.5.2).

Note that if the quantity of work performed is the basic price, then the value is determined by the category that occurs in the accounting system and is the corresponding remuneration for the work done. Because the essence of commodity-money economy is the exchange of paid remuneration for work done on products, we respectively see that gold and silver in antiquity were only products (as well as now) that contained a certain amount of work in the unit as well as any other product.

5. Conclusion

The history of work accounting confirms that the system of measuring the value of work and the appropriate remuneration has been present in economic life since the dawn of civilization. Archaeological excavations show that in the ancient cities-states a measure of the unit of work as a unit of value was used in daily operations. Work accounting can be seen as an activity resulting from the systematic problem solving of harmonious work and appropriate remuneration.

From the theory of capital and the fundamental principles that create the nature of reality (Dobija, 2013), it follows that in order for a worker to perform certain work, he must first acquire the ability to do it (in modern scientific thought this ability is called human capital). This means that work does not originate from anything, and that its execution, that is, the transfer of employee capital to the workplace, requires the creation of a parallel transfer of fair wages for the work done. Otherwise the process of work will encounter difficulties.

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PART II

TOOLS AND APPLICATIONS OF MODERN INFORMATION AND COMMUNICATION TECHNOLOGIES

Chapter 7

Software Tools Usage in Fraud Detection and Prevention in Governmental and External Audit Organizations in the Republic of Serbia[1]

Dragomir Dimitrijević, Zoran Kalinić

1. Introduction

Financial statements are a company's basic documents to reflect its financial status i.e. the mirrors of a company's financial status and they generally include balance sheets, income statements, cash flow statements, statements of retained earnings, and some other statements (Tangod & Kulkarni, 2015). Enterprise financial statements have become a major source of information for numerous investors, creditors, employees and states in the process of making decisions related to the allocation of funds. Financial statement fraud is performed with the aim of displaying false financial position, performance, and cash flows of a company. The greatest responsibility for financial statement manipulation is held by a company's management. The most frequent excuse of management for committing fraud is that it was a way to try to save the company and ensure profit for the company's owners. Practical experience showed that existing system of control (government, internal and external audit) is not enough to reveal and prevent frauds.

In their work, these forms of control must use modern software tools, because in the process of fraud detection it is necessary to analyse large amounts of data, which is much easier and more efficient with the use of appropriate software tools. These tools can also help controllers in the process of fraud prevention, by warning them of the appearance of certain warning signs, so called "red flags", that indicate the possibility of fraud or some illogic that can either be the result of errors or manipulation. For these reasons, the paper analyses the software tools used by all forms of control in the financial reporting process in the Republic of Serbia, with special focus on official, governmental institutions and external audit companies.

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2. Frauds in companies' operations and methods of its detection

Fraud is an intentional deception made to achieve a certain goal, or to inflict damage to another person or organization. International Standard on Auditing defined fraud as intentional action of gaining unfair or illegal advantage by cheating, made by one or more persons from the management, supervisory board, employees or third parties (International Standard of Auditing No. 240 – Auditor's responsibilities related to fraud in the audit of the financial statements). Association of Certified Fraud Examiners defines fraud as "deception or misrepresentation that an individual or entity makes knowing that the misrepresentation could result in some unauthorized benefit to the individual or to the entity or some other party" (Zabihollah, 2002).

To better understand the purpose and importance of fraud it is necessary to make a distinction between fraud and errors. Although their effects might be the same – the presentation of incorrect information, there are significant differences between errors and frauds. The main difference is that in case of fraud, there should be a conscious intention of the individual towards achieving illegal goals. Frauds are usually classified into three groups: corruption, asset misappropriation and fraudulent financial statements. Although 2016 Report to the Nations on Occupational Fraud and Abuse by the Association of Certified Fraud Examiners (ACFE, 2016) survey found asset misappropriation as the most common type of fraud (occurring in 83% of cases), fraudulent financial reporting was relatively rare, occurring in less than 10% of cases, but those cases inflicted greater damage, with median losses of almost $1 million. The fraudulent financial reporting usually involves overstatements of accounts receivable, inventory, securities or other assets.

Detecting fraudulent financial reporting can be difficult – but not impossible. Although, in general, fraud prevention is much better solution, companies and organizations need to consider appropriate measures to assist them in fraud detection. According to the study conducted by ACFE (2016), the largest number of frauds in the companies is discovered by alerts from individuals. Most of these alerts come from the employees, but also from suppliers, customers, creditors, shareholders, etc. In order to detect fraud, various business intelligence and data mining techniques are employed (Tangod & Kulkarni, 2015). Data mining techniques are very often used as a tool in financial accounting fraud detection, since we are dealing with the large data volumes and complex financial data. The detection of accounting fraud using only traditional audit procedures is a difficult or sometimes an impossible task. Because fraudulent manipulation of accounting data is so infrequent, the auditors often lack the required knowledge, experience and expertise needed to detect and prevent frauds (Shaheen et al., 2014). Therefore, specialized software based on data analysis i.e. various data mining techniques is a very useful tool in such cases. Data mining routines are being incorporated in specialized fraud detection components for software such as SAS, SPSS and even traditional audit programs such as ACL and IDEA (Wong & Venkatraman, 2015). Othman et al. (2015) reported that, although rated as very effective, the implementation of fraud detection software in public sector in Malaysia in very limited. Bierstaker et al. (2006) found that companies often may be reluctant to invest in anti-fraud technology, although the perceived benefits and effectiveness of the software may outweigh the cost, and that even at larger firms, anti-fraud methods and software are under-utilized. In their study of fraud detection and prevention in the public sector in Nigeria, Okoye and Gbeki (2013) suggested that ministries should take the advantage of the modern accounting and auditing software to enhance efficiency and smooth forensic accounting operations.

In the process of financial fraud detection, two possible approaches are used: deductive and inductive (Stancic & Dimitrijevic, 2014, p. 2). Deductive approach goes from general analysis to specific details. This approach is considered to be quite simple and economical. Deductive approach is usually used in the cases of preventive investigatory examination or when there is a suspicion on fraud, but there are no clear signs or proofs of manipulation. In deductive approach, several methods and models are used: Beneish's analysis, Benford's Law, Altman's models, Bex model, FEFQM model, general program of forensic analysis and similar models (Stancic et al., 2013, p. 17). In the inductive approach, we start from the specific experiences on which items of financial statement frauds usually occur. Therefore, these items are investigated first, in order to bring the conclusion of whether there is a significant risk of fraud. Inductive approach, as a rule, applies when there are significant doubts and warning signs of manipulation with certain items in the financial statements. It is generally considered that the inductive approach is more efficient and economical for large and complex enterprises that have an extremely large amount of various transactions (Dimitrijevic, 2012, p. 22).

Red flags in financial statements represent warning signs that investors should take note of. They do not necessarily indicate that undoubtedly financial statement fraud has occurred, but merely signal that special attention and further in-depth research must be conducted. But, sometimes spotting red flags can be extremely challenging, as companies engaged in fraudulent activities are attempting to portray the image of financial stability and normal business operations.

Looking at the main categories of fraud defined by Association of Certified Fraud Examiners – ACFE (corruption, asset misappropriation and fraudulent financial statements), we can distinguish some common warning signs. The asset misappropriation is a type of fraud that is usually performed by employees against the organization, for their own benefit. Common warning signs include: changes in behaviour, avoid direct views, increased irritability, CV with several breaks, problematic character, constant anger, the tendency to blame others and changes in lifestyle (Lux & Fitiani, 2002). There are other warning signs that indicate the possibility of disposition of property in situations where employees: express dissatisfaction with their employer or supervisor; never take a vacation; have financial difficulties or problems with debt; exhibiting psychotic features; constantly complain to their supervisors treat them badly; exhibit behavioural characteristics that are associated with self-centeredness or exaggerated by the need for the control; refuse reassignments, promotions or other business deals (Singleton & Singleton, 2010). The creation of fraudulent financial statements is typical for senior management. These frauds are executed for the organization (at least partially or indirectly), for the benefit of the organization and the perpetrator. Usual warning signs for this type of fraud include accounting anomalies, rapid business growth and an unusual amount of profit, deficiencies in internal control and aggression that manifests executive management (Singleton & Singleton, 2010). The focus of this study in on detection of this type of fraud.

3. Software tools for fraud detection and prevention

Software tools used for fraud detection and prevention enable auditors and forensic investigators to examine massive volumes of transactional data and many types of financial documents, in order to detect and prevent fraud. They save forensic-accounting investigators thousands of man-hours by compiling data and identifying possible patterns. In addition, some software solutions can track fraud as it happens i.e. they can look for an unusual number of transactions just below the limit

needed to require a supervisor's assistance or too many partial payments by customers. Programs used by auditors to interrogate files, generally known as audit software, come in a number of forms, ranging from software packages specially designed to support auditing, to any other computer program that the auditor finds useful (AuditNet, 2003).

Computer Assisted Auditing Tools (CAATs) are computer programs used by auditor as part of the audit procedures, in order to process data of audit significance contained in a client's information system i.e. to automate the audit processes (Shaheen et al., 2014). CAATs represent powerful tool for auditors that can identify unusual or unexpected trends in data that may indicate possible fraud. The main advantages of CAATs are: it saves time, with no loss of quality or accuracy; data analysis is focused and allows any future adjustment to be made with minimal effort; preliminary data can often be analyzed early in the audit process and a more efficient audit plan can be made (CAAG, 2006). In addition, historically, auditors have relied on samples of transactions or companies to perform their tests (AuditNet, 2003). With the use of automated data analysis tools, it is possible to assess all records and companies in focus. Automated fraud detection software tools and programs are used help pinpoint anomalies and unusual patterns as well as revealing potential red flags (Aiken, 2016).

One of the most popular and most used software solutions is Audit Command Language (ACL), developed by ACL Service Ltd (www.acl.com). ACL's software program is one of the leading tools in the industry and delivers audit data analytics to its customers and quickly uncover potential fraudulent schemes, without exhausting a lot of time and money (Aiken, 2016). Although it has automated analytical procedures i.e. built in analysis command and there is no programming language needed, it also offers script for auditors who want more customized programmable commands. One of analysis command often used for fraud detection is Benford's Law analysis, which is commonly used in auditing especially in fraud detecting, by many auditors including internal, external and governmental. Benford's Law refers to the frequency distribution of digits in many real-life sources of data, including financial documents (Shaheen et al., 2014). In this distribution, digit 1 occurs as the leading digit in about 30% of the cases, while larger digits occur in that position far less frequently: for example, digit 9 as the first digit is in less than 5% of the cases. So, if financial document analysis shows that digit 1 appears as the first digit in 10 or 50 percent of the cases, possible fraud is indicated. ACL use Benford's Law analysis in a digit-by-digit basis, which might increase the chances of findings actual fraudulent entries (Cleary & Thibodeu, 2005). Newest versions of ACL can read and analyze PDF file. However, despite its powerful functions, ACL's price is quite expensive.

CaseWare IDEA software (www.casewareanalytics.com) includes a full range of auditing tools in a standalone package and it can read, analyze, sample or extract from data files from almost any source including spreadsheets, exported data from databases, accounting programs, ERP systems and documents in formats such as PDFs or plain text (.txt). IDEA also, among others, may perform Benford's Law analysis. This software lowers the cost of analysis, but also adds more quality to audit work and meet the professional requirements regarding fraud and audit. IDEA (Interactive Data Extraction and Analysis) is used in over 90 countries by major accounting and auditing companies, federal, state, provincial and local government and corporations in all industry sectors. For example, IDEA is extensively used by the National Audit Office in the United Kingdom (AuditNet, 2003).

SAS software programs are also often used to manage the risk of fraud along with detecting and deterring potential instances of fraud (Aiken, 2016). By implementing SAS software programs

within company systems and using its powerful data analytics, audit managers can analyse large sets of data and detect and prevent instances of fraud and abuse.

Picalo is a collaborative, open-source data analysis application suitable to auditors, fraud examiners, data miners, and other data analysts. Users can either use the built-in routines or write their own, which can be shared with others in the Picalo community. The final goal is to create a large set of analysis routines that meet many different needs. Another example is Arbutus Fraud Detection Software, which is also a proven, effective fraud detection software tool. Also, other CAAT solutions include ESKORT Computer Audit (also known as SESAM), InfoZoom, SoftCAAT, Easy2Analyze, etc. Finally, many CAATs are provided as Excel add-ons: Active Data for Excel, eCAAT, ACL, TopCAATs, etc.

4. Data analysis and results

In order to analyse the software solutions used by government authorities and audit institutions in the process of fraud detection and prevention in the Republic of Serbia, we have conducted interviewing of the most important institutions included in this process. At the state level, three basic institutions are key players in the process of fraud detection and prevention: Tax Administration (TA), Serbian Business Registers Agency (SBRA) and State Audit Institution (SAI). All three institutions participated in the survey.

Tax Administration collects public revenues, monitor and improve the level of fiscal discipline and creates an environment in which every taxpayer voluntarily, without excessive costs, fulfils its tax obligations, which enables the Government of the Republic of Serbia to provide public services to its citizens. Tax Administration as an administrative body within the Ministry of Finance, which performs the following tasks: keep an integral register of taxpayers; perform tax control and tax assessment in accordance with the law; perform regular and enforced collection of taxes and secondary tax duties; reveal tax crimes and their perpetrators and take legal measures, initiating and conducting first instance misdemeanour tax proceedings and impose penalties for tax violations; keep tax accounting. Serbian Business Registers Agency, founded in 2004, is established to keep main registers as a single centralized electronic database and to lead the reform of registration system, in order to create a favourable business environment for starting a business and attracting investments. The main task of the State Audit Institution is to examine and check the transactions disclosed in the financial statements of state institutions, i.e. to express an opinion whether they are carried out in accordance with the legislation and principles. SAI performs audits, prepares reports, issues legal acts and documents, advises users of the budget, make recommendations for amendments to the existing laws, adopt auditing standards, cooperate with international accounting and auditing organizations, etc. Subjects of audit are all direct and indirect budget (national or local) beneficiaries i.e. mandatory social insurance budget funds, the National Bank of Serbia, public enterprises, companies established by direct or indirect budget user or participates in the capital of that company.

The study also included private external audit institutions that perform audits of financial statements of companies in the Republic of Serbia. Eight most important external audit organizations in the Republic of Serbia were invited to participate in the study, but only three of them agreed to participate and have sent required data.

The results showed that state institutions mainly use their own software solutions (SBRA and Tax Administration), while State Audit Institution uses existing commercial software solutions (CaseWare IDEA). Software solutions used by state institutions had to undergo some adjustments to meet the needs of these institutions. In addition, the state institutions, in their work, use other available methods and applications, such as Excel and Access. Unfortunately, state institutions do not use specialized modules for fraud detection and prevention. In addition, state institutions, except for SBRA, do not use a specialized methodology for fraud detection. It should be noted that, except State Audit Institution, which takes 100% of the institutions in the sample when examining the existence of fraud, other state institutions did not want to give answers to the question regarding the number of institutions included in the sample in the process of fraud detection.

The external audit institutions that participated in the survey also mainly use own software solutions (some institutions use software solutions that is completely new and specially developed for these institutions, while others, besides own solutions, use existing commercial solutions, like IDEA). Software solutions used by external audit institutions usually have not had to undergo some adjustments to meet the needs of these institutions. In addition, as in the case of state institutions, external audit institutions use other available methods and applications, such as Excel and Access. It should be noted that the fraud detection is not a priority for external audit institutions, which is probably one of the reasons why they do not have and do not use specialized software modules for fraud detection. On the other hand, research has shown that external audit institutions, if they are engaged for the purposes of fraud detection, using specific methodology, but they were not ready to talk in detail about it.

5. Conclusion

While organizations should still complete routine audits, it is highly recommended to implement proactive fraud detection software programs and tools, which are very useful in the analysis of big data, finding any discrepancies with patterns and preventing potential fraud schemes (Aiken, 2016). Considering the results of the research, it can be seen that majority of the surveyed institutions (governmental and external audit) use their own, custom-made software solutions in their work. Also notable is the fact that neither of the institutions have and use specialized modules for fraud detection, which indicates a low degree of fraud control, especially in state institutions. The absence of a predetermined sample of companies examined to fraud shows that no surveyed institutions consider fraud detection and prevention as one of its priorities. This attitude has led to the ever-growing number of frauds and late responses of all the institutions, particularly government authorities.

Existence of adequate specialized software solutions, which would be used only for fraud detection, is not a guarantee that fraud will not occur. But, a lack of these software solutions creates a favourable situation for frauds and fraudsters, and huge potential financial losses for both, institutions and the state. Therefore, it is highly recommended to state institutions, that are most responsible for fraud detection and prevention, to get these software solutions, capable to indicate the existence of warning signs of the possible existence of fraud in the institution. These warning signs are not necessarily indicators of fraud, but they are a sure sign that one should examine further and in more details, whether or not there is fraud in the institution.

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Chapter 8

Proposal for the Experimental Use of FeedForward Neural Networks Together with a BOW Text Classification Method in the Audit of Staff Documentation – A Case Study[1]

Sławomir Szurman, Roland Górnisiewicz, Jan Trąbka

1. Introduction

Lately, we have seen a dynamic development of content processing technologies in the domain of management information systems (MIS). Content is a term which combines structured data with the largest by volume group of data and non-structured information (mostly documents, e-mails, records on social media, or multi-media content, such as images, sound or image recording). The combination of document management system (DMS), BPM/workflow systems, image-processing applications, website content management systems (CMS), and team-work tools has produced a new class of systems known as Enterprise Content Management (ECM). This class systems are currently the most desired tools among enterprises of various trades and specialities (Trąbka, 2015). The most common, classic scope of application of ECM technology is the circulation of documents and information concerning financial and staff-related processes. Scanning, optical character recognition (OCR) of text, and managing the circulation system through dedicated workflow engines has now become a standard. OCR is not an efficient method, and it entails a large risk of incorrect data and, consequently, incorrect results of further processing, in terms of categorisation and description of originally formalised financial or HR-related documents (invoices, applications, notes, etc.). The objective is to correctly read values from individual areas of the source document (e.g. employee's surname, Tax ID No. NIP, Resident ID No. PESEL, or gross amount). In practice, such processes are categorised manually, and the description of documents is carried out manually, too (a scanned copy replaces working with paper documents). Human participation in the process results in greater costs, longer delivery time, and poses the risk of errors due to tiredness or lack of focus of the employee. This observation is confirmed by a common view

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in IS literature that the preparation and initial processing of data are among the most essential, difficult and time-consuming activities in Data Analysis (Pyle, 1999). Such conclusions also come from the experience of AdAc company, which is the subject of the case study described herein. The company provides outsourcing services in the scope of HR and payroll for several thousand employees of large organisations, including international ones. Proper calculation of remuneration and other payroll-related components is contingent on correct input data. Data-flow is executed in the form of electronic documents (previously scanned paper documents), which need to be registered in an HR and payroll system. This stage is done manually and constitutes a bottleneck for the whole process in terms of time consumption and costs. The correctness of entered HR data is an even more critical issue. Errors which occur at input stage have a direct impact on the calculations of payroll, taxes, or other liabilities. AdAc bears full responsibility for such errors, which can result in financial penalties, as well as in the loss of companies' most precious asset, i.e. clients' trust. Therefore, AdAc has decided to start a research and development project aimed at finding an efficient method of automatic audit of processed documents which in the future could replace human work at the stage of preparing data for the process of remuneration calculation. The research in question will be described in this paper.

Alongside Enterprise Content Management systems, a very dynamic growth is seen in the applications of many AI technologies, machine learning in particular, in the scope of recognition and classification of content, images, or speech. The aim of this paper is to present an own proposal for the use of FeedForward neural network model together with Bag of Words (BoW) text classification method for verification of the correctness (audit) of categorisation of HR documents processed in HR departments. The proposal will be verified by way of an experiment. The concept and experimental system have been executed under the above-mentioned research and development project started at AdAc.

The first part of the paper presents the theoretical argumentation behind the selection of the abovementioned set of methods. The second part provides a specification of the operations of AdAc as well as motives which lead to the decision to start research and development works. The third part discusses IT components created for the execution and verification of FeedForward network model and BoW. The next part describes steps of the experiment in which the system, under the working name *onPoint Intelligent File*, will be executing an audit a set of a few hundred HR documents. The summary contains quantitative measures of the efficiency of the method and a discussion over the results of the experiment. The conclusions of the paper provide further directions of research works over the application of artificial intelligence technologies in HR and payroll systems.

2. Literature review – Specification and application of FeedForward network together with BoW text classification method

2.1. FeedForward neural networks

Artificial neural networks are mathematical models developed based on observations of natural neural networks made of cells known as neurons and connected together through synapses. Research in this area has resulted in proposals of a number of models of artificial neural networks together with the rules of their operation and learning (Wawrzyński, 2014). Just like a biological

neural network, an artificial neural network is composed of neurons. Each neuron in the network has its internal memory, represented by current values of weight and threshold, and some options to process input signals into an output signal. The network functions as a whole and all its elements contribute to the execution of all activities involved. An extensive study of the structure of neural networks can be found in the paper (Tadeusiewicz, 1993).

The paper utilises a FeedForward neural network along with supervised learning (with a teacher). The term FeedForward refers to structures with a precisely defined direction of signal flow. From the specified input, through which the network receives signals which are input data, to the output at which the network provides a specified solution. Neurons are arranged in layers. The first layer is the input layer, and the last one is the output layer. Between these two layers, there are the so-called hidden layers. Learning with a teacher means that the network is provided with examples of correct operation, which it is then supposed to imitate in its current operation. An example is to be understood as a pair of values of:

- input signal,
- expected output.

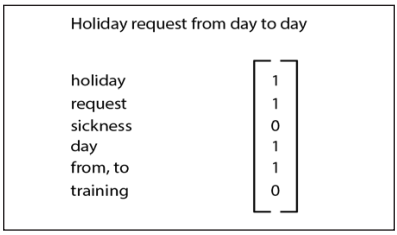
The network observes the relationship between provided input data and required result, and learns to imitate such principles (Tadeusiewicz, 2007).

Since the creation of a model of a neural network by McCulloch and Pitts in 1943 (McCulloch & Pitts, 1943), artificial neural networks have been used to solve a number of issues in various domains, including qualification problems. The author of the paper (Tadeusiewicz, 1993) described their use in the recognition of a selected set of words. The aim of the study was to construct a network which was able to identify seven distinct voice commands. The learning and testing set consisted of ten and three various statements for each individual command, respectively. The system of neural networks eventually recognised 85% of messages in the testing set. Yet another example of the use of a neural network is its application in the classification of soil for the construction of earth blocks in construction works (Sitton, Zeinali & Story, 2017). The learning set consisted of 33 samples of 11 soil types. The samples were processed in five different tests. Each test determined different features of soil, which allowed for using a neural network. Once the experiment was over, results were compared with laboratory tests. The match with the testing base was at the level of 89.35%.

2.2. Bag of Words method

BoW method is one of the most convenient methods of natural language processing (NLP) used in classification (Joahims, 2002). BoW method is used to transform text into a set of features, presented through a vector. The occurrence or a lack of a word or group of words in a document is the key issue in text classification. The occurrence of each word or word group is represented by different vector coordinates. However, a coordinate may determine the number of occurrences of a given word in a text or only information whether a given word has occurred. The paper utilises the second option, i.e. it does not matter how many times a given word has occurred; what counts is the information whether it has occurred or not. The figure below (Fig. 1) illustrates a practical depiction of BoW method illustrating a text of a fragment of a typical HR document through a vector.

Figure 1. BoW method – example of determination of occurring words through a vector of features



Source: own work.

In theory, the preparation of BoW features is proposed as follows:

- text is divided into individual words;
- words of similar meaning are grouped into one feature;
- unnecessary, commonly occurring words (stop words) are deleted. Thus, we receive a list of a group of words which will create a vector.

BoW method was first proposed by Zellig Harris in 1954 (Harris, 1954). Since then, it has been used to check the occurrence of given words in documents and for other techniques of natural language processing. The application of the method in searching for legal information is described in the paper (Hyman, 2010). The aim of the quoted paper was to compare the simple method of BoW with more complex algorithms, and to find an answer to a question whether it is worth using these more complex solutions. In the comparison, the authors of the paper obtained the same number of good searches when they used BoW as when using other methods. However, they failed to confirm comparable precision of the method. Complex methods were more accurate, i.e. they found fewer documents which were later rejected.

Another interesting example of the use of BoW is searching for information from satellite images (Cui, 2015). In such model, object patterns are replaced with words, and the classification of photographs is carried out based on recognised objects. The authors of the work compared BoW method with the Normalized Compression Distance (NCD) method. Conclusions from the experiment showed that in many cases BoW method produced better results than the other method. At the same time, the authors of the publication state that NCD requires very large calculation capabilities, making it extremely expensive. Thus, its actual use is impractical, unlike BoW method.

2.3. Method composition

Solutions combining methods mentioned above have been used in the issues of classification. Combined methods of neural networks and Bag of Words have been successfully used in the development of an algorithm controlling account numbers for the purposes of accounting for and settling transactions in accounting systems (Bengtsson & Jansson, 2015). In the quoted paper, the authors present a system which, based on data from banking transfers and transactions (most of all including data concerning organisations being a party to the transaction), suggests numbers of accounts on which an event is to be accounted for and settled.

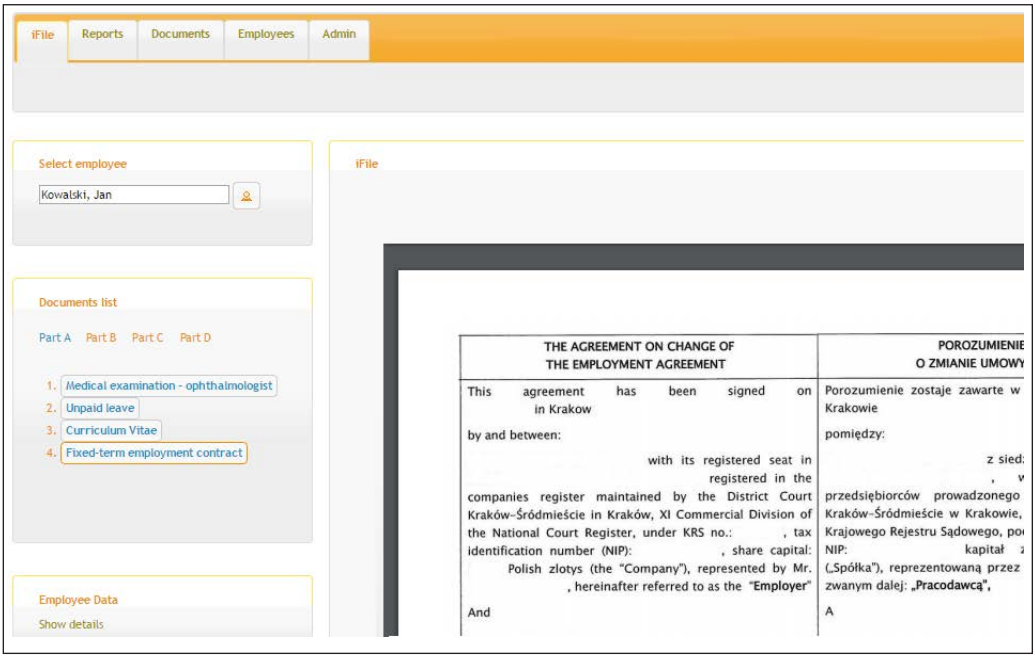
Finally, it is worth mentioning that combined methods constitute a system of machine learning (a kind of artificial intelligence), which is fed with presented various examples, used by the system to identify useful information. Then, the information is generalised and creates a model for solving problems, also other than those presented in examples (Lula, Paliwoda-Pękosz & Tadeusiewicz, 2007).

3. Specification of the company and the research project under the case study

3.1. Specification of AdAc and problems of operating the electronic employee file

The subject of the case study will be the company AdAc DFK Polska Sp. z o.o. seated in Kraków. The Company deals with outsourcing services in the scope of HR and payroll processes. Each month, it calculates salaries for over 6,000 employees. The Company grants its clients access to the electronic personal file of the company onPoint.pl Sp. z o.o. The system called onPoint iFile (Polish "iTeczka") is used for maintaining an electronic equivalent of a paper personal file of an employee. Staff documents, which include, among others, employment agreements, work certificates, OHS training certificates, personal questionnaires, and many other kinds of documents, are digitised and then categorised in onPoint electronic file. Digitisation consists in scanning a document and then entering the scan into a system (this action is also conducted by authorised employees of clients' companies – with the use of the above-mentioned onPoint iFile system). In the system, the documents are assigned manually by AdAc employees to the correct employee file and document category. Depending on the size of the client's company, the number of document categories ranges from 150 to 200.

Figure 2. Example of onPoint iFile system screen presenting a personal file of an employee



Source: own work.

One important problem in the management of an electronic personal file is the correct classification of documents in the file. For incorrect maintenance of staff records, the employer or a person acting on its behalf can be awarded a fine of up to PLN 30,000 (about EUR 7,500). Incorrect classification of a document also makes it more difficult to find the document later on. The problems discussed above prompted the Management Board of AdAc to start searching for technologies which could verify and, in the future, automate activities in the scope of classification and record-keeping. A research and development project under the name "onPoint Intelligent File" was launched.

3.2. Specification of onPoint Intelligent File project

AdAc appointed an analysis and implementation team, made up of, among others, two authors of this paper. At the concept stage, the team put forward an idea to prepare a process for the automation of the audit of document classification with the use of AI algorithms (machine learning, to be precise). A few options were considered, based on a review of specialist literature and own experience. The most promising option was the one which combined BoW text classification method with FeedForward neural network model. For the purposes of assessing the efficiency of the above-mentioned method, it was decided to carry out an experiment, which is described in the subsequent chapter hereof.

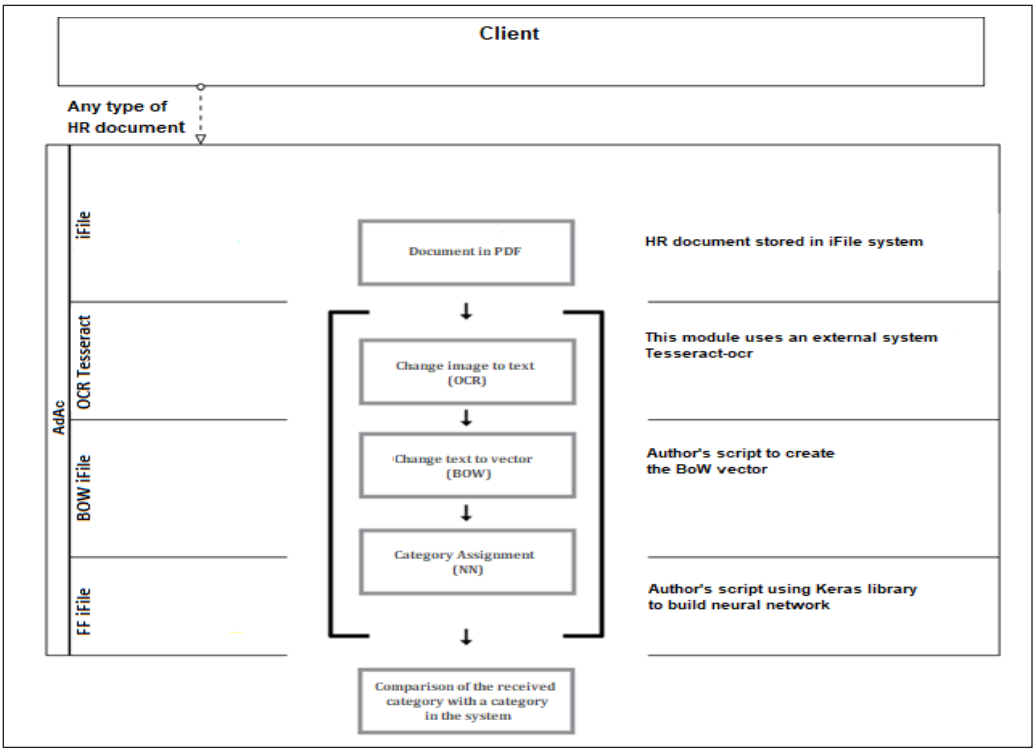
Design works (concept stage, experiments) lasted for about 2 months. Currently, after a positive decision by the Management Board of AdAc, implementation works over a production version of onPoint Intelligent File are being started.

4. Method of the experiment

4.1. Structure of the process of auditing a single document

A complete process of auditing a single HR document with the use of components of onPoint Intelligent File is presented in the diagram below (Fig. 3). The aim of the process is to verify/check the most important classification parameter, i.e. document category, which has been assigned to a document manually by an employee, against the category as assigned by the neural network.

Figure 3. Process of auditing an HR document together with components of onPoint Intelligent File system



Source: own work.

The first step of processing is the transformation of the document stored in PDF format (in iFile module) as an image into a sequence of readable words. This task is executed by OCR algorithms sewed in the OCR module, Tesseract. In the next step, BoW method is used. Here, the input document is transformed and expressed in the form of a numeric vector, in which occurrence markers are attributed (or not) to pre-defined features (i.e. conclusion, address, release, see: Chapter 2). This task is executed by BoW iFile module. Such prepared document is subjected to classification through parametrised and taught FeedForward neural network. The neural network designates the document category (based on previous learning process). This task is executed by FF iFile module. The last stage consists in checking the match of the result of classification conducted by the neural network with the category designated for the document manually by an employee of AdAc.

4.2. Technological specification of components of the experimental system

The server used for the operation of onPoint Intelligent File system is equipped with Intel XEON E5530 2.4 GHZ processor, 24 GB RAM memory, and an installed operating system Windows Server

2012. The experimental version of onPoint Intelligent File system consists of components created by the authors of this paper as well as external publicly available libraries. It operates in a batch mode. In the production version, it will become a component of the master system – onPoint File – or will continue to be executed in a batch mode run through scheduled server tasks. After an audit, the programme will send an e-mail with a summary of conducted works and found irregularities. If an action is required on the part of the user of iFile system (e.g. approval of a proposed change of document category), it will be requested to do so by the programme through an e-mail.

Own components of onPoint Intelligent File system have been saved in Python 2.7.10 language. Python language has the largest number of libraries for machine learning and data analysis. The construction of the tool has been planned as follows:

- data base operation – storing documents, texts and feature vectors in the same MySQL data base in which staff records are stored. Connection with the database is executed through mysqli library,
- operation of OCR module will be supported by an external library *Tesseract-OCR*,
- operation of the neural network – construction of the optimal neural network will be executed with the use of Keras library (with Theano back-end),
- generation of reports on system operation through csv library. It will be possible to analyse generated reports through a spread-sheet (e.g. MS Excel).

5. Description of the experiment

5.1. Input data and limitations

At the time of the experiment, over 150 document categories were in use in onPoint iFile system. Twelve of the categories were selected for the experiment. Introducing a larger number of categories would have caused a geometrical increase of network model parameters and the number of documents necessary for the network to learn (learning set).

Documents are stored as PDF images. A category is assigned to each document (manually by an employee of AdAc – one of 12 categories selected for the experiment). The figure below provides an example of a document processed in the experiment. Owing to the occurrence of personal and company data, the document has been anonymised.

Figure 4. Fragment of an example of a document used in experimental application of onPoint Intelligent File system

THE AGREEMENT ON CHANGE OF
THE EMPLOYMENT AGREEMENT

This agreement has been signed on in Krakow

by and between:

with its registered seat in registered in the companies register maintained by the District Court Kraków-Śródmieście in Kraków, XI Commercial Division of the National Court Register, under KRS no.: , tax identification number (NIP): , share capital: Polish zlotys (the "Company"), represented by Mr. , hereinafter referred to as the "**Employer**"

And

hereinafter referred to as the "**Employee**"

Source: own work.

In the experiment, the learning base consisted of a set of 1241 documents, each of them marked with one of the 12 categories.A prepared model of a neural network was tested on a set of 935 documents from the same source (each also marked with one of the 12 categories). Due to the volume and time necessary to recognise text by an OCR module, documents of maximum 1 page were selected.

5.2. Stages of the experiment

Preparation of source data

The first stage of the processing was the creation of a data base for storage of all documents from iFile system used in the study. Once the required number of documents of each category had been gathered, their content was to be read. The transformation of a document stored as a PDF image into a sequence of readable words was executed by an OCR (Optical Recognition System) algorithm. Due to differing file extensions of .pdf and .img, each file was processed through OCR Tesseract library. As a result, the documents were transformed into a text format.

Application of BoW method — BoW iFile module

The next stage was the creation of a base of key features, representing each document type. In order to prepare the features (word groups), specimens of all 12 documents making up specimen categories were reviewed. Words, which were helpful in the identification of categories, were marked manually. Thus, a vector of 134 features was obtained. With such a set, an own script was created

for automatic attribution of features to documents and their presentation in the form of a numeric vector. Each studied document was presented in the form of a BoW vector, as shown in Figure 5.

Figure 5. Fragment of a BoW vector

```
[['0', 0], ['1', 0], ['2', 0], ['3', 0], ['4', 0], ['5', 1], ['6', 0], ['7', 1], …, ['129', 0], ['130', 0], ['131', 0], ['132', 0], ['133', 1]]
```

Source: own work.

The first number in a feature pair (expressed in [] brackets) defined the feature identifier, and the second one defined the occurrence of a feature, where "1" means that a given feature occurs in the text, and "0" — that it does not.

Learning of the neural network — BoW iFile module

With vectors representing document features, it is possible to move on to the execution of machine learning with the use of FF iFile module. For that purpose, all documents were divided into two groups. It needs to be remembered that both groups contained documents of all types. The first group is used to create a learning set of the neural network; whereas the other one serves as a training set for the testing of the whole system. For the purposes of document categorisation, a four-layer FeedForward Sequential neural network of 339 elements was prepared. The first (input) layer consisted of 134 elements, in line with the assumed number of vector features in a BoW module. The output layer consisted of 12 elements (because the network was supposed to recognise 12 types of documents). The network had two hidden layers made up of 193 elements in total. The selected network featured ReLU-type (Rectifier Linear Unit) and Sigmoid-type basic elements. Layers were connected with each other through the peer-to-peer method. Hidden layers were connected additionally with a Dropout element in order to avoid excessive overcrowding of the network. In the third (hidden) layer, a bias-type element was added. The Sequential neural network was created with the use of Keras library (with Theano back-end). The neural network was taught in line with assumptions with the use of a learning set consisting of 1241 documents, each falling under one of the 12 categories. The preparation of the model was calculated with the use of "adam" optimiser. The model learned as per following parameters:

- Number of repetitions (presentations) of the whole learning set (epoch): 200,
- Size of set loaded into one iteration (batch size): 10.

Figure 6. illustrates the script constructing the described neural network.

Figure 6. Fragment of the script representing the model of the neural network

```
model = Sequential()
model.add(Dense(134, input_dim=134, init='uniform', activation='relu'))
model.add(Dense(134, init='uniform', activation='relu'))
model.add(Dropout(0.1))
model.add(Dense(58, init='uniform', activation='sigmoid', bias=True))
model.add(Dense(12, init='uniform', activation='sigmoid'))
```

Source: own work.

Conducting the final capability test of the neural network – BoW iFile module

The previously prepared network model "taught" in accordance with described parameters was tested on a set of 935 testing documents. The learning set came from the same base from which documents for the learning process were obtained. As mentioned before, each testing document had been previously categorised by an employee of AdAc in order to enable a real audit, i.e. to compare categories assigned by a human with categories assigned by the neural network. Results of tests were saved in text files in csv format.

5.3. Results of the experiment

Obtained results will be presented in two perspectives. The first one shows the efficiency of the network model implemented in onPoint Intelligent File system. The other perspective illustrates the capability of the device to audit document categorisation, which is of key importance for the experiment. Results of operating efficiency of the implemented network model are presented in Table 1.

Table 1. Operating efficiency of FF iFile module

Result grouping	Number of documents (pcs.)	Amount of documents (%)
Correct results	***915***	***97.86***
Incorrect operation of the model (model weakness)	9	0.96
Incorrect operation of the model (OCR – illegible document or impossible to read)	11	1.18
TOTAL	935	100

Source: own work.

As shown in the table, attribution of a category was executed for 915 documents, which means efficiency at the level of almost 98%. This efficiency can be improved even further by taking into account the reasons of a lack of categorisation for incorrect results in 20 cases. Namely, 11 documents were simply incorrectly read by an OCR component. These errors result from low quality of paper documents (stained, blurred, etc.) or improper operation of the scanner (reverse or incorrectly aligned document, etc.). Nine documents remain which prove the model's weakness. Also, this result can be improved by increasing the size of the learning set or by increasing the number of presentations. Methods of improving the efficiency of neural network models are described in the paper (Tadeusiewicz, 1993). As part of the experiment, tool optimisation was not conducted because the basic objective of the experiment was to find out whether the proposed method was capable of detecting human errors in the procedure of documentation audit.

In the second perspective of the analysis of experiment results, the essential element is the report presenting a comparison of categories assigned by the tool described herein and categories assigned by an employee in a standard process of document classification. The report is presented in Table 2. The key result of the experiment was the finding of 6 documents which had been as-

signed by employees to incorrect categories, and the experimental system detected these errors and suggested a proper category for each document.

Table 2. Fragment of a report presenting a comparison of categories recognised by onPoint Intelligent File and categories assigned manually

In.	Probability	Id_category recognized	Id_category original	Correctness	Id_document
1	0.71	11	1	0	33
2	0.99	1	1	1	39
3	1	10	10	1	42
4	1	16	16	1	54
5	1	5	5	1	62
6	1	10	10	1	67
7	0.99	1	1	1	70
8	1	5	5	1	76
9	1	10	10	1	80
10	1	1	1	1	83

Source: own work.

In item 1 of Table 2, it can be seen that document with ID no. 33 had been incorrectly assigned to category no. 1. The experimental system detected the error and recognised it with 71% probability that the document fell under category no. 11. Other items of the report confirm the match of categories assigned by an employee and categories assigned by the system.

6. Conclusion

The experiment has produced some very promising results. The major result is the confirmation of efficiency of proposed BoW methods and FeedFroward neural networks in the audit of classification processes of HR documents. Human errors detected in the course of the audit executed by onPoint Intelligent File experimental system were confirmed. It could be stated that in the future "neural" auditors will be a tool of higher efficiency than human alternative in verification tasks conducted on large sets of documents and data. The question of economic effectiveness of such tools remains an issue. Authors of this paper estimate that, taking into account the very high (and rising) labour costs, systems such as onPoint Intelligent File can have a rate of return of 1 to 2 years. Such a result is a very positive market outlook for solutions of this class.

At the same time, the experiment has shown risks, which also set the directions for further work in this area. One very important identified factor is proper preparation of features which can demonstrate differences between individual kinds of documents. These features are the key to preparing correct input data and, subsequently, learning results and the operation of mechanisms of a neural network. What turned out to be a bottleneck in the process is the OCR technology, for which it is difficult to correctly read some documents, e.g. incorrectly aligned scans or text written with a non-standard font. Such problems can be dealt with by using broader technologies of image recognition. This aspect will be yet another research issue for the authors of this paper.

In the context of expanding onPoint Intelligent File system, the research team will focus on following directions of work:

- configuration of the system to operate all 150 categories of documents used in staff records;
- creating and programming an algorithm for automating the process of selection and preparation of BoW features. The automation will consist in:
  - analysing the text of each document specimen from each category;
  - preparing an initial proposal of BoW features (with the use of grouping and deleting stop words);
  - analysing obtained features and checking whether model vectors for two different categories do not coincide.

At the time of completing works contemplated herein, the Management Board of AdAc accepted positive results of the experiment (as described above) and adopted a decision to continue development works over onPoint Intelligent File system.

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Chapter 9

Persistence Homology as a Tool for Multidimensional Data Analysis[1]

Artur Żuwała

1. Introduction

The growth rate of data collected by institutions, businesses and individuals has increased significantly in recent years. This trend will continue. This is influenced by factors such as online commerce, social media, multimedia, the development of the internet of things. Often, the amount or nature of data makes it difficult to use them directly. Analysis of large data sets, the so-called big data, is often a factor of competitive advantage for enterprises and a source of innovation.

Big data is a term that describes large volumes of high velocity, complex and variable data that require advanced techniques and technologies to enable the capture, storage, distribution, management, and analysis of the information. It is often defined by 3V: volume, variety and velocity. Volume refers to the magnitude of data. Variety refers to the heterogeneity in a dataset which can consist of structural spreadsheets or relational databases, text, images, audio or video. Velocity refers to the rate at which data are generated and the speed at which it should be analysed and acted upon (Gandomi & Haider, 2015).

In order to gain knowledge based on the collected data, they need to be systematized and processed. Practical problems in addition to the amount of data, their variability and diversity is information noise, incomplete, inaccurate or unverified data.

A new approach to data analysis is to notice that data has shape and this shape has meaning. Here comes topological data analysis. Topology is a field of mathematics that studies properties of objects that do not change even after deformation. Deformation is any transformation that does not require tearing and joining of different parts, such as stretching or bending. It is crucial that objects are not limited to two or three dimensional space. They can have any dimension which translates into the ability to analyse arbitrarily complex data using a similar methodology. For example, genetic data has more than half a million features related to each other.

The first scientifically considered topological issue was the Konigsberg's bridges problem solved by Euler in the 18th century. However, it has only been over a dozen or so years since

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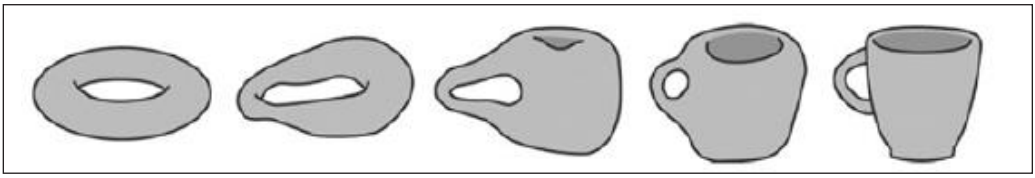
the beginning of the relationship between topology and data analyses. Data set is a finite points cloud in multidimensional space. Such a cloud can be treated as a sample taken from a geometric object, possibly containing noise. Topological data analysis tries to determine the properties of such an object (Carlsson, 2009).

The aim of the article is to introduce persistent homology as a main tool of topological data analysis and to indicate its distinctive features. Basic concepts and methods will be presented. The results of some examples of applications will then be discussed.

2. Shape of data

Topology is a mathematical formalism that allows to classify shapes. It is a proper approach when algebraic solutions are too rigid. Rigidity lays usually in coordinates and distances. Topologically two objects are considered to be the same if one can be transformed to another by bending, stretching, twisting, etc., but without tearing and gluing. The flagship example is transformation of the donut into a coffee cup (Fig. 1).

Figure 1. Example of topological transformation



Source: (Kraft, 2016).

Topology is interested in the properties of an object that are invariable during such transformations. These are primarily the number of disjoint components (in this example we have only one dense element) and the number of holes (in the example also one, we assume that the transformed object is full). Holes are intuitively simple but mathematically complex. For the n-dimensional space, the number of k-dimensional holes is the kth number of Betti β_k ($\beta_k = 0$, $k \geq n$) (Zomorodian, 2005). The number of β_0 always denotes the number of independent objects, β_1 is number of the closed cycles on the plane or tunnels in the three-dimensional space, β_2 are closed spaces, for instance interior of the sphere. Higher Betti's numbers cannot be easily interpreted geometrically. For example, Betti's number for the flat letter "i" is (2, 0) − two components, zero holes, for the digit "8" is (1, 2), for the circle (1, 1), for the sphere (1, 0, 1), and for torus (1, 2, 1) − one component, two cycles and one closed space.

Data is usually multidimensional so it is difficult to imagine it's visualization. This makes it impossible to notice simple dependencies, for example, data from three or more dimensional spaces can form clusters of points in a flat circle. For more dimensions, it's hard to even figure out examples.

Three basic topological ideas enable the extraction of knowledge from data and distinguish it from other methods: insensitivity to metric, deformation invariance and compressed representation (Carlsson, 2009). It does not matter which side we look at, the circle is a circle, even if we scale one of the axes we will further recognize a single object forming a closed loop. The letter "A" is still letter "A" when we change font used to print it or handwrite it. Large or even infinite number of points can be approximated by a small number of vertices and edges. The circle is topo-

logically the same with a hexagon as well as a quadrangle and a triangle. So sample of data set often has the same topological properties as full set.

Compression can be used to analyse and classify multidimensional data sets and to look for dependencies, degree of compression can be regulated. This may look like the equivalent of a well-known clustering techniques, but it can produce better results, especially as the dimension of the data space is increased. Compression does not interfere with the relationship between similar data that can be grouped into clusters in relation to the selected features. Example of analysing the genetic profiles of patients with breast cancer can prove it usability. In this case the data had 1500 attributes. Topological analysis, unlike traditional division, has helped to isolate a "perfect survival group" of patients (Nicolau et al., 2011).

In summary, the topological shape of the data allows to simplify and highlight points with similar characteristics. This allows to simplify the structure, to understand the relations between data, and to make predictions. The most important advantages of a topological view of data are: no need to make initial assumptions, knowledge of the field in which data is concerned is not necessary, data dimension is no limited.

Unlike other methods, we are not looking for answers about whether there is a dependency, but we are looking for any existing relationships between the data. This allows to notice previously unrecognized factors. On the other hand, knowing the shape of the data usually does not give an answer why the dependencies occur. For data whose topological properties are not sufficiently distinctive, masking can be used to give the analytical properties desired properties (Mrozek, 2012). Topological data analysis may be the first but not the only way to explore data.

3. Persistence homology

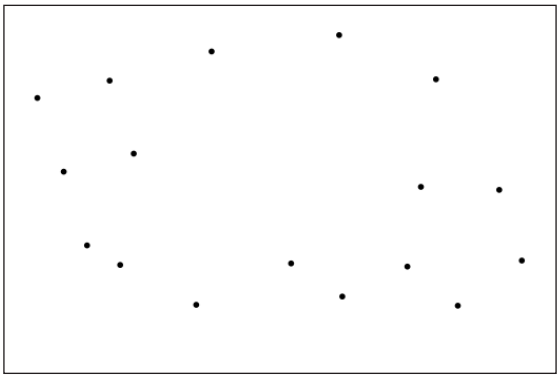
Persistence homology is an algebraic method of measuring the topological properties of shapes and functions (Edelsbrunner & Harer, 2008). In case of cloud of n-dimensional points, the main idea is gradual "fattening" of points and checking in which steps topological properties of the analysed set are changing. Then we can infer something about the original set from this sequence of changes. As a change of properties we treat the appearance and disappearance of k-dimensional holes ($k < n$).

If a set of analysed points is denoted by X_0 then fattening means creating a sequence of topological spaces X_i, (i from 1 to m) such that $X_0 \subset X_1 \subset X_2 \subset \ldots \subset X_m$. Usually, such a sequence is formed from the level sets of a function f: $X \rightarrow R$ such that $X_i = f^{-1}((-\infty, a_i])$ with $a_0 \leq a_1 \leq \ldots \leq a_m$. For a sequence of sets X_i we can define a sequence of homology classes for any dimension p: $H_p(X_0) \rightarrow H_p(X_1) \rightarrow \ldots. \rightarrow H_p(X_m)$.

In each step i of enlarging (fattening), homology classes $H_p(X_i)$ can appear or disappear. The class disappear when it is incorporated into another homology class. As the class lifetime (persistence), we define the iteration range $[i, j]$ from the time the class appears to its inclusion it in another class. The mathematical fundamentals are discussed in more detail by Edelsbrunner and Harer (2010). In practice, for each set X_i we need to compute the Betti numbers and observe their variance corresponding to the lifetime of each k-dimensional hole. Simple way to create a sequence of X_i sets for a point cloud is to add to each point it's neighbourhood with radius ε_i with $\varepsilon_1 \leq \varepsilon_2 \leq \ldots \leq \varepsilon_m$.

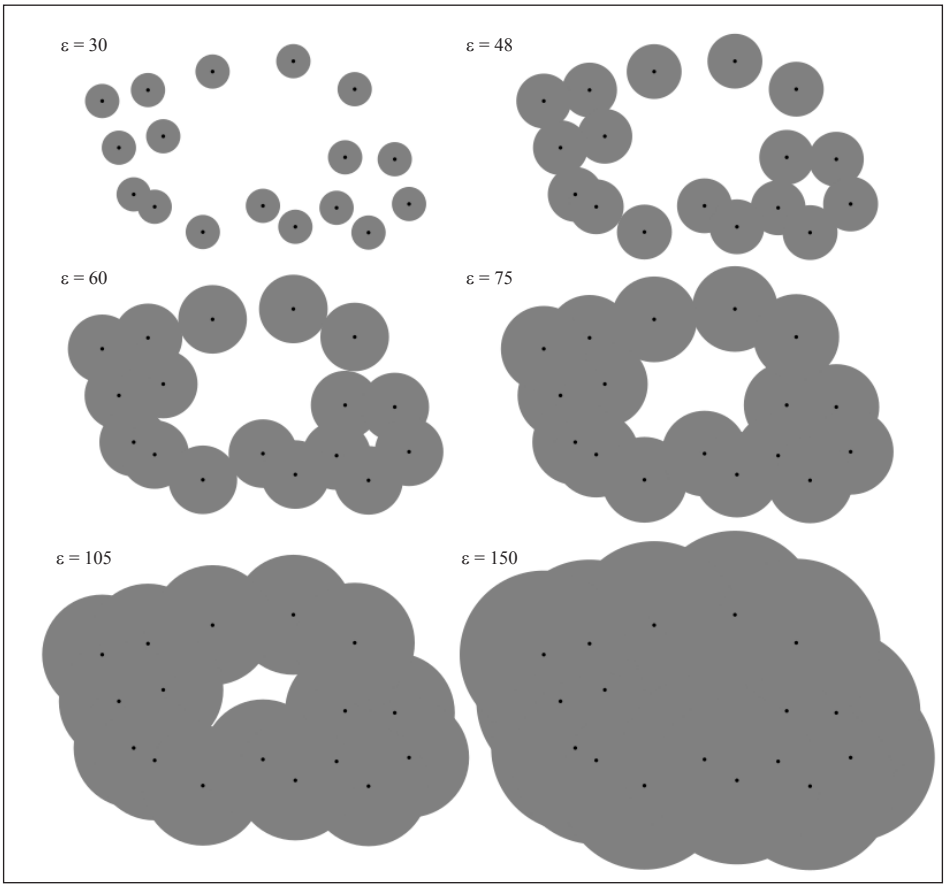
Figure 2 shows an example of a cloud of seventeen points on a plane. We can create a sequence of homologous spaces by fattening points. Graphically, it is represented by circles with ever-larger radiuses. Results for several selected ε are presented in Figure 3.

Figure 2. Sample data set – cloud of seventeen points on a plane



Source: own work.

Figure 3. Fattening point cloud for several selected radiuses



Source: own work.

The initial data set consists of 17 independent components, so it's Betti number β_0 is 17 and all the subsequent Betti numbers are zero. For $\varepsilon = 30$ we can see first join, one homology class disappears – β_0 for X_{30} is 16, higher Betti numbers are still zero. The subsequent iterations cause the disappearance of further topological classes. The set X_{48} has only 5 independent components, but in meantime two cycles appeared so it's $\beta_0 = 5$, $\beta_1 = 2$. It is worth noting that in subsequent iterations β_0 can only decrease − there is no possibility of new independent components birth. By contrast, holes may appear and disappear in the following steps.

The life time of holes or homology persistence existing in X_{48} class is not long. One of the holes died before the 60th iteration, the next one before the 75th. The X_{75} set has only one disjoint component and one new hole, it's $\beta_0 = 1$ and $\beta_1 = 1$. Such homology lives relatively long. In the 150th iteration, there is only one consistent component with no holes, the next iteration will change nothing for homology classes. For each finite set of points we can find ε, which increment will no longer change the homology classes, so finite number of iterations is enough to analyse data set.

The assumption of topological data analysis is finding relevant relationships between the data based on their shape. The significance of a given homology is equivalent to its persistence or life time (excluding last one which lives for ever). Longevity of H_0 classes started by original cloud point is related to density of dataset. More compressed representation of analysed data means longer H_0 classes life. It is interesting to watch persistence of combination of all homology classes.

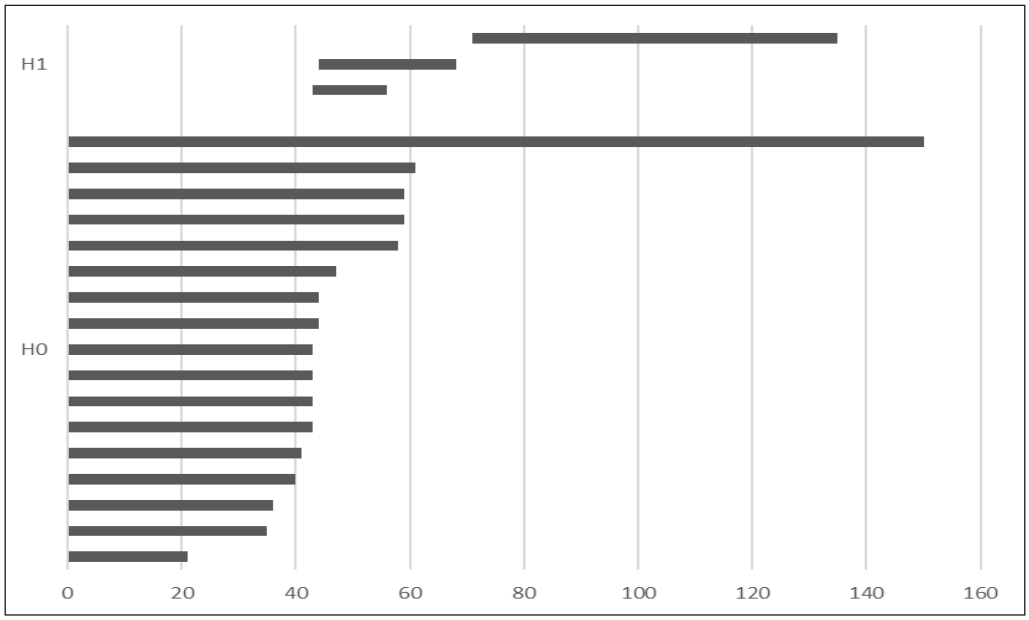
In the example shown, the longest life time has a combination with one consistent component and one hole. This corresponds to the shape of the points on the plane of the closed oval shape. Two holes with shorter persistence may indicate less relevant local features or information noise.

4. Barcodes and persistence diagrams

In the case of multidimensional space visualization of fattening points is no longer possible. Results are presented on barcodes and persistence diagrams to find dependencies. Barcode is a chart with iterations on the horizontal axis and homology classes for each dimension on the vertical axis. The horizontal bars of the graph indicate the lifespan of each class. Implementations of algorithms generating for barcodes are publicly available with source code. One of them is the JavaPlex library developed by Stanford University (Adams & Tausz, 2016).

Figure 4 shows the barcode for the point cloud presented on Figure 2. For H_0 – homology of zero-dimension, we have 17 bars starting from zero. Shortest H_0 bar means early joining of the first two fattened points. Next bars notice almost parallel merging of about dozen other classes. Five classes which live a little longer can be interpreted as clusters with more similar properties or, due to the small difference in life time, as a result of the irrepresentability of the analysed data. H_1 bars for the one-dimension classes (the holes) vary in length clearly. First two appearing earlier have a shorter lifespan – they can be interpreted as minor features or information noise. The third bar indicates by its length an essential topological characteristic.

Figure 4. Homology classes barcode for point cloud presented on Figure 2

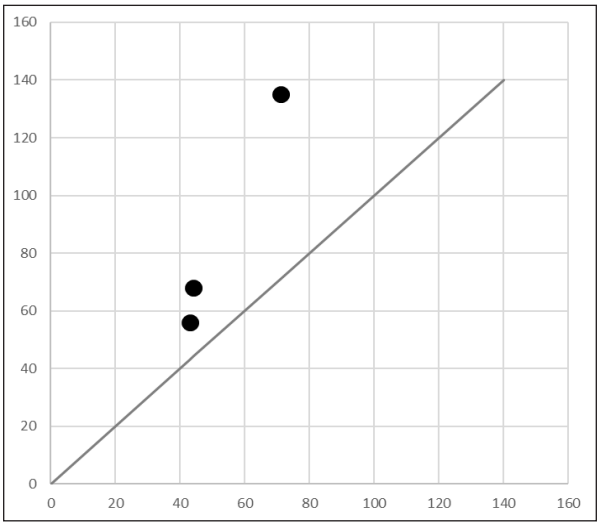


Source: own work.

Another way of presenting homology class lifetimes are a persistence diagrams, usually used to show homology with a non-zero dimension. It is a graph showing the birth time of a given class on the horizontal axis, and the death time of this class on the vertical axis. Classes are marked with points above diagonals x = y (death cannot be earlier than birth). Points near diagonals are potential noises, structural objects are far from it. Figure 5 shows a persistence hole diagram for the discussed example.

Both methods concentrate on graphical presentations of homology classes lifetimes in a way which allows to find important homological properties of analysed dataset. The key feature of persistence homology is low sensitivity to interferences, information noise, data inaccuracies. As it is easy to notice, small data point shifts are not able to significantly change the persistence diagram and its implications. The shift of several points in an analytical set can change the occurrence and disappearance times of holes, but will not change the relationships in the life of particular structures.

Figure 5. Persistence diagram for point cloud presented on Figure 2



Source: own work.

5. Persistence homology applications

Persistence is based only on the cloud of data points. The method itself does not make assumptions about the nature of the data. So it is quite versatile and can be tried in different fields.

One of examples of the use of persistence homology for medical data analysis is finding correlations between persistence diagrams based on topology of the brain arteries and the age and gender of the patients, described by Bendich et al. (2016). The arterial tree found on three-dimensional magnetic resonance images were compressed form 10^5 points to only 3000 points. Generations of zero- and one-dimensional persistence diagrams were generated. As a result age could be determined on the basis of the number of independent components, and sex on the basis of the number of cycles. It turned out that the elements with the longest persistence were not a distinguishing feature. For example, classes with two longest bars of independent components gave a low correlation coefficient with age, and the highest individual correlation was observed by the 28th-time class. Similar relationships exist for age correlations. The explanation may be that the most characteristic traits are common to all human brains. The long term goal of such studies is early diagnostic of diseases.

Goldfarb (2011) analysed the composition of hockey teams from the NHL based on official data from season 2013/14. Each NHL league team was treated as a collection of 14 to 20 players with 12 statistical characteristics each. So players become 12-dimmensions data points. For each team barcodes for their data clouds were created and then compared. There were only zero- and one-dimensional homologies. The purpose of the study was to check the correlation between team composition and it's offensive strength. There was a strong positive correlation between the average persistence of zero homology classes and negative correlation in the number and lifetime of one-dimensional holes and team's strength. This means that better team is more diverse, it lacks players with similar statistics (long H_0 bars). The one-dimensional holes (H_1 bars) account for the uneven

distribution of players' characteristics. Practical application can be a comparison of different team compositions and notice their deficiencies.

Further examples of use in different fields can be study the persistent homology of the data set of syntactic parameters of the world languages (Port et al., 2015), pattern recognition and text mining (Wagner et al., 2014) or 3D surface analysis (Zeppelzauer et al., 2016).

6. Conclusion

Persistence homology is a computational tool of the topological data analysis. It uses the idea of topology and geometry to find the interesting properties of a multidimensional data set. First impression can be discouraging – why to use method which does not distinguish a donut from a cup? But applications show that it can be useful – to uncover relationships between data without prior assumptions. Topological data analysis is already commercially exploited and has become a part of the big data market. In 2008 Stanford University spin-off Ayasdi (www.ayasdi.com) was founded. It specialize in medical and financial data analysis. The value of venture capital investment in Ayasdi in 2012-2015 exceeded 100 million USD.

Main advantages of persistence homology as a tool for multidimensional data analyses include versatility, data noise resistance and data compression. The disadvantage may be the lack of possibility to indicate the causes of the found relationships. Further research requires verification of its usefulness and cost-effectiveness for the analysis of data from different disciplines.

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Chapter 10

BI System of Plekhanov Russian University of Economics in Scientific-Educational Process

Pavel A. Smelov, Katerina A. Shestaeva, Viktoria A. Izvarina

1. Introduction

Plekhanov Russian University of Economics is the country's leading economic university with over 110 years of history, highly developed in research and innovations. The University provides its students and postgraduate students with the quality education in the field of economy, commodity, technology, law and other fields. The Situation Centre for Socio-Economic Development is the scientific and educational Centre of Plekhanov Russian University of Economics, created in 2012.

The main objectives of our activity are to realize fundamental and applied research and development in the field of social and economic development of the Russian Federation regions, to support the educational and research activities of the structural divisions of the University.

Economists around the world are mostly working with numbers. Many good economists are able to see behind the numbers the movements of trains, but only the coolest economists can briefly convert these columns of numbers into the vector of the whole territory or state development. All of them use computational analysis tools, but much depends on the personal qualities as well.

We can teach students the art of strategy. Therefore, we have translated the digital information too easy to read format and give students a significant amount of training in this visual medium. This is actually a minister simulator, giving the opportunity to see the situation from a height and learn to manage it. It is like a strategies family computer game, but instead of elephants – a real Russian land, cities and enterprises, and there is a powerful group of experts and professors.

Situation Centre is located on the Plekhanov University campus and represents a team of remarkable macroeconomics specialists armed with a class of 16 wide touchscreen workstations and a giant wall monitor. We have organized free access to all our resources via the university information grid featuring tablets and smartphones support.

Methodological possibilities of the Centre are not limited to passive submission of information to the university cloud. Every new day our team runs a variety of events, from business consulting to school quizzes.

2. BI system capabilities

Situation Centre provides to students and officers of the University the opportunity to quickly analyze huge/large information massive of local, regional and world scale. For the work, we use Business Intelligence system.

The concept of Business Intelligence includes, as stated in (Wikipedia.org), a set of theories, methods, architectures and technologies, by means of which a great volume of primary data, most often historical data, is synthesized into information of interest such as key performance indexes for a company management. This information is presented in the form of reports, charts or tables. Quality is the most important aspect when we talk about a correct implementation of any Business Intelligence solution. This must be presented in all of the four moments of the implementation: source data standardization, data processing, data warehouse implementation and reporting. Regarding data warehousing, it has been noticed in time a change from relational to multidimensional. This change was necessary for the creation of dimensions as close to the user perspective as possible. Moreover, a multidimensional analysis offers a database much easier to consult and interrogate at a synthetic level with less keys and administrative tables then in relational theory (Ionescu et al., 2014, p. 60).

Even if it occurred in 1958 (Berta, 2012, p. 62), Business Intelligence begins to become known since 1989, when Howard Dresner defines it: "an umbrella concept that describes a set of concepts and methods to improve business decisions by assist systems use decisions based on facts" (Power, 2007). In our vision, Business Intelligence is a complex of economic applications used for data analyzing from various sources in order to transform them into information that will substantiate the decisions taken by researchers, professors and students (Airinei et al., 2012, pp. 72-73).

Along the time, attempting to keep up with technology, Business Intelligence passed through several phases, becoming from operational BI real-time BI (Sandu, 2008, pp. 2-4), adding socialization modules (Berta, 2011, pp. 89-90), and expanding its functionality to be used by mobile phones, turning to Mobile BI (Airinei et al., 2010, p. 5) and now by adding new semantic technologies becomes Semantic Business Intelligence (Airinei et al., 2012, pp. 72-73).

Among the implemented projects, it is possible to single out monthly monitoring of the most important indexes of the Russian Federation regions, a robust analysis of labor resources based on the primary data of a monthly population survey, identifying hotbeds of social tension based on employment and demographic data (*Monitoring of*..., 2017).

However, the core of the Situation Centre is universal. The information-analytical system of the Situation Centre is an easy-to-use platform for interactive reporting, data analysis and report distribution.

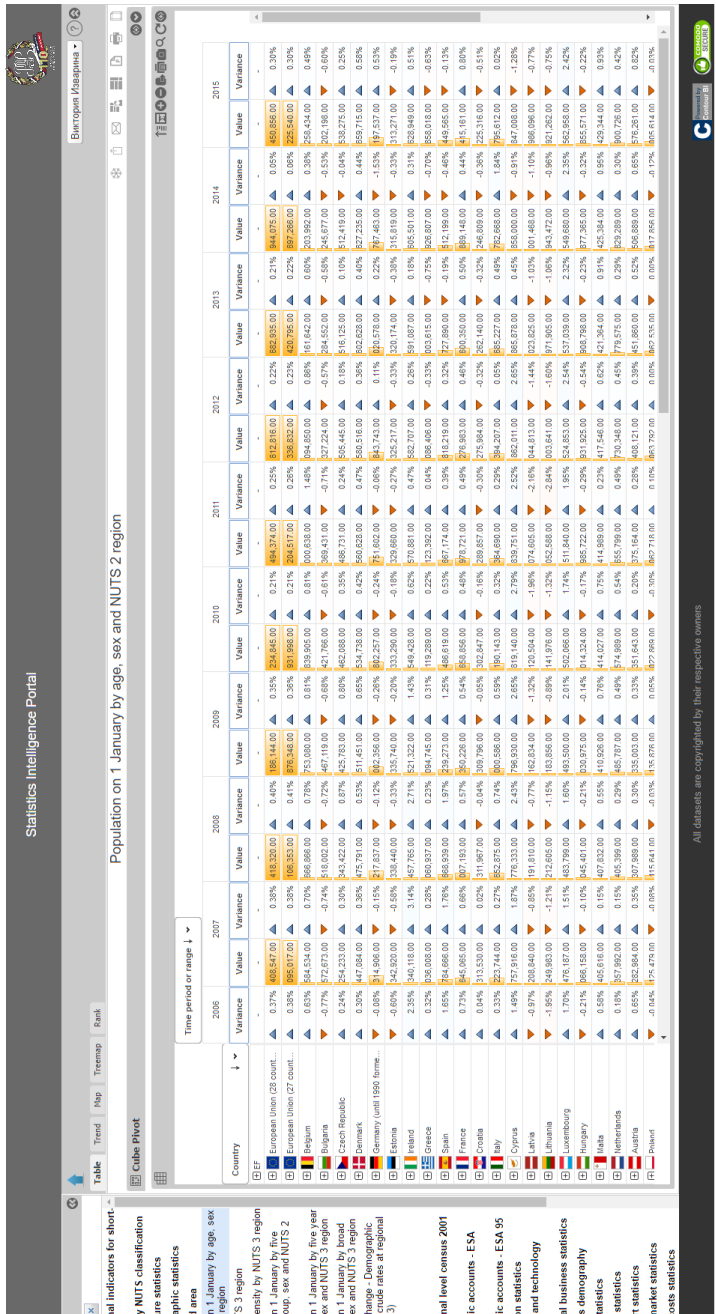
The information-analytical system of the Situation Centre can accumulate data from any source – there are public data, databases, for example, SPSS, and even unstructured Excel table pools.

After automated data collection, the system allows you to present information with a large set of visualization tools, including:

- Interactive tables with extensive conditional formatting functionality (Fig. 1),
- A whole range of diverse diagrams, graphs, instruments (Fig. 2),
- Multilayer vector and raster maps (Fig. 3).

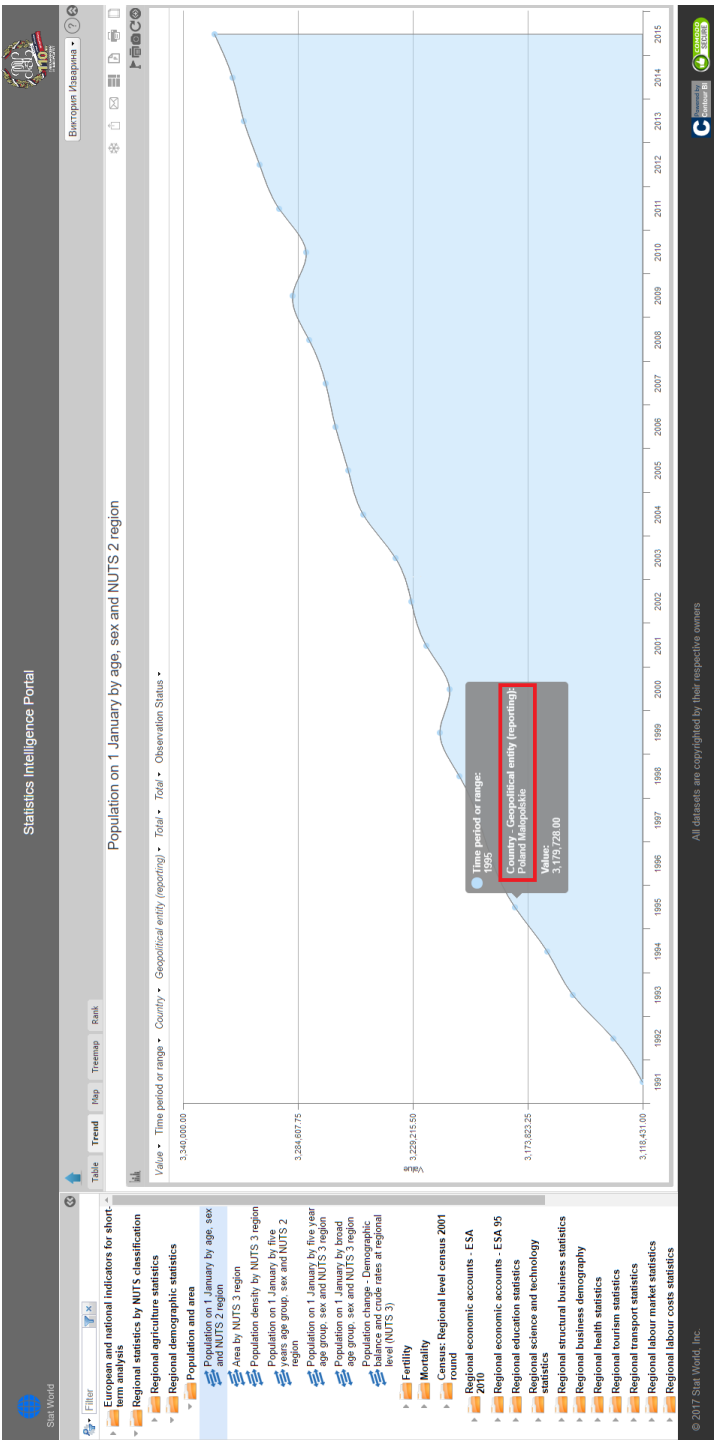
When updating the data, the user does not need to reconfigure the visualization.

Figure 1. Visualization "Interactive tables with extensive conditional formatting functionality" on the example of Eurostat data (web-based solution)



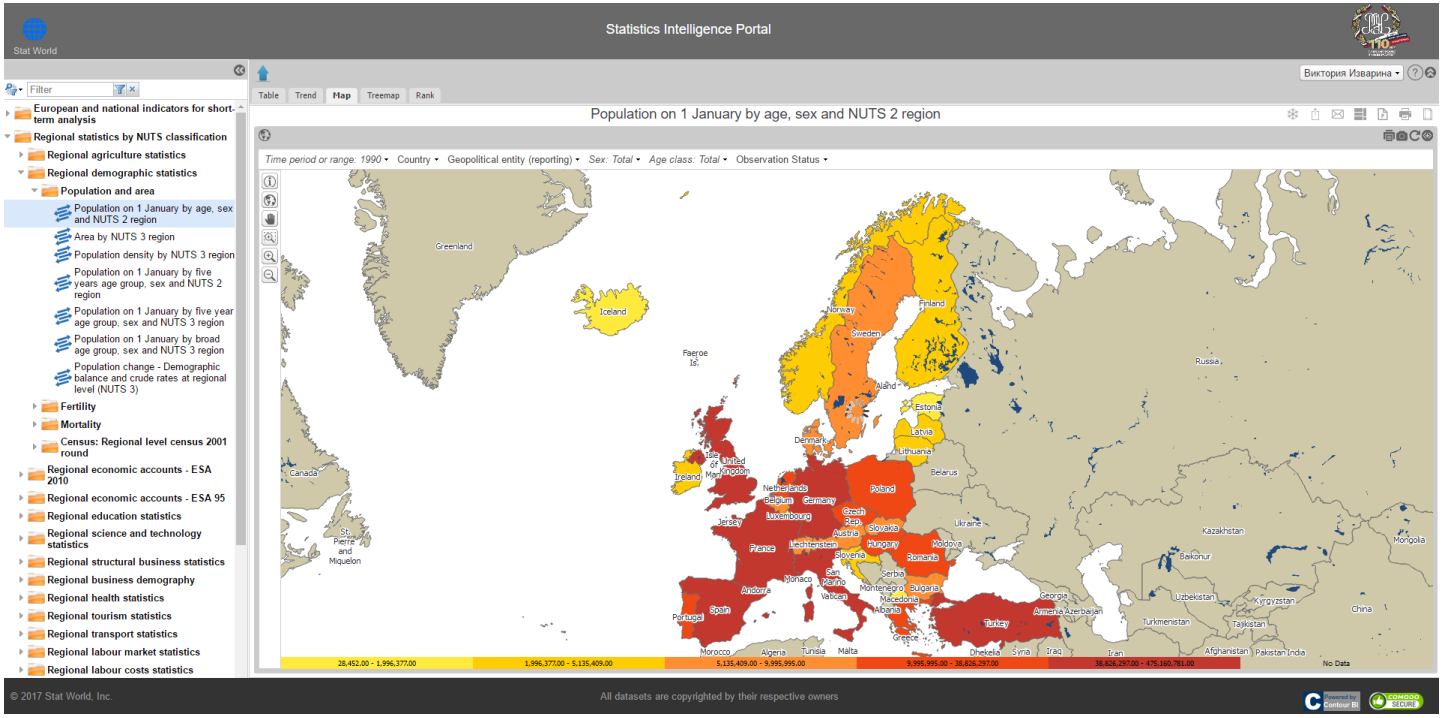
Source: http://stat.university.

Figure 2. One of the possible types of visualization "Graphic image" on the example of Eurostat data (web-based solution)



Source: http://stat.university.

Figure 3. Visualization “Multilayer vector and raster maps” on the example of Eurostat data (web-based solution)



Source: http://stat.university.

System has a simple and friendly spreadsheet-like user interface. When working with reports, users can independently and in real-time obtain dozens of visualization variations with sub-second response times, they build interactive reports with zero programming and publish them in a local network and web. Thus, there are two options of interaction with the system – "thick" client (report designer, is installed on PC) and web-based solution (viewing and express analysis on the Internet).

Users also can print and save reports in various formats: Microcube, MS Excel, MS Word, HTML.

The information-analytical system of the Situation Centre also creates reports based on large amounts of data − millions of records − and does it very quickly. In order to ensure maximum performance optimization, system supports three OLAP technologies:

- ROLAP – building reports from relational databases. Query the database and receive reports in real-time,
- MOLAP – instant opening of pre-built reports,
- HOLAP – immediate opening of pre-built reports with the ability to update them from a relational database.

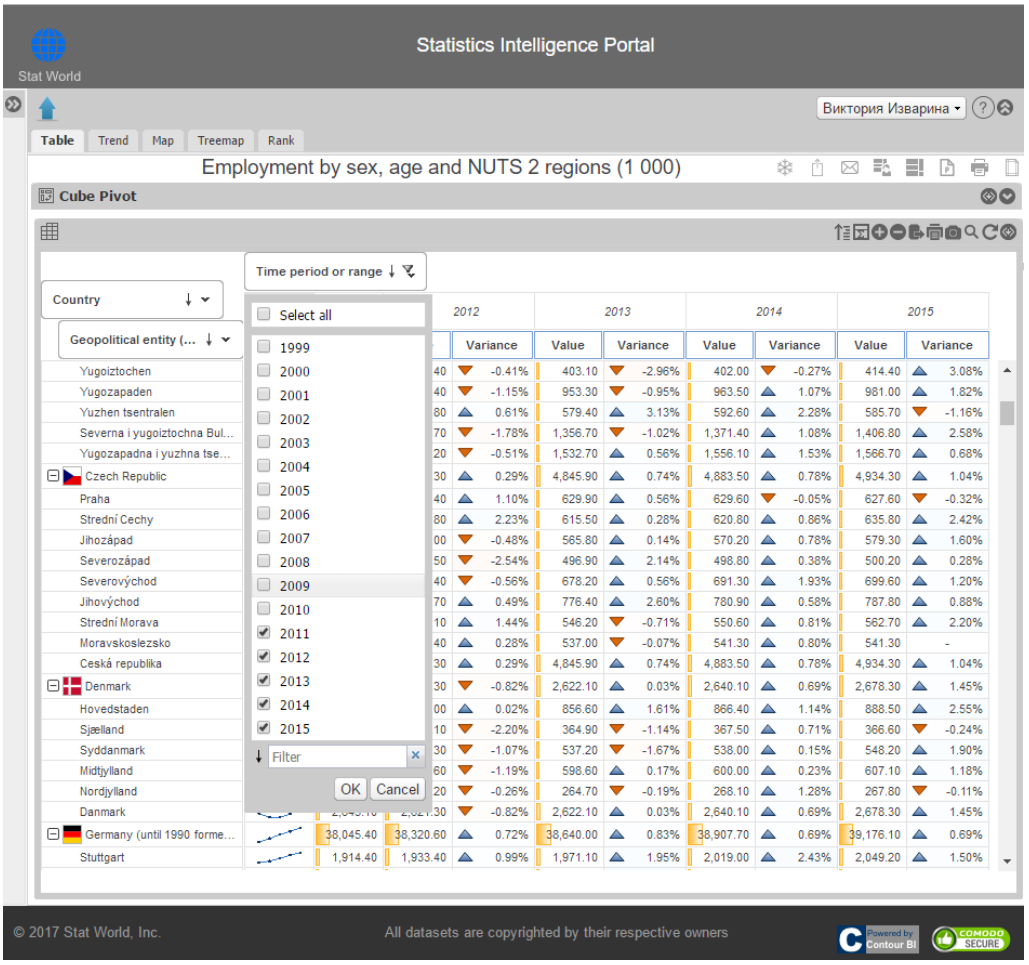
There is Linked reports' technology. It allows for the quick setup of a workplace for specialists, gathering together connected reports that get information from the different informational systems within an organization. A report built from CRM data can immediately be integrated with a report containing data from ERP, and from there receive a report based on data entered in an Excel spreadsheet.

As an example of work with the big data, it makes sense to consider the project, created on the basis of Eurostat open source data.

Thousands of indexes presented on the Eurostat website are automatically downloaded and converted with the help of the OLAP operations in the convenient form for analysis. For each index, all types of visualization are automatically generated (Fig. 1-3). In online mode, the user can independently go deeper into the data to the regional level of the selected country; change the time series (Fig. 4). If necessary, it is possible in the interactive mode to quickly add to the table an additional detalization of the index (for example, gender, age of the population, Fig. 5).

In the report designer, the range of tools for analysis is much higher – the analyst can create additional calculated facts: as elementary (percentage of the total, deviations from different periods, etc.), and more complex (data verification, kurtosis coefficient calculation etc.).

Figure 4. An example of data deepening and filtering using the configured tools in web-based solution



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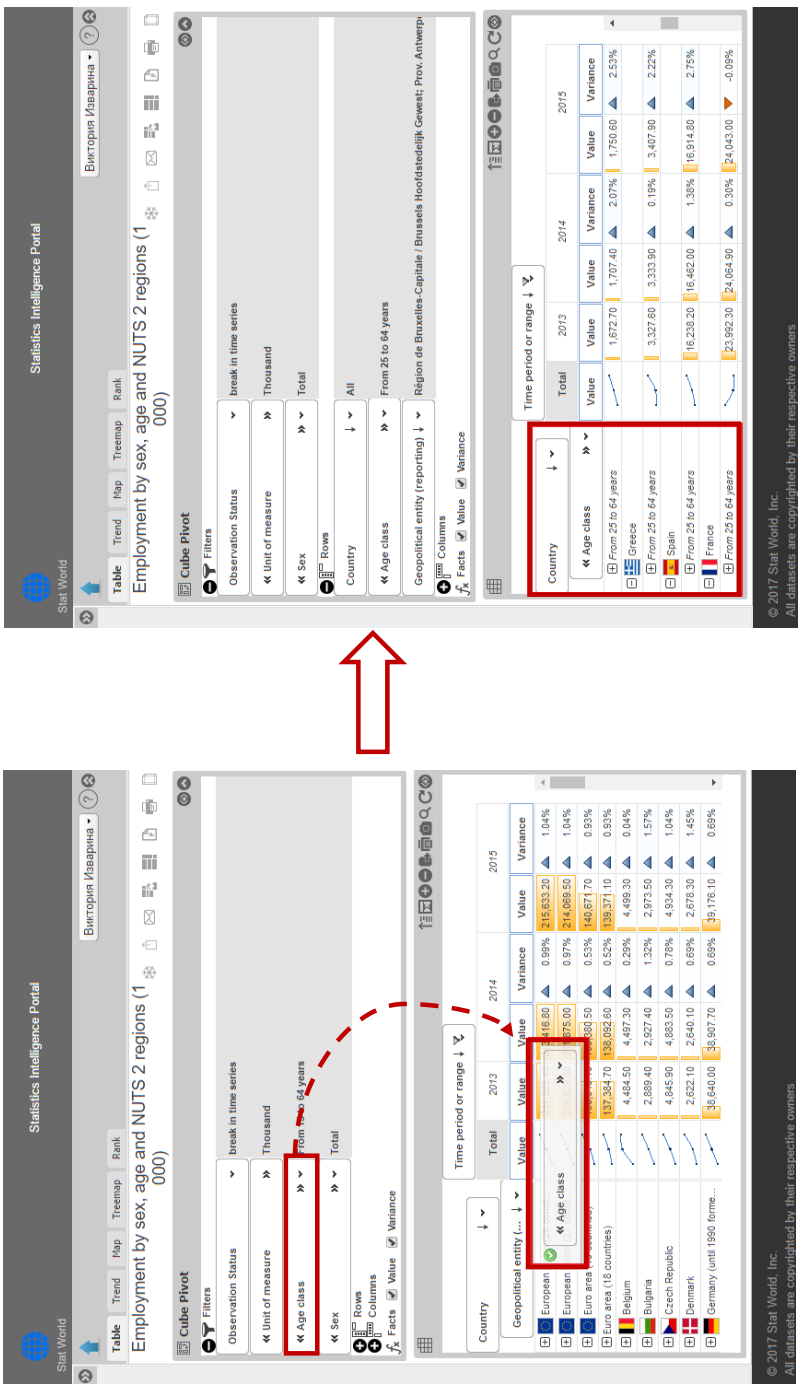


Source: own work.

Figure 5. Example of interactive table setting in web-based solution

A user also can work with the reports either locally without access to Internet using projects stored on a server.

In the University, analysts and lecturers use information-analytical system of the Situation Centre as a "thick" client for the advanced data analysis. Students view reports in the web using only their browsers.

Today we are working with students and lecturers according to the following plan (Fig. 6):

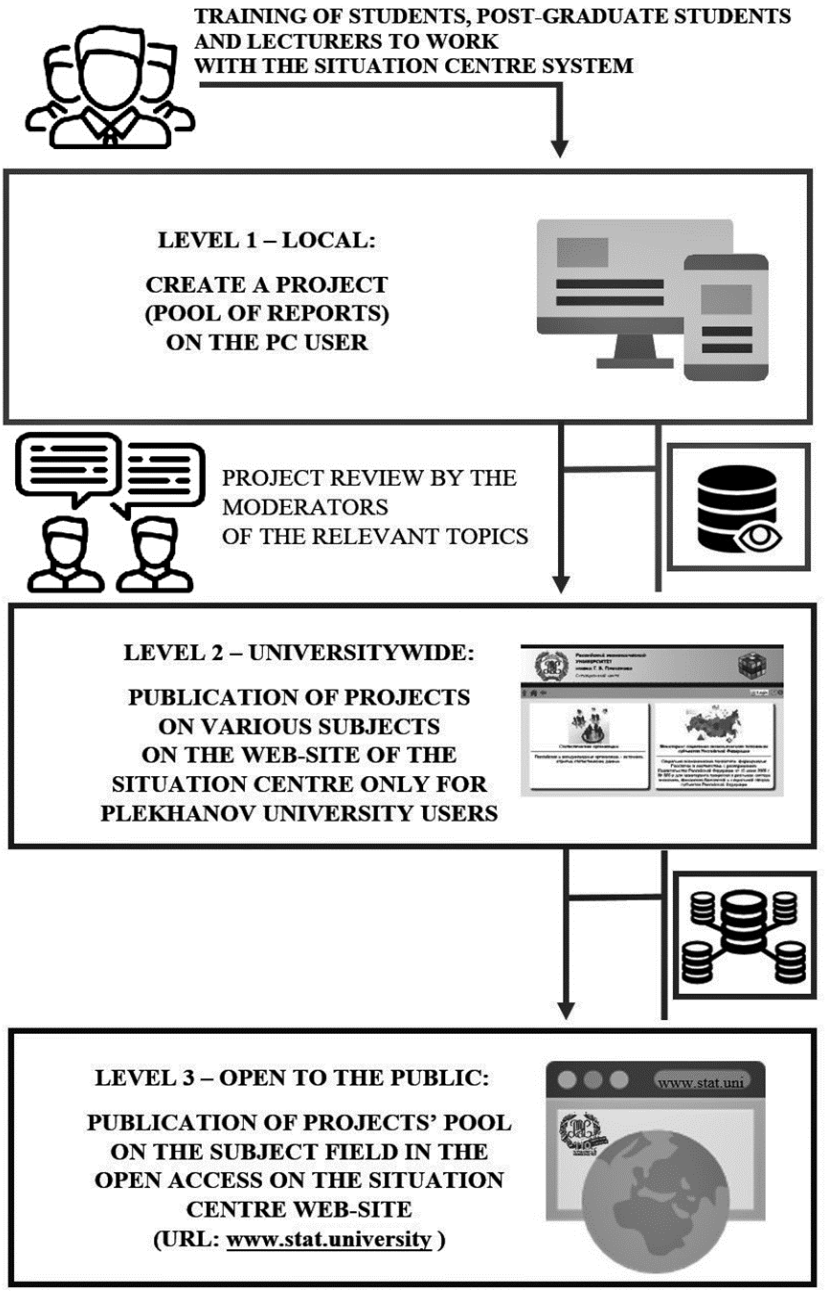
1. Those who are interested can be trained to manage the Situation Centre system. Then we install the software on the personal computers of the trained. Then students and lecturers work locally − they create local projects for their own needs.
2. The management team of the Situation Centre appoints moderators of the directions of social and economic development of the regions, for example, the financial sector, industry, labor market, etc. Moderators are lecturers or researchers of the relevant subject area. They assess the level of projects created by users locally and are responsible for placing these projects on the closed portal of Plekhanov Russian University of Economics. Thus, if a student has created a project that, in the expert's opinion, will be useful to other students, graduate students and staff of the University in the scientific and educational process, the moderator places this project on the portal of the Situation Centre of Plekhanov Russian University of Economics.
3. The reports' pool for a particular subject area can be placed in the public access so that all Internet users can view it by going to the Situation Centre web page.

This approach helps:

First, to create a centralized statistical database on various socio-economic spheres, which will allow students, graduate students and staff of the University to receive up-to-date information timely, to minimize the time costs for data searching in the Internet.

Secondly, to master the methods of multidimensional data analysis, to gain experience in creating your own analytical solutions.

Figure 6. Interaction pattern of the Situation Centre of Plekhanov Russian University of Economics with students and departments



Source: own work.

3. Conclusion

The information-analytical system of the Situation Centre is a Business Intelligence platform and it allows significantly accelerating the creation of new analytical solutions, preserving all the accumulated experience, and gives new qualities to the research − multidimensionality and interactivity.

System of the Situation Centre can be installed on any laptop or desktop and used to develop personal techniques in data analysis and build interactive tables, graphs and maps for the course work. Lecturers and researchers, using the tool to write scientific papers can significantly improve the level of their research.

Multidimensional data analysis plays a crucial role in any work done with statistical, financial and business data, and for this reason ought to be made accessible to every university student and officer.

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Chapter 11

An Example Application of Tournament Approach in Grading Student Assignments[1]

Paweł Wołoszyn, Katarzyna Wójcik, Przemysław Pływ, Jacek Wołoszyn

1. Introduction

Evaluation of written assignments is widely used as a mean of measuring student achievements at all stages of education. The most commonly used approach is evaluation according to a number of criteria followed by aggregation of grades into scalar final assessment. The disadvantage of this approach is the inability to take into account temporary, unique and individualized criteria noticed by the teacher during the evaluation. Students provide in their works an extremely diversified range of the style of reasoning, the way in which the problem is approached, or even the form of expression.

A typical requirement for teachers evaluating students work is objectivity: objective evaluation is one that can be formally justified and reproduced. For this reason a set of criteria is used as an auxiliary tool. Grading criteria allow to focus on narrower aspect of student work thus facilitating objective assessment. However, students are diverse and limiting this diversity would limit creativity. In order to stimulate creativity, diversity in evaluation criteria must be taken into account. The teacher is then faced with the dilemma whether to ignore features outside established criteria or to dynamically expand the set of criteria as new features differentiate in students work.

An assessment system with rigidly defined criteria can not reward creativity, and simple aggregation of partial grades often does not reflect the subjective quality of the work. In addition, if the evaluation criteria are announced earlier, students are willing to conform by optimizing the content of the work and causing a phenomenon similar to web page positioning. On the other hand, if the set of grading criteria is dynamically extended as more assignments are evaluated, the number of possible grade configurations grows exponentially, but in practice some criteria apply only to single students, while other act as an unnecessary burden for teacher.

Another important grading problem is the monotony felt by the teacher during the evaluation of longer written assignments. Paradoxically, evaluating work as a whole may be less objective than

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just evaluating a piece of work. Taking a break during evaluation of a long piece of text may require the entire procedure to be repeated. Some sentences read in a long work can become stuck in teacher memory and may dominate the judgement. Lastly, the grade given to the work can be heavily influenced by teacher weariness and tiredness caused by reading several works on similar topic.

The problems mentioned above justify in authors' opinion the need for alternative assessment methods, especially addressing the issue of excessive adaptation of written works to predetermined criteria. Non-standard approaches in the assessment of written works still get very little attention, although similar attempts have been made by other authors (Heldsinger & Humphry, 2010). The method proposed below tries to alleviate grading problems by moving the aggregation stage to the beginning of the assessment process.

2. Tournament approach in grading

Instead of using a fixed set of predefined criteria – which we refer to as exogenous criteria since they are chosen without knowing actual features of evaluated works – teachers can evaluate texts by referring to endogenous criteria which arise directly from the content of particular texts being reviewed. As an example, students can make references to classic films when writing assignments in computer science. Introducing such a feature as an exogenous evaluation criterion would be difficult to justify and would inevitably result in optimizing texts in this respect. However, the teacher may appreciate this feature and take it into account, sensibly deciding whether it is indicative of student erudition or rather immaturity.

Evaluation based on the endogenous criteria becomes more suitable for assessing such features as individualism, erudition and knowledge, the ability to perceive problems in creative and holistic style, or the precision of abstract thinking. This is valuable in the context of academic education, and especially in the formulation of formative assessments (Mokwa-Tarnowska, 2014), although on the other hand it is not useful for obtaining quantitative reproducible measurements of learning outcomes based on summative assessments, which require a completely different approach (Harlen, 2005).

Endogenous criteria in our opinion are induced only in the presence of other works providing comparative reference. In the evaluation process the characteristics of the subject matter are compared with different patterns and examples of similar works. Those characteristics do not have to be fully consciously considered features and similarities to exemplary patterns can be very subtle. In the process of grading it is difficult to overestimate teacher intuition and the wealth of experience and knowledge which can not be replaced by a formal set of exogenous criteria.

Endogenous criteria allow only for grading by comparison and not by using absolute scale. This is the foundation of the approach proposed which postulates replacing the traditional evaluation with comparison of works in pairs with one another. In this approach student assignments become themselves the criteria for evaluation. For each pair the teacher's task is to choose the item that he valuates superior, but this is a purely qualitative choice, without indicating quantitatively the difference of values. Using a sport analogy, the teacher acts as an arbiter who decides the outcome of the match between two competing works and indicate the winner or announce a draw. The winner of one match can be defeated in another match as there is no absolute reference point.

The teacher is encouraged to simply follow the entirely subjective opinion, so the assessment is clearly intuitive (Kozak, 2005). Continuing the duel metaphor, students as authors of evaluated

works are confronted and competing among themselves, which can be positively used for their activation and inclusion in the process of formative grading, very desirable in the modern education system (cf. Ludyga, 2014).

The lack of predefined criteria may raise concerns about the reliability of such a method, but the proposed approach is not to abandon the use of any evaluation criteria at all, but to ensure the freedom of choice for each pair of comparable works. The assumption that the teacher may use or omit any criteria at their own discretion is based on our belief that features and qualities considered by experienced teacher are indeed important and those that are omitted are actually not of great importance in the particular case.

It is important to emphasize the role of teacher's experience: the proposed method can confuse the evaluator who is accustomed to using a fixed set of criteria, as he will not be able to decide what characteristics are to be ignored in the given case. Full freedom in the choice of criteria can also be taken as an incentive to bend the rules and deliberately favor or repress certain students (Bartmańska, 2007). It seems, however, that in the case of pairwise comparisons this is not a major concern, since the results of individual comparisons do not translate easily into the final score, so the teacher can not consciously control the assessment.

Tournament evaluation by pairwise comparison is an iterative process perfectly suited to computer implementation. Appropriately designed software can take care of selecting pairs, avoiding repeats, recording results and analyzing the final results. However, comparing longer texts due to the tediousness of the procedure would inevitably lead to a two-step simplification: first the evaluator would become acquainted with evaluated texts and develop a general opinion on each of them independently and then he would compare only those opinions, invalidating the basic assumptions of the method.

To avoid this one can split each text into short fragments and select them randomly from different works to create pairs, prompting the evaluator to read them each time they are compared again. Using short snippets – for example, 1/3 of a page – should make the tournament more entertaining by preventing weariness and providing a variety of work pieces. Reading a few paragraphs also takes less time than even a cursory review of the entire work, so the evaluator may more often take breaks in the assessment.

Comparison of fragments creates new circumstances which can help alleviating a number of psychological problems accompanying assessment (Tyszka, 1999). Firstly, text snippets can be truly anonymous, or at least associating them with the author may be very difficult. Even identifying the author of a single fragment does not have to make it easier to identify other passages of the same work, especially if the typography of all works in the collection is unified. Secondly, evaluating fragments independently helps to avoid the effect of extrapolating to the entire work the impressions gained from reading its most brilliant part. Thirdly, the random order of the selected fragments helps to avoid the contrast effect (an overly outstanding grade given to dissimilar work coming after a homogeneous series of other works), the priority effect (the more strict and demanding evaluation of the first works in the order), and the so called freshness effect (overrating final fragments of works).

The evaluation of fragments instead of entire works brings to the foreground the local characteristics of text: the stylistics and dexterity of the formulation of statements, the continuity and the speed of narration, the coherence of the subject matter, the logic of reasoning, the clarity of thought, inquisitiveness, intellectual load or originality of views, technical and linguistic correctness. In contrast, the traditional way of evaluation tends to attach more importance to global

features such as the choice of subject matter, the plan and structure of work, the completeness and consistency of subject presentation, the degree of exhaustion of the topic, as well as quantitative features such as volume of work, number of illustrations, tables, equations or citations from literature. These differences in the set of foreground features will undoubtedly make the assessment outcomes of traditional method and pairwise tournament method different in the general case.

The quantitative assessment mechanism itself must also be different. Comparing works defines only a collection of binary preferences. In order to obtain the required numerical grade it is necessary to generate a quantitative ranking based on the winnings and defeats recorded during pair confrontations. It seems natural to use a well established and widely proven Arpad Elo ranking system, originally developed for creating chess players rankings (Elo, 2008). The Elo system, by aggregating the results of multiple matches played between pairs of players, allows them to be ordered in a numerical ranking, where player score can have only relative interpretation: the difference in scores between two players determines the probability that the player with higher score wins a match with the other player.

It is worth pointing out that the fact that random text fragments are used for confrontation instead of entire works is precisely what makes it possible to use the Elo system, which has probabilistic nature and assumes that a tournament participant with lower rank can still with some probability overcome another participant better than itself. If the teacher was considering entire works during the assessment, then the result of the comparison of the same pair should always be the same. However, the fragments of texts are differentiated and depending on the random choice one work can with certain probability win, lose or draw with exactly the same second work, and the chances depend on the distribution of its local quality. It restores analogy to chess games and opens the possibility of using the Elo system.

3. Experimental implementation of the method

Before performing experiments with tournament evaluation method described above we developed a dedicated IT system designed for document management, text fragmentation, pair selection, running a tournament and aggregating scores. Fragmentation of the document is made after the submission of a work file in universal PDF format via the website, which allows for comparison of any type of work, including for example technical texts with equations or illustrations. System operator must manually remove fragments of the work that are not suitable for comparison, such as title pages, table of contents, footnotes or pages containing no text at all. In future development of the system it is planned to introduce adaptive fragmentation, which would allow automation of this process by adjusting fragment dividing boundaries to the text layout on the document page.

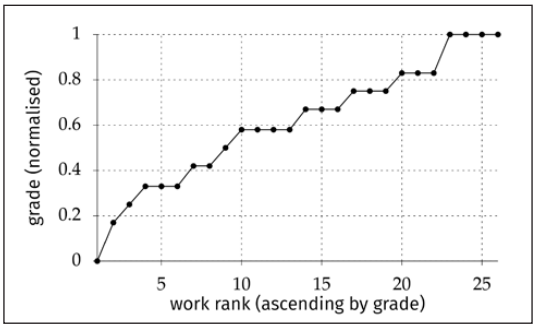
When creating and running tournaments, the important parameter is the number of pairs to be involved in a single tournament. From a combinatorial point of view, the ideal, although definitely impractical, solution would be to compare each fragment with all fragments of all other works. By putting a limit on the number of pairs in a tournament one can avoid the fatigue due to high number of comparisons that the teacher has to perform. Tournaments within the same set of works can be repeated any number of times. For the selection of pairs we use random mechanism drawing in the first place from the set of those fragments that were the least used. Despite such balancing, a shortcoming of the method is the requirement that all works to be evaluated should have similar volume and similar number of fragments, otherwise repetition of fragments from shorter texts will be clearly noticeable in confrontation with longer texts.

The process of comparing pairs is performed through a web interface, where the system presents two fragments arranged side by side in random order. The evaluator can indicate the preferred part, signal the tie or simply skip the pair if for some reasons its elements are not comparable. Although compared are specific fragments, the score is recorded on the account of the entire work to which the winning fragment belongs.

Using the described system, a study was conducted using 26 essays of one student group written on the same topic and having similar size. The limit for the number of pairs in a single tournament was set to 32. Over a few days a total of 7 tournaments were held which included 224 pairs of passages. The results of the comparisons were aggregated into a score ranking list using the Elo system, where scores were updated collectively at the end of each tournament. In addition, the same teacher after the next few days re-evaluated the same works using the traditional method.

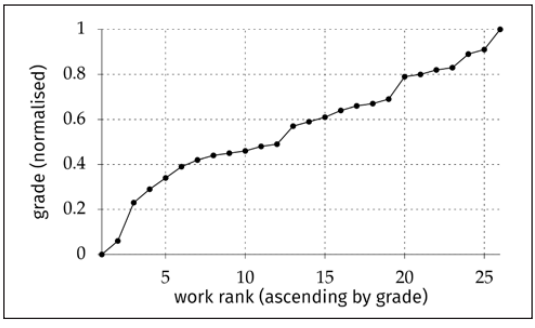
Tournament Elo scores ranged from 1300 to 1500 points, traditional scores were assigned on a scale of 0 to 100 points. For further analysis both sets of ratings were scaled linearly into the interval [0, 1]. Both traditional and tournament evaluations show a distribution similar to the normal distribution (according to the Shapiro-Wilk test at significance level 0.05), but their diversity is different. Traditional grades have a tendency to repeat (Fig. 1), while tournament evaluations can better differentiate works (Fig. 2). In our perception the distribution of tournament scores is more natural, as the cases of exact draw due to the inability to determine which work is better are rather rare.

Figure 1. Distribution of traditional grades in the set of evaluated works



Source: own work.

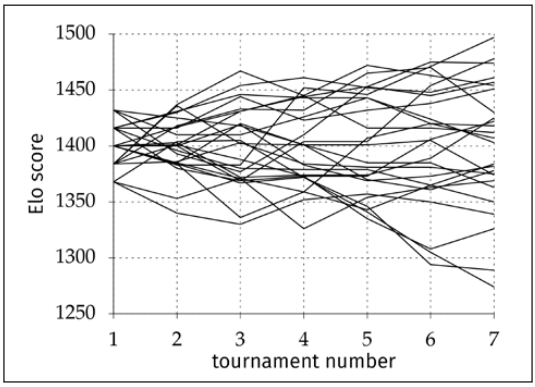
Figure 2. Distribution of tournament scores in the same set of works



Source: own work.

The workload associated with both methods of assessment is in practice similar. Repeated tournaments may take longer and be more tedious than a traditional rating. On the other hand, as tournaments repeat, some fragments become recognizable to the evaluator, making comparing fragments less tedious, especially for low quality work. In subsequent tournaments, the position of the work on the score scale changes, the diversity grows, and the ranking gradually stabilizes (Fig. 3). The decision at which point to break the assessment process can be made objectively, based on observation of score changes, or left to subjective choice of the teacher.

Figure 3. Changes in Elo ranking scores occurring in consecutive tournaments

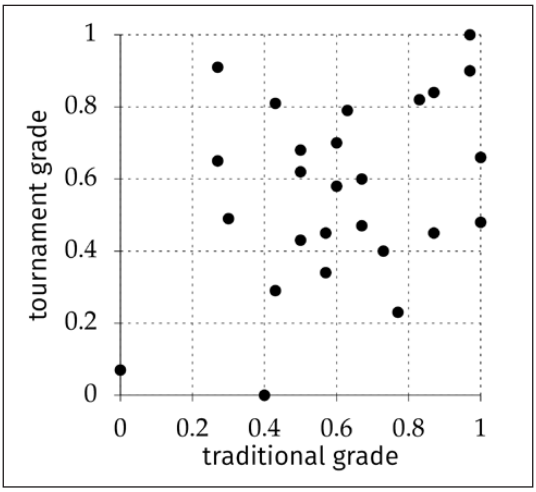


Source: own work.

4. Conclusion

The comparison of scores obtained for the same set of essays in traditional grading scheme and in tournament approach leads in the first place to the conclusion that these methods provide very different evaluations and it is difficult to find a clear relationship between them (Fig. 4). On the contrary, it can be observed that works graded similarly by one method achieve diametrically opposite results with the other method of assessment.

Figure 4. Comparison of traditional and tournament scores for the same works



Source: own work.

The divergence of grades is the expected and desirable result, because the consistency of both methods of evaluation would mean that the whole text can be replaced with small fragments read in random order without changing the perception of its quality. The tournament method takes into account only the local characteristics of the text, while the traditional method attaches more importance to the global features, and the discrepancy between the two assessments indicates a lack of consistency between these scales.

An analysis of those essays which have received extremely diverse grades reveals that large dominance of tournament grade over traditional grade suggests inconsistency of the work, lack of keynote motif or main thesis, difficulty in determining and achieving the objective of the assignment. Works belonging to this category had a structure resembling a loose set of observations, sometimes quite apt and valuable, but not connected into an ordered whole. Conversely, dominance of traditional grade over tournament score indicates problems of literary workshop, fluency and precision of written language. Works within this group presented an uncomfortable style of expression and abounded in meaningless passages not conveying specific thoughts, overwhelming otherwise valuable content which could only be seen in global context of the entire work.

The method of pairwise comparison of written assignments presented in this article adds an additional dimension to the assessment space, independent of the traditional grades and allowing for further differentiation between works graded equally. In the conducted experiment, the comparison of traditional grades and tournament scores allowed to highlight the advantages of low-graded works and to point out the flaws and defects in previously high-graded works. Although the use of the tournament method as the only form of assessment is undoubtedly controversial, it can nevertheless be regarded as a complementary tool providing more complete feedback to the student.

Certainly, this method requires further research involving more teachers and larger volume of evaluated work. However, the experience gained confirms the practical possibility of applying the proposed approach in the real working conditions of an academic teacher. The directions of further development of the method include extending the procedure to a group of multiple

evaluators, aggregating the preferences of many teachers, automated detection of ranking settle conditions, employing graph-oriented methods in analysis of preference relations and, perhaps the most interesting, observation of possible influence of this assessment technique on the style and content of student work.

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Chapter 12

Mobile Technology in Knowledge Acquisition: A Preliminary Study[1]

Janusz Stal, Grażyna Paliwoda-Pękosz

1. Introduction

The recent changes that have taken place in various spheres of socio-economic life have been the result of the development of a new civilization era where knowledge becomes the most valuable resource. The emerging new knowledge-based economy model in which goods are understood as a special intangible asset treats human capital and human resources as one of the dominant drivers of growth. It is therefore necessary to constantly increase investment in education, research and development of modern education systems and to seek new teaching methods that meet the learners' demands.

In recent years, the rapid development of technology and the increasingly widespread access to the Internet have resulted in many implementations of systems of knowledge delivery. One of them is e-learning. Even though lack of consistency in terminology (Moore, Dickson-Deane & Galyen, 2011), e-learning is often defined in terms of using technological tools as non-stationary teaching through utilizing modern information and communication technology, where participants of the education process are separated from each other in space and time. It implements the ideas of lifelong learning with the support of technical means, especially Information and Communication Technology (Paliwoda-Pękosz, Stal & Wojtowicz, 2015; Put, Stal & Żurowicz, 1999), used to create, process, transmit and present information related to the education process. It is used successfully in both academic education as well as employee training to provide knowledge anywhere and anytime. It should be noted that in practice extremely often blended-learning is applied combining knowledge delivery through online media with traditional classroom methods (Paliwoda-Pękosz & Stal, 2013; Stal et al., 2012).

Creating educational systems based on that form of teaching has many benefits. This includes: (1) access to educational resources, anywhere, anytime, (2) ability to update educational content, (3) monitoring, management and control of the learning process at all stages, (4) inclusion

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of the learner in his or her own learning process, and (5) customization the learning process to individual learner's expectations. In his comprehensive study, Feu Yang (2006) discusses the goals of e-learning. Among the most important are: (1) increased access to learning at all levels of education, (2) personalization of the teaching process, (3) cost reduction and improvement of the didactic process, and (4) ease of management of a didactic process. These characteristics significantly influence the achievement of the idea of building a knowledge-based society. Access to educational and training materials becomes easier. Thus, this form of information transfer may be addressed to those interested in improving their qualifications, including working people, elderly and disabled, regardless of their economic or social status.

The last decade has brought tremendous growth in the use of mobile technology. The impact on this is not only the diminishing cost of mobile devices, or increasing functionality, but also the changes that take place in the way people live and work. Mobile technology is commonly present in almost every domain of a contemporary society. We can observe its utilization in numerous domains, both in industrial applications and in the field of education (Hwang & Wu, 2014). Examples include successful projects that use mobile technology for improving language skills (Kukulska-Hulme, 2013; Hsu, 2013). However, the research works that concern the investigation of the real benefits and possibilities for mobile technology adoption in systematic knowledge acquisition are still scarce. We would like to narrow this gap by conducting the research which the main goal is the indication of real benefits of mobile technology adoption in systematic knowledge acquisition. Specifically, based on literature review and the survey conducted among students of the Cracow University of Economics (CUE) we would like to answer the following research questions:

"Does the mobile technology utilization contribute to a more successful knowledge acquisition?"

The paper is organized as follows. In the next section, we concentrate on literature review concerning mobile technology. Then, in order to answer the research question, we present the results of a survey conducted among students of Cracow University of Economics followed by conclusions and future research directions.

2. Related work

One of the most valuable assets in the 21st century is knowledge; hence it is extremely important how and when it will be delivered. We should take into account that business is not confined to a fixed place and mobile employees need continuous access to organization database knowledge. Similar situation takes place in relation to education; it is desirable to provide knowledge and access to education content not only during regular classes but also at the time when such activities do not take place. Thanks to the fact that students have access to knowledge regardless of time and place, they can simultaneously shape and organize their own learning plan (Veith & Pawlowski, 2005; West, 2015).

The rapid development of mobile technology results in the development of mobile learning, providing widespread support in the educational process. These changes entail transformations in the development of methodologies that activate the teaching processes, among which dominate (Lubina, 2007): (1) innovation of working methods, (2) personalization of the learning process

(adaptation to individual learner's expectations), (3) changing in the way of student evaluation, (4) changing methods of group collaboration, (5) developing individual work methods, and (6) changing the methods and organization of teacher and student work. Support for these processes is provided by numerous mobile applications. Knohova (2017) point out a number of areas where these applications may be useful, namely in: (1) organization and administration, (2) researching and information seeking, (3) collaborating and sharing, and (4) enquiry and knowledge gathering. Mobile learning (ML) is emerging as a new wave of mobile-based development in combination with wireless infrastructure. It can be perceived as a range of capabilities offered by mobile technology, wireless infrastructure and the development of eLearning (McLean, 2003).

It should be noted that there are many definitions of mobile learning (Traxler, 2005; El-Hussein & Cronje, 2010). ML can be defined as the type of learning that occurs when a learner is not in a pre-established location or uses the learning opportunities offered by mobile technology (Zuga et al., 2006). Often, ML is not an autonomous learning system but an extension to the existing e-learning providing an additional, sophisticated form of learning content. Hence, due to the characteristics of mobile devices, it is necessary to change the approach to content adaptation to the requirements of devices (Stal, 2010), as well as the way content is integrated with learning systems.

The considerable advantage of ML compared to a traditional form of teaching is the context in which it is realized. In their study, Victor and Werkenthin (2016) suggest that knowledge in traditional teaching is delivered in advance, whereas in mobile technology it is possible to deliver information when it is actually needed. However, as Crompton and Burke (2017) point out, despite the undoubted advantages of mobile technology, nowadays the scope of its use for knowledge delivery remains insignificant.

3. Research methodology

In order to answer the research questions formulated in the Introduction, we conducted a survey among the students of Cracow University of Economics, Poland. The survey was distributed in the academic year 2015/2016 to 347 students of Applied Informatics and Accounting and Controlling university programmes. We diversified the respondents' population on purpose to analyse the differences in mobile devices usage between students closely connected to information and communication technologies and other students not involved in the field of computer science. The structure of respondents is presented in Table 1.

Table 1. Respondents' structure

Course \ Gender	Female	Male	Total
Applied Informatics	55	192	247
Bachelor	25	113	138
Master	30	79	109
Accounting and Controlling	80	20	100
Bachelor	80	20	100
Total	135	212	347

Source: own work.

The students were asked to answer 15 open and close-ended questions listed in the Appendix. The survey content was divided into three sections: questions referring to general usage of mobile devices, concerning the usage of mobile devices in connection with knowledge acquisition, and demographic questions.

4. Results

4.1. Mobile devices usage

First, our intention was to recognize the types of mobile devices and the circumstances of their usage. As the survey revealed, the vast majority of students used smartphones and roughly one third of them own both smartphones and tablets (Tab. 2). It should be noted that almost all of the respondents leveraged mobile devices at university and in a public transport (Fig. 1).

Table 2. Students' possession of mobile devices

Device type	Quantity	[%]
Smartphone	240	69
Smartphone and tablet	96	28
Tablet	7	2
None of the listed	4	1
Total	**347**	100

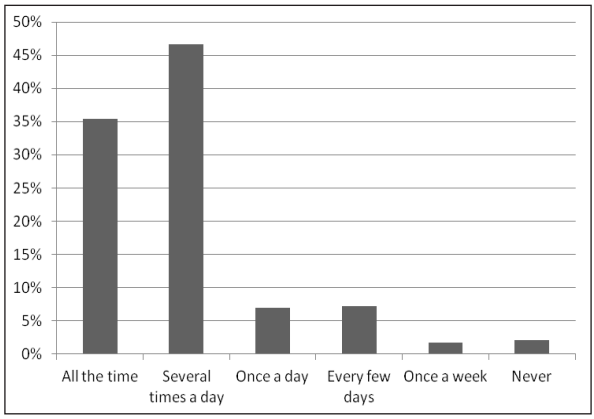
Source: own work.

Figure 1. Venue of mobile devices use

Source: own work.

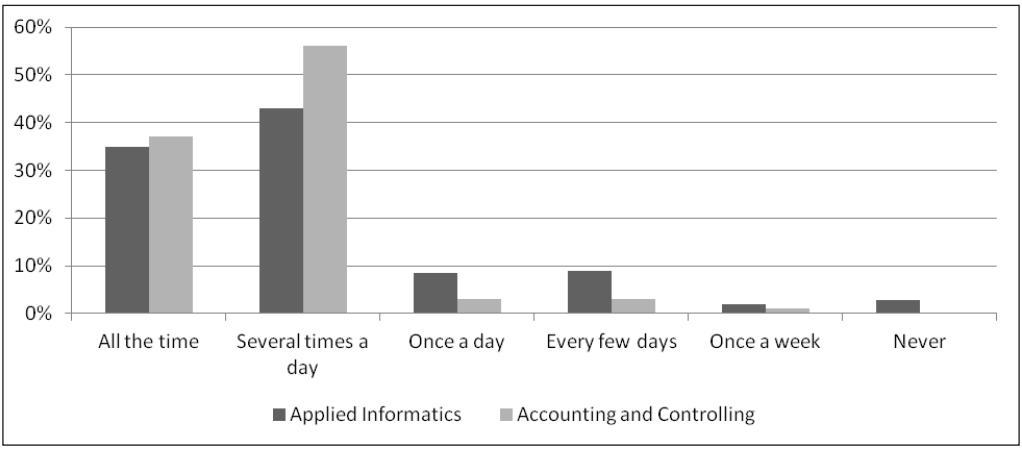
Further survey results have shown that more than 35% of respondents declared making use of mobile devices on a continuous basis and nearly half of students exploited their smartphones and tablets several times a day (Fig. 2). Interestingly, Applied Informatics students seemed to be less attached to mobile devices compared to their Accounting and Controlling peers. In contrast to the latter, a declared daily usage of mobile devices by the former was noticeably smaller (Fig. 3).

Figure 2. Frequency of mobile devices usage



Source: own work.

Figure 3. Frequency of mobile devices usage in relation to the course of study



Source: own work.

4.2. Mobile devices usage in relation to knowledge acquisition

The most important part of the survey contained questions connected with the investigations of mobile devices usage in the context of knowledge acquisition. It should be noted that almost all students used mobile devices to access the course schedule, however only half of them made connections to the university website and the e-learning platform (Tab. 3).

Table 3. Goals of mobile devices usage (in the context of learning/studying)

Goals of mobile devices usage	Percent of students [%]
Access to the course schedule	94
Access to Internet resources	81
Communication with other students	80
Access to your university website	50
Access to the e-learning platform (VLE)	50
Access to the virtual dean's office	43
Communication with teachers	18
Other (WiFi connection diagnostics, music, playing during lectures)	1

Source: own work.

The respondents were asked to rate usefulness of mobile devices in various aspects of knowledge acquisition. The results show that almost ninety percent of students find mobile devices useful in studies in accessing to learning resources, doing assignments, and facilitating communication both with students and, to a lesser extent, teachers. It is also worth mentioning the little use of mobile devices by teachers to increase students' motivation for doing homework (Tab. 4).

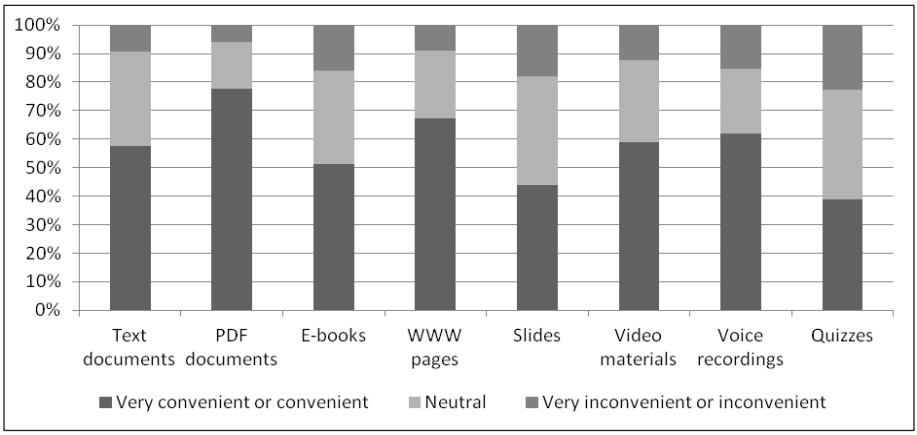
Table 4. Usefulness of mobile devices in knowledge acquisition

	Strongly agree or agree [%]	Neutral [%]	Strongly disagree or disagree [%]
Allows access to materials regardless of time and location	87	7	5
Useful in studies	86	10	5
It can help in efficient access to resources	85	9	5
Improves communication with other students	85	10	5
Facilitates access to course materials	84	11	4
Allows easy access to notifications from teachers and other students	81	15	5
Helps in doing assignments	77	15	8
Offers opportunities for communication and group work	75	20	5
Develops learning skills	53	33	14
Improves communication with lectures	53	35	13
Increases motivation to do homework	26	**40**	**34**

Source: own work.

As far as learning content delivery on mobile devices is concerned, respondents find pdf documents the most convenient to view on mobile devices, following by web pages, voice recordings, and video materials. Surprisingly, only about 40% of respondents found quizzes convenient to take on mobile devices (Fig. 4).

Figure 4. Ease of use of learning content on mobile devices



Source: own work.

Finally, students were asked to indicate barriers of mobile device usage. In general, they listed obstacles of mobile devices utilization in learning that falls in one of the following categories:

- **communication** – inadequate Internet coverage and powering, limited data package (cost of Internet access),
- **human factors** – lack of concentration caused by distraction by other applications (social media, communicators), technology not accepted by some tutors,
- **learning content** – format not adjusted to mobile devices, lack of content responsiveness,
- **device characteristics** – small screen, lack of physical keyboard.

As it was mentioned earlier, the questionnaire contained some of the open-ended questions in which the respondents could share their opinions. From the point of this study topic, it is worth mentioning an observation made by one of the students: "In my opinion, teachers do not see the potential of mobile devices. As these devices are an integral part of the lives of most students, it is worth using them to achieve greater interactivity on the part of students who resort to mobile devices during lectures to kill time" (own translation). It shows clearly the dormant potential and expectations for leveraging mobile technology in providing knowledge.

5. Discussion

The survey results provided the considerable insight into the current patterns of mobile devices usage and their usefulness in knowledge acquisition. It seems that despite the fact that students have mobile devices at hand all the time and use them practically in every place, their application in knowledge acquisition is exceptionally limited. The pattern of this utilisation could be called "passive" as students mainly use mobile devices to check the study schedule or communicate with each other. The reason for this might be the learning materials that are not adjusted to characteristics of mobile devices and that could not take advantage of their full capabilities (continuous access to resources anywhere, anytime, the possibility of an instant feedback). There seem to be the need of developing a new style of learning materials and teaching methods that could rip of the benefits

of mobile devices. This need, clearly seen by students, should be addressed by teachers to take the opportunity to improve teaching effectiveness.

6. Conclusion

The aim of this chapter was to present the results of the preliminary study that concerned the current utilisation of mobile technology in knowledge acquisition by students. The survey, conducted among the students of Cracow University of Economics, Poland, revealed that although they use mobile devices on a daily basis (some of them virtually all the time), they did not use them actively in learning. The most common activity connected with studies was checking the study schedule or communication with other students. Interestingly, students saw that some measures should be taken to incorporate mobile devices into learning process as currently these resources seem to be wasted and related with them possibilities ignored by teachers. However, in order to take the full advantage of mobile devices, new teaching frameworks and learning materials should be developed that could really be adjusted to mobile devices characteristics. In our future research, we would like to develop a comprehensive framework for mobile technology utilization in knowledge acquisition that would incorporate various aspects of learning, namely considering formal and informal learning, monitoring progress of learning, acquisition of tacit knowledge, and tracking of knowledge acquisition that can be carried out with the use of the Experience API – a learning software for recording and tracking all types of users' learning experiences.

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Appendix 1. Survey questions.

1. What type of mobile device do you use?
2. What operating system on your device do you use?
3. Where do you use mobile devices?
4. What are your goals of using mobile devices?
5. What applications do you use?
6. How often do you use mobile devices?
7. What are your goals of using mobile devices in connection with learning?

8. Rate (Very convenient, convenient, neutral, inconvenient, very inconvenient) the convenience of using documents in the following formats on mobile devices
   - Text documents
   - PDF documents
   - E-books
   - WWW pages
   - Slides
   - Video materials
   - Voice recordings
   - Quizzes
9. Evaluate the following statements in connection with mobile technology (strongly agree, agree, neutral, disagree, strongly disagree)
   - Useful in studies
   - Helps in doing assignments
   - Develops learning skills
   - Facilitates access to course materials
   - Increases motivation to do homework
   - Improves communication with other students
   - Improves communication with lectures
   - Allows access to materials regardless of time and location
   - Offers opportunities for communication and group work
   - It can help in efficient access to resources
   - Allows easy access to notifications from teachers and other students
10. Other possibilities of mobile technologies usage
11. Barriers in usage of mobile technologies in knowledge acquisition
12. Gender
13. Study level (bachelor, master)
14. Course of study
15. Comments

Chapter 13

Fostering Transition to Digital Enterprises[1]

Zora Arsovski, Slavko Arsovski, Dragana Rejman Petrović

1. Introduction

Economy is permanently growing towards digital economy in all area (e-commerce, automated vehicles, diagnostics in medicine, social networks, education, etc.). Digital economy now becomes key elements for professional and personal life, governments, and individuals. It is reason why practically all states try to define national digital agendas for boosting economic and social growth. Besides passing several key starting milestones the digital economy has not yet reached own full potential.

In this accelerated trend enterprises do differently. Dominant group of enterprises is still on starting point regard digitalization. This group enterprises dominantly working in "old fashion style", with using of ICT only in part necessary for communication. Business processes are eventually supported in small amount and lack of ICT related knowledge and skills are barrier for broader and deeper using benefits of digital economy. Business models of these groups of enterprises are dominantly resource oriented with individual entry to the market. In each state, especially in industry sector, this group is very big. It is motive for this article – to improve way of digitalization in industrial enterprises in purpose to find a new business model and fulfill its business potential.

National digital strategies and information and communications technologies policy priorities are essential for enterprise digitalization, because enterprise in it could find needed information about existed and future digital infrastructure, characteristics of information and communications technologies (ICT) sectors, government services supported by ICT, digital entities, privacy and security, as well as global challenges, ICT related skills and competences, and so on. Results of impacts of information and communications technologies on added value are different across states. In Korea is more than 10%, *OECD* average amount is cca 6%, in Poland is cca 4%. It is still not energy and each state and all stakeholders must find reason for it. One port of reasons is related to enterprises.

In process of enterprise digitalization each enterprise has to recognise the five key technological trends: (1) internet, (2) outcome economy, (3) the platform revolution, (4) the intelligent enter-

[1] The research presented in this paper was supported by the Ministry of Science and Technological Development of the Republic of Serbia, Grant III-44010, Title: Intelligent Systems for Software Product Development and Business Support based on Models.

prise, and (5) workforce reimagined (*Digital*…, 2017). Based on strategic consideration of these technologies, in each enterprise is necessary to deploy national strategies into own enterprise strategy of digitalization.

Purpose of the paper is to emphasize fast changes of business environment and urgency for digitalization of enterprises as condition sine qua non of sustained success.

The goal of the paper is to develop a new model of enterprise digitalization with including paradigms of business excellence, sustainability, quality, leadership, and change management. This goal is obtained using new methodology based on different methods and techniques, as requirements engineering, system analysis, business modeling, strategic information systems, and theory of constraints, information and communication technologies (ICT) methods, and goals modeling.

The novelty of the papers is related to new methodology with respecting a time of transition, digitalization of permanent innovation, and achieving sustainable competitive advantage. This approach is tested through case study related to Serbian' enterprises.

Results of research are twofold, i.e. theoretical and empirical. The theoretical result is new model for transition to digital enterprise. The empirical result is related to generation of different scenarios for enterprises digitalization.

The article is structured in five chapters. After introduction, in second chapter is presented literature review related to digitalization, business excellence, sustainability quality, leadership, change management, and business model, all related to information and communication technologies. In third chapter is presented base model of transition of "classic" enterprise to digital enterprise, based on application of difference methods, techniques and tools. For testing the model of enterprise digitalization are, in fourth chapter, performed simulation in three enterprises. In firth chapter are presented comments and conclusions.

2. Literature review

In purpose to research a transition of enterprise into digital enterprise is analyzed five groups of references. The first group is related to digital economy and digitalization. The most of references in this area concerns on digitalization on state level or digital transformation on sector levels. So in Tang, Pee & Iijima, (2013) digital transformation emphasizes following steps: (1) identity, develop and launch new, digital business models, (2) set-up a successful corporate venturing business, (3) re-exam every aspect of operations, (4) understand and leverage data, (5) consider increasing your investment, in security, (6) build a high-quotient digital workforce, (7) integrate automatic and on-demand workers info the workforce, (8) establish the right digital traction metrics, and (9) convenience your investors about your digital transformation journey.

Each step in this approach needs leadership, management and professional knowledge and using other resources in enterprise and in business environment. This and other approaches are connected to studies on state levels. In survey The Digital Economy and Society Index (2017) are analyzed the Networked Readiness Index, especially digitization for economic growth and jobs. According The Global Information Technology Report (2013) impact of digitization on Gross Domestic Product was in Western Europe 31.5 billion USD and jobs 0.213 million jobs. For East Europe it was respectively 7.0 billion USD and 0.159 million jobs. Digitization impact on output, productivity, and employment was for manufacturing sector respectively 1.19, 1.79 and less than 1, as percent of total growth. Digitization has also social impact, starting from of improvements of existing enterprises, through new business covered by digitization to flexible working patterns (p. 68).

In The Digital Economy and Society Index (2017) is presented structure of Digital Economy and Society Index (DESI/I-DESI) with five dimensions: (1) connectivity, (2) human capital, (3) use of internet, (4) integration of digital technology, and (5) digital public services with different weights (15% – 25%). For European Union counties DESI (2016) was 0.52 and DESI (2015) 0.50, but the progress in digitalization was slowed. The states with bigger score and growth are Netherlands, Denmark, Austria, Portugal and other. Poland is in opposite quadrant with Belgium, Slovakia, Hungary, Czech Republic and France. This model is appropriate for international aspects, but as approach could be used for enterprise digitalization. Other aspects of digitalization on macro level are presented in articles (OECD, 2015; TERA, 2010; Frey & Osborne, 2017).

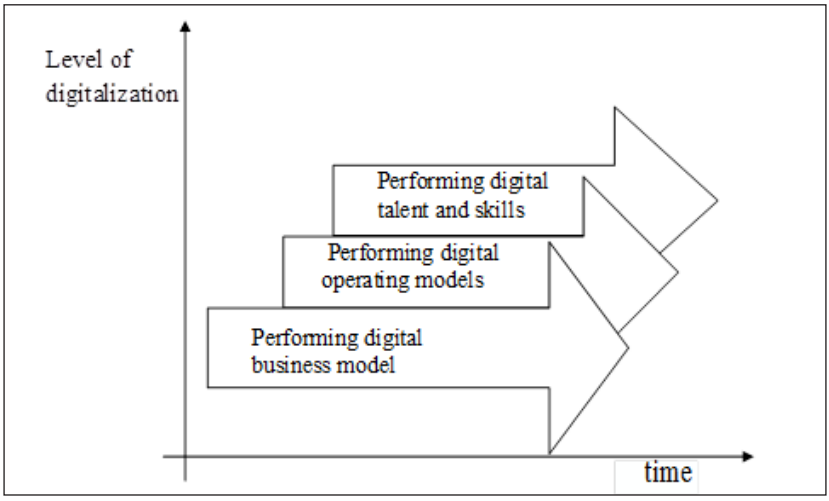
Impact of information and communication technologies on processes and related goals, outcomes and performances is presented in the next text. So in paper (Bala, 2013) is analyzed the effects of information and communication technologies enabled supply chain process change an job and process outcomes. Author stated research model with input variables: (1) perceived supply chain management process complexity, and (2) perceived supply chain management process rigidity. Intermediate variable is perceived change radicalness, and output variables are: (1) perceived job outcomes and (2) perceived process outcomes based on questionnaire technique in one large manufacturing enterprise and two other studies. Using correlation analysis and descriptive statistics author analyzed changes in process complexity and process rigidity, as well as related to change radicalness. He concluded that these impacts exist, but it is not high impact and correlation among variables.

Impact of complexity of supply chain management in cloud environment is analyzed in paper (Bala, 2013).

3. Transformation to digital enterprise

According to Digital Transformation Initiative (2017) this transformation process has five areas of transforming (Fig. 1). The first area is changing existing into digital business model.

Figure 1. Areas of digitalization in enterprises



Source: own study.

At the starting point is innovators dilemma with two opposite solution: entry of new, disruptive digital innovation or focuses on the present state rather than the future. In first case enterprise takes a risk in present, bat in second case takes a risk in future. Pressure to digitalization dominantly leads to data-and technology-enhanced business models. There are none revenue models i.e.: (1) transaction from producer to buyer, (2) capacity leasing, (3) licensing, (4) subscription, (5) commission, (6) advertising, (7) trading, (8) donations, and (9) subsidies. Are thinking process of an existing business model can be performed in three-steps:

1. do not mess with your core business, but despite innovation at the edge of your company, with focusing on new products, services or customer segments,
2. hive black ops/hacking teams,
3. try to copy *Google* related to focussing on big ideas and creating a fast-track partnering programme.

This process has to be supported by organisational culture. Description of existing model can be performed by application of five distinct methodologies:

1. scenario-based design,
2. epicentre-driven design,
3. unorthodox design,
4. customer-centric design, and
5. mirrored design from other industries.

For creating the new business model business leaders could use follow options:

- build in case to cover enterprise's core business,
- baying another company,
- partnership with a digitally native disruptor,
- investing in start-ups, and
- incubate/accelerate.

For large enterprises an active venturing is a crucial strategy.

Performing operating models covers introducing a digital operating model or adapting new technologies to find operational efficiencies. For this view technology is not just cost, it is means to satisfying the goals. A new technologies based on: (1) sensors, (2) RFID/near field communications, (3) machine-to-machine communications, (4) robotics, (5) 3D printing, (6) drones, (7) blockhead and crypto currencies, (8) virtual and augmented reality, (9) artificial intelligence/cognitive computing/machine and deep learning results of application of these technologies are impressive (Digital Transformation Initiative, 2017), and enterprise's leaders don't may regret digital capabilities, especially following capacities:

- sense and interpret disruption,
- experiment to develop and launch idea faster,
- understand and leverage data,
- build and maintain a high-quotient digital team,
- partner and invest for all noncore activities,
- organize for speed, and
- design a delightful user experience.

In time of acceleration of business change is necessary to introduce flexible operating models which deliver:

- greater flexibility,
- lower profit volatility in case of high-fixed costs,

- higher cost savings driven by operating at scale within investing.

Using previous approach is possible to recognise five digital operating models:

1. customer centric, with introducing a quality approach,
2. extra-frugal, with high quality of products at a low costs,
3. data powered, with agile culture based on data as base for innovation and experimentation,
4. sky net, with engineer led, culture dedicated to automatization,
5. open and liquid, with flow of dialog with environment.

To ensure a supportive is necessary starting with the Chief Digital Officers (CEO), as in quality paradigm. Besides number of Chief Digital Officers (CDOs) is quadrupled between 2012 and 2014, they are not in change in cca 60% of enterprises.

In all previous approaches, a new business model for digital enterprise is based on introduction of ICT. For purpose of very quick response to market, is evident move to multi speed IT operations. For creating a multi-speed IT enterprise are recommended (*Digital*…, 2017) four key actions:

1. recognise the business need for different speeds of IT use,
2. employ multiple governance and operating methods,
3. rethink architecture needs,
4. invent the new *IT* organization.

3.1. Digital talents and new skills

The third area of digitalisation in enterprises is related to digital talent and new skills. For it is crucial attracting and retaining talents in the digital age. Young talents are new population, with habits to work with digital assets. They have new requests and enterprises must find strategy to recruit them, retain in next years and continuously upgrading their knowledge. A digitalization of enterprises becomes good chance for millennia's. They prefer, according World Economic Forum survey, career advancement (48%), company culture (38%) and training, development opportunities (32%). For the future a new job roles are different in areas of commercial, technology, web, marketing, facilitation, human resources etc. For each enterprise digital job competency is different for each role. An example, for chief data office most important are competences for: (1) big data, (2) management/leadership, and IT infrastructure.

Leading and fostering transition to digital enterprises are imperative in digital age, as answer on permanent and rapid changes. New roles of leaders are:

- creator of vision and vision,
- strategic planner,
- driver of information-based business models,
- enabler of the shift to on-demand operating models,
- innovation promoter,
- operational excellence driver.

Leaders in digital enterprises must: (1) recognise and create environment where humans and machines can work successfully together, (2) prepare for the rise of the on-demand workforce with digital skills, (3) fostering a digital culture in the enterprise. It is realised in four key areas:

- communication,
- journey management, and
- make changes visible.

3.2. Measuring the success of digitalization

For digital business traditional financial key performance indicators are no longer effective, because fewer than 15% of enterprises con quantity the reform of investment in digitalization. According World Economic Forum/Accenture a digital traction metrics covers:

1. scale (number of visitors, unique users, number of registered users, MOM i.e. month-on-month growth in registrations, organic user acquisition,
2. active usage (number of active users, daily active users-DAU, monthly active users-MAU, ratio of new users to repeat users/customers, number of repeat users (customers, conversion rate, abandon rate),
3. engagement (net promoter score-NPS, customer satisfaction index-CSI, downloads, cohort retention on metrics for that business, time on site, bounce rate, source of traffic, customer concentration risk, churn/exit rate, posts contributed, photos/videos uploaded/shared and views completed, number of likes and shares.

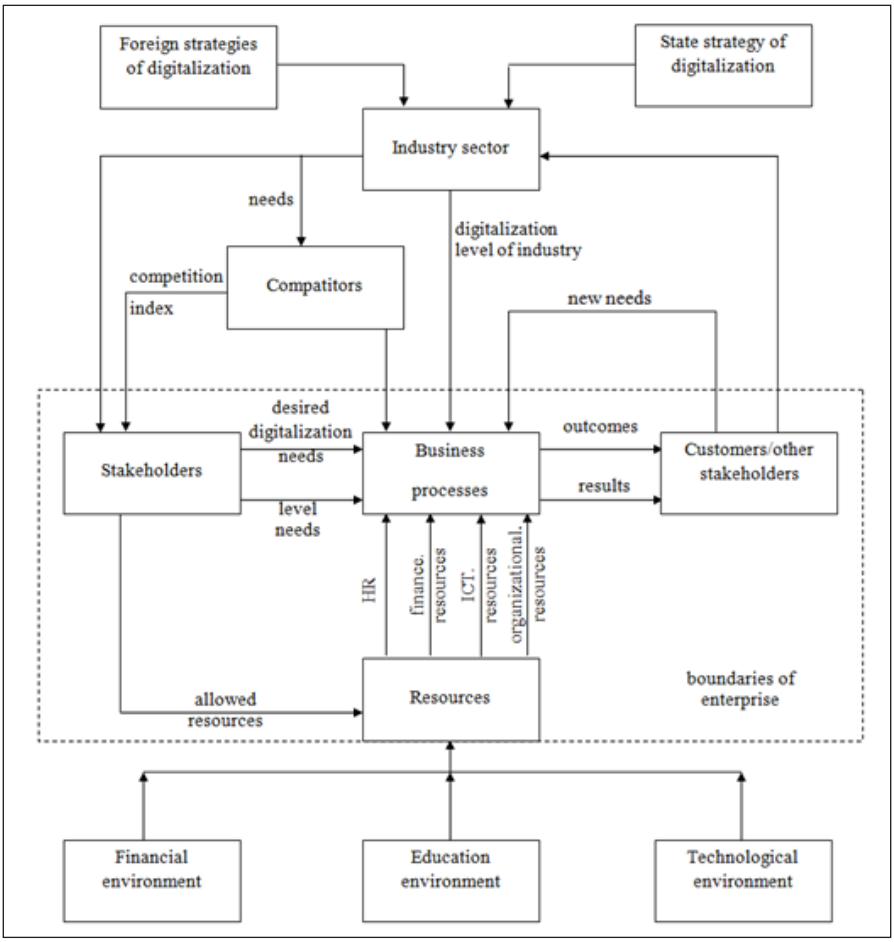
For purpose of monetization of digitalization process, a success of digitalization covers additionally:

- cost to acquire a typical customer (CAC),
- lifetime value of a typical customer (LTV),
- ratio of LTV/CAC, and
- months to recover CAC (CAS/average monthly recurring revenues-a rule is to be less than 12).

Analogue to DESI/DESI (Digital Economy and Society Index) is also possible to measure progress of digitalization of enterprise. This index is composed from five dimensions (connectivity, human capital, use of internet, integration of digital technology, and digital public service) and 30 indicators. The next approach to digital globalization comes from McKinsey & Company with using Cobb-Douglas production function and two steps error correction model (ECM) in GDP growth.

With including aspects of complexity, risks, change, quality, sustainability, and business excellence (Aleksić et al., 2013, 2014; Arsovski, Arsovski & Mirović, 2009; Arsovski et al., 2017a), the base model is presented in Figure 2.

Figure 2. Base model of enterprise digitalization



Source: own study.

In central part is enterprise with stakeholders needs and desired digitalization level, as inputs. Also, inputs are available human resources, financial resources, ICT resources, and organizations resource. On the upper side are competitive level of digitalization and digitalization level of industry, as control inputs. The outputs (outcomes and results) are level of digitalization impact on customers/other stakeholders. Outside from enterprise are financial, education, and technological environment, competitors, and industry sector.

For further improvement of this base model is necessary to define:

- competitive level of digitalization and competition index,
- desired digitalization level,
- amount of investment in resources,
- outcomes measures,
- metrics for assessment of enterprise digitalization.

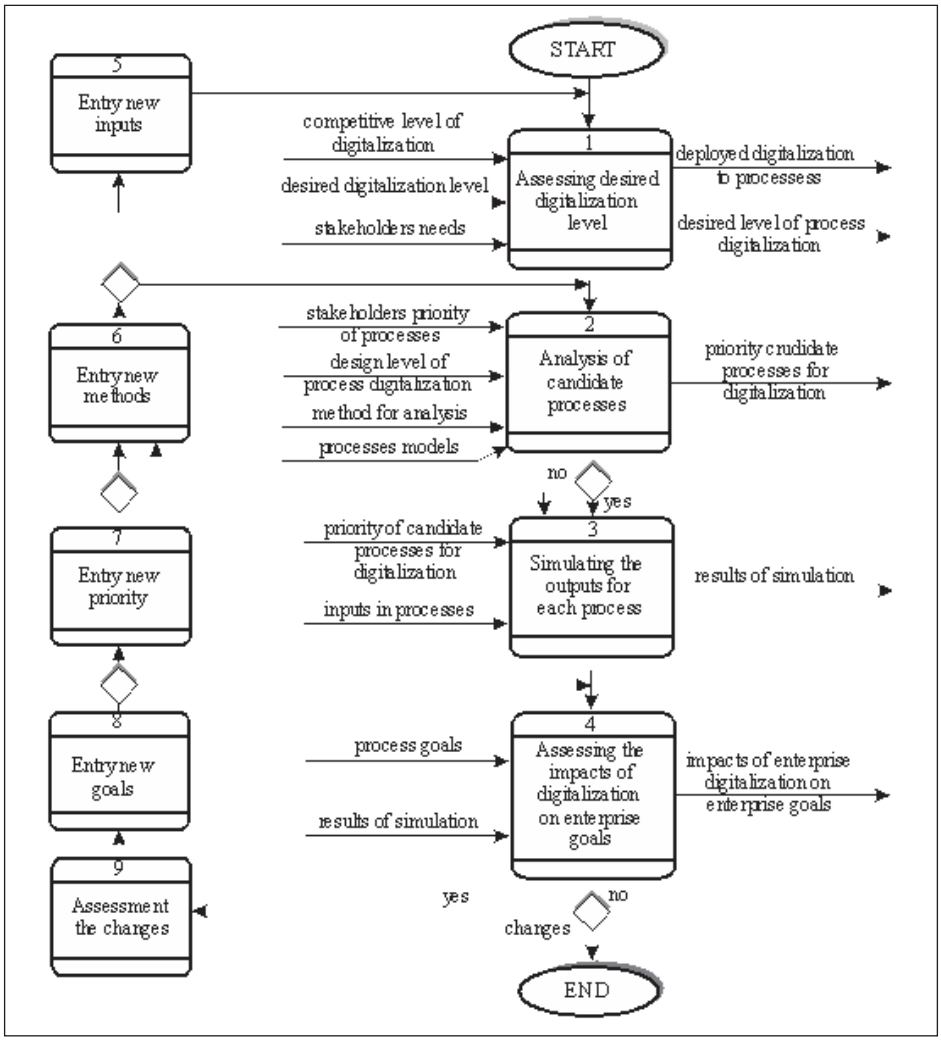
Competitive levels of digitalization and competition index are inputs in business processes and stakeholders analysis. Stakeholders on basis of information of digitalization of industry sectors in state or in foreign states make decision about: (1) desired level of digitalization and (2) needs and request for digitalization of business processes. They also give inputs for leadership and management. According APQC (2016) a business processes are structured into 12 groups:

1. Develop vision and strategy,
2. Develop and manage products and services,
3. Market and sell products and services,
4. Deliver products and services,
5. Manage customer services,
6. Develop and manage human capital,
7. Manage information technology,
8. Manage financial resources,
9. Acquire, Construct and manage assets,
10. Manage enterprise risk, compliance, remediation and resiliency,
11. Manage external relationships, and
12. Develop and manage business capabilities.

For each business process is possible to define performances, existing and desired level of digitalization (Arsovski et al., 2009, 2012, 2015, 2017b; Arsovski, Arsovski & Nikezić, 2012). Each of business processes in enterprise can be analyzed according business process management approach (BPM) and assess impact of digitalization on output performances (Nestic et al., 2015a, 2015b).

In Figure 3 is presented methodology for assessing of processes on digitalization.

Figure 3. Methodology of process digitalization for assessing the impacts on enterprise goals



Source: own study.

The first step in this methodology is assessing digitalization level of enterprise on the basis of inputs: (1) competitive level of digitalization, (2) desired digitalization level, and (3) stakeholder needs and new inputs from close-loop. All these inputs are in form of values (numerical or attributive, depends on used methods for further analysis). In this step is performed deployment of needed digitalization from enterprise as whole to each business process. This is possible to obtain using different approach as policy deployment on key processes, Hoshin Kanry, Fuzzy sets etc. Authors methodology is based on policy deployment enterprise on key processes (Arsovski, 2016). Outputs of this step are: (1) deployment of enterprise digitalization on process digitalization, and (2) desired level of process digitalization.

The second step in this methodology is analysis of candidate processes from view of digitalization. The outcome of this step is priority of candidate processes of digitalization.

The third step is simulating the outputs for each candidate process. The outcomes of this step are results of simulation.

The fourth step is assessing the impacts of process digitalization on enterprise goals. The outcomes of this step are impact of digitalization (processes and enterprise) on enterprise goals.

If it is not necessary to make change the methodology is ended. In opposite cases, is necessary to conduct activities presented on left side of Figure 3.

4. Model of process and enterprise digitalization

After analysis of literature about digitalization of processes and enterprises are high lightened variables:

- digitalization level of industry (V1),
- competition level for business operations of enterprise (V2),
- competitive level of digitalization, based on benchmarking studies (V3),
- level of stakeholders needs (V4).

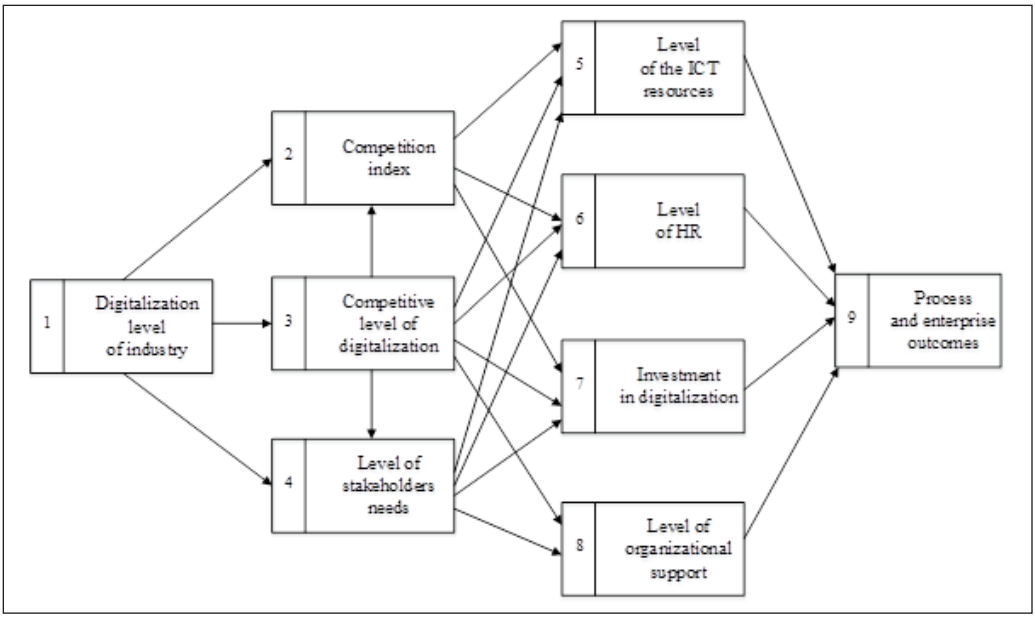
All previous variables are constructing based on relationship between enterprises and business environment (market).

On the level of each enterprise are variables:

- level of the ICT resources (V5),
- level of Human Resources (V6),
- level of investments in digitalization (V7), and
- level of organizational support for digitalization (V8),
- dependent variable in this model is processes and enterprise outcomes (V9).

In Figure 4 is presented base model of digitalization's impact on process and enterprise outcomes. For defining each of variables can be used different approaches. Digitalization level of industry is generally one assessment, but each enterprise has different assessment because different sectors or sub-sectors. Also, competition index is different for each industry, sector, or sub-sector or for each enterprise against rivals. A competitive level of digitalization is also different view of each enterprise, because it depends from existing level of digitalization and strategic view on areas of competitivity. A level of stakeholders needs is also different for each enterprise. An analog analyze is for variables V5, V6, V7, V8, and V9.

Figure 4. Base model of digitalization's impact on process and enterprise outcomes



Source: own study.

For each variable in base model is defined appropriate metrics and on scale 1÷5 defined level of performance.

Competition index is calculated based on weights of elements of competition In this case weight for each element of competition is chosen to be same (0.25) and weighted assessment of competition is calculated as mean value of competition elements. On similar way is defined and calculated all variables in model. The base for it is appropriate analyze for each enterprise, based on enterprise data and expert analysis.

In the model of variable V5 the difference between original a simulated values is very small and R test pointed out that R= 0.94561. It means that 94.561% of variable is predicable.

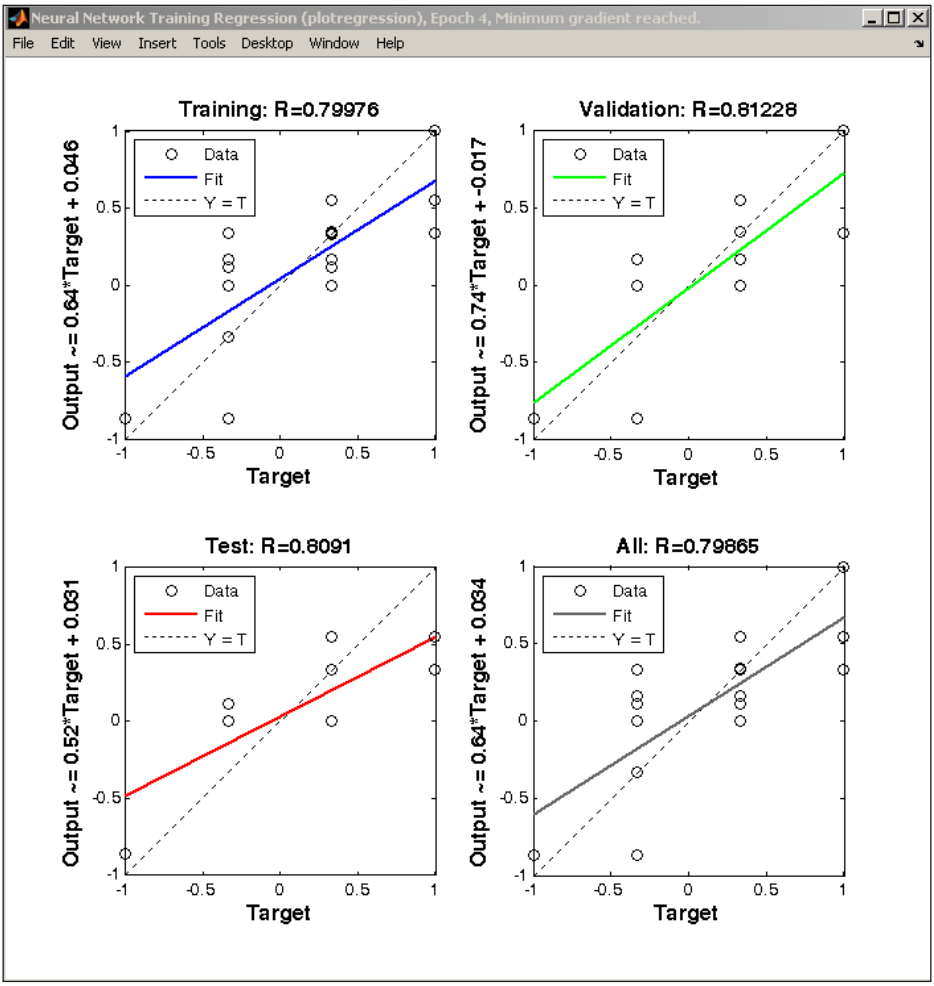
In the case of variable V5 the amount of predictability is smaller but it still high (R=0.61239).

Better prediction was for variable V6 (R= 0.61762) and variable V7(R= 0.74101).

For variable V8 the prediction was much less than previous variable (R= 0.34129). That implies to upgrade this model with added impacts and broader structure.

In Figure 5 is presented model of variable V9 – process and enterprise outcomes. Result of simulation of variable V9 is very impressive because R test pointed out very high level (R = 0.8091). That means the proposed model is proved.

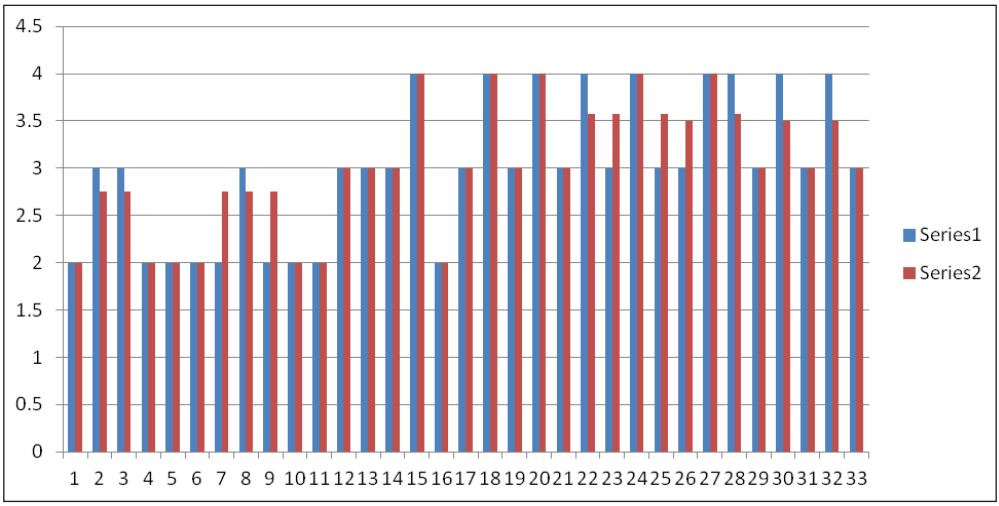
Figure 5. The model of variable V9



Source: own study.

In Figure 6 is presented original and simulated values of variable V9 for all enterprises in sample. For most enterprises the difference between them is small.

Figure 6. Original and simulated values of variable V9



Source: own study.

The final simulation is related to variable V9. In this case the key outcome variable is extremely good simulated (R = 0.9623), and for each enterprise is similar value based on input data and simulation result.

5. The model verification

Model verification of digitalization of processes and enterprise as whole is performed by using Artificial Neural Network (ANN). For sample of 33 enterprises (12 small, 11 medium, and 10 big) are calculated values of variables. An input variable in the model is V1. For variable V2 for sample of 33 enterprises is tested compliance between target and output value. It is extremely good (R = 0.94561). So, values of V2 are possible to explain with proposed model with impact of V1 and V3.

On the same way is less explainable (R = 0.61239). Results of simulation of variable V5, variable V6, variable V7, and variable V8 with R = 0.8091 are much beter against previous results.

In the next step is analyzed situation of verification of model sensitivity. If we suppose that V1 and V3 have same values as previous, and suppose that planed values of variables change for next period are:

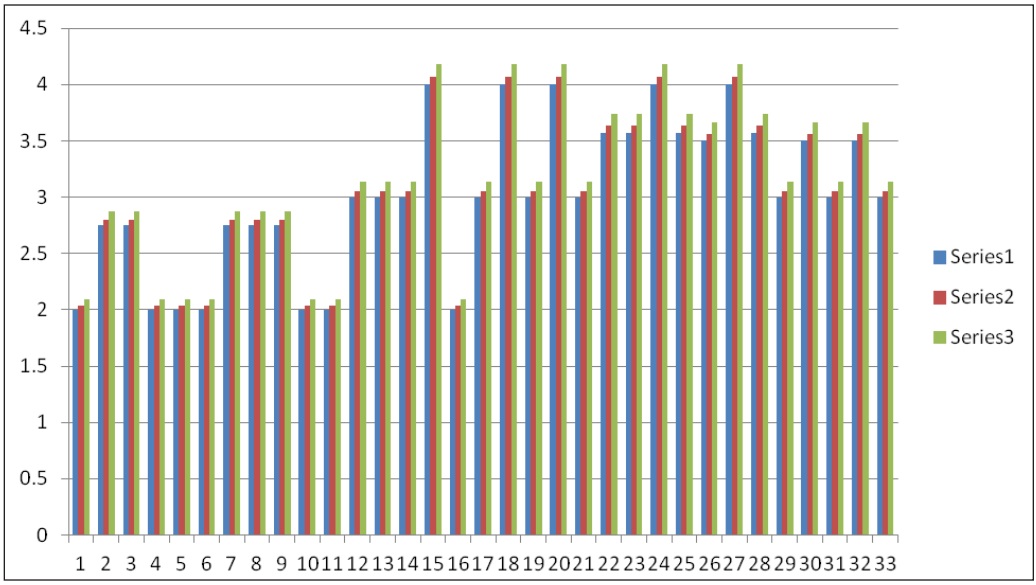
- V2: 2%,
- V4: 3%,
- V5: 2%,
- V6: 4%,
- V7: 5% or 10%,
- V8: 2%,
- V9: 3%.

We calculate expected growth of variables V2, V4, V5, V6, V7, V8, and V9 with two scenarios of V7 growth (5%, or 10%). In all cases we can see that differences between planned and simulated

values of enterprise business performances outcomes. In case of growth of V7 for 5% difference in V9 is less for 1.17% of planned value, and in case growth of V7 for 10%, outcome is greater than planned value for 1.59%. It also point out that for enterprises in the some industrial sector or sub-sector, on the basis of sample is possible to develop overall strategy of digitalization for different sectors.

In the Figure 7 are presented values of variable V9 with three series. The first series is related to original data of variable V9. The second series is is related to planned change of variables (V7 = 5%), and in third series is planned value of V7 of 10%.

Figure 7. The original and expected values of variable V9



Source: own study.

Based on changes of variables can concluded that variable V9 increased but amount of increased is relative small for each enterprise in sample.

6. Conclusion

Digitalization of processes is one of a key enablers of fostering transition of enterprises into digital enterprises. Areas for digitalization different and optimal area depend on business model and business strategy. In some cases it is based on digital operating model (higher level) and highest level of digitalization is established with performing digital talent and skills.

According base model for digitalization of enterprises is necessary, educational, and technological to distinguish level of industry sector, enterprise flows, and financial environment. Inputs in the model come from global and local environment, stakeholders and customers.

In methodology for assessing the digitalization impact on enterprise foals are recognized four basic steps and five added steps in case to include specific situations. According this methodology is developed base model of digitalization impact on processes – and enterprises outcome.

Using artificial neural networks (ANN) on sample of 33 enterprises is performed two cycle simulations. Using the first simulation is proved base hypotheses about impact of digitalization processes on business outcomes. Using the second simulation is proved robustness of proposed model.

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Chapter 14

Supporting Independent Living of the Elderly through ICT: A Review of Available Solutions[1]

Ewa Soja

1. Introduction

Europe has a rapidly ageing population because of an increased longevity combined with falling fertility. According to UN projections (United Nations, 2017), the share of people aged 65 years and more will increase from 2015 year to 2045 by about 9 percent. At the same time, the potential labor resources in group age 20-64 years will fall by 8 percent. This will cause a demographic crisis: a strong increase in people no longer working, often in need of long-term health and social care, combined with an imbalance between active and inactive people and a lack of (formal and informal) caregivers (European Commission, 2015).

Information and communication technology (ICT) is a critical component of the contemporary world, offering a wide range of potential benefits in the field of healthcare. ICT solutions can enable integrated person-centered care, with more focus on prevention and early detection and independent living, provided in the own work and home environment (e.g. Soja & Soja, 2015a; Kubitschke & Cullen, 2010). This situation should help in realizing the idea of active and healthy ageing (e.g. Walker & Maltby, 2012).

The general goal of this paper is to investigate the need for informal care and possibility of using ICT to enabling older people to continue to live independently with functional limitations. The paper starts with the discussion about issues related to elderly long-term care in the context of ageing populations of European countries. Then, it examines the potential of ICT for promoting and supporting independent living of older people. The last section includes discussion with concluding remarks.

2. Health and Informal Care of the Elderly in the Context of Ageing Populations in Europe

The demand for healthcare goods and services depends on the number of people in need of care. This depends not only on the size of the population but also on the health status of the population, which

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is linked to the age and gender structure of the population and notably with the share of elderly people in the overall population. Table 1 shows the percentages of the population aged 50 and over in 16 European countries in 2015 and their expected value in 2045 (United Nations, 2017). These countries were chosen because they, together with Poland, participated in the international SHARE project (wave 4, 2011-2012 years). The SHARE Survey (Survey of Health Aging and Retirement) is conducted in European countries and focuses on people aged 50 and over. Its purpose is, among other things, to create a database of micro data combining information on demography, epidemiology, economics, psychology, and sociology. The SHARE database allowed us to estimate the percentages of people aged 50 and over who need long-term care, as well as the percentages of people who provide or need informal support.

Table 1. Percentage of people aged 50-64 and 65 and more in 2015 and 2045

	2015	**2045**	**2015**	**2045**
	50-64		**65+**	
Austria	20.5	20.1	18.8	29.6
Belgium	19.9	18	18.1	26.1
Czech Rep.	19.5	20.1	18	28.7
Denmark	19	17.3	19	24.9
Estonia	20	20.9	18.8	27.4
France	19.2	16.5	18.9	26.5
Germany	22.1	20	21.1	30.2
Hungary	20.4	20.7	17.5	27.2
Italy	20.9	17.2	22.4	34.6
Netherlands	20.5	18	17.9	27.6
Poland	**20.9**	**23.6**	**15.6**	**28.5**
Portugal	20.3	18.7	20.7	34.4
Slovenia	21.8	19.3	18	31.2
Spain	19.9	17.5	18.9	35.2
Sweden	17.9	18.5	19.6	24.1
Switzerland	19.9	19.3	18	27.7
min	17.9	16.5	15.6	24.1
max	22.1	23.6	22.4	35.2
Me	20.15	19	18.8	28.1

Source: own elaboration based on (https://esa.un.org/unpd/wpp/DataQuery/).

According to UN projection (United Nations, 2017), the percentages of people aged 65 and over will increase in all countries. The median value of the share of population aged 65 and more years will increase by about 9 percentage points between 2015 year and 2045 year. In Poland, this percentage will rise by almost 13 pp. In the case of the group of people aged 50-64 years, growth is expected only in five countries (Czech Rep., Estonia, Hungary, Poland, and Sweden). In other countries, a slight decline is expected. This shows that the potential share of older people in need of help will increase, and that the participation of informal caregivers at a younger age (50-64 years) will remain at a similar level.

Long-term care is by uniform definition of international institutions (OECD, Eurostat, WHO) defined as a range of services required by persons with reduced degree of functional capacity (physical or cognitive) and who are consequently dependent for an extended period of time on help with basic and/or instrumental activities of daily living (ADL). Basic ADL activities or personal care ser-

vices are frequently provided in combination with help with basic medical services such as nursing care, prevention, rehabilitation or services of palliative care. Instrumental Activities of Daily Living (IADL) or assistance care services are mostly linked to home help (European Commission, 2015).

Changes in the size and structure of families and households, which consist in reducing the families' size and verticalization of relations, denote that aid will be especially important for the elderly provided by relatives and unrelated persons (e.g. Kurkiewicz & Soja, 2015; Stypińska & Perek-Białas, 2014).

In Table 2 we present the percentages of people in group at age 50 years and more who experience difficulties with activities of daily living. Measurement of difficulties of everyday life has been adopted according to the recommendations defined in the SHARE project. The measures ADL cover the following limitations related to everyday activities: dressing; walking across a room; bathing or showering; eating, such as cutting up food; getting in and out of bed; and using the toilet, including getting up or down. The indicators IADL, in turn, cover the following activities: preparing a hot meal; shopping for groceries; making telephone calls; taking medications; and managing money (Guide to easySHARE release 1.0.0, 2013). Anyone who is experiencing even one from the abovementioned limitations was included in the appropriate type of group of people with difficulties of everyday life (ADL or IADL).

Percentages of people experiencing difficulties of everyday life in a group aged 50 and more in the selected countries range from 6% to 18% for ADL and from 4% to 17% for IADL. Poland is one of the countries with the highest proportion of people requiring long-term care.

Table 2. Percentages of people in the group aged 50 and more who are experiencing difficulties of everyday life and who are receiving help or giving help

	ADL	**IADL**	**Received help from outside the household**	**Given help to others outside the household**	**Given help to someone in the household**
Austria	10.8	8.8	17.6	21.2	4.8
Belgium	16.0	11.7	19.8	35.6	6.4
Czech Rep.	10.1	8.6	30.0	30.7	7.0
Denmark	7.7	7.7	29.4	45.9	4.3
Estonia	17.1	13.5	22.4	23.9	7.4
France	13.2	10.3	15.3	25.5	6.4
Germany	13.7	9.2	20.9	27.2	6.7
Hungary	13.1	16.6	16.2	22.2	7.9
Italy	10.9	9.3	14.1	22.5	9.3
Netherlands	7.3	7.5	17.7	34.2	5.6
Poland	**18.0**	**14.0**	**13.2**	**17.1**	**7.5**
Portugal	17.8	13.8	12.7	16.7	10.0
Slovenia	10.6	8.2	9.5	15.4	6.1
Spain	14.8	12.4	14.6	12.6	9.6
Sweden	11.4	8.0	16.8	36.6	3.7
Switzerland	6.3	4.4	12.8	27.2	4.1
min	6.3	4.4	9.5	12.6	3.7
max	18.0	16.6	30.0	45.9	10.0
Me	12.2	9.2	16.5	24.7	6.6

Source: own elaboration on the basis of SHARE (wave 4).

Informal support for the people aged 50 and more refers to non-financial help received from any family member from outside the household, any friend or neighbor. This support concerns personal care (e.g. help with dressing, bathing, eating, getting out of bed, and using the toilet), practical household help, and help with paper work such as settling financial or legal matters. The percentage of people receiving this kind of help varies widely and it ranges from about 10% to 30%. The value for Poland (13.2%) is below a median value (16.5%).

Given aid to others outside the household means that someone has personally given aid to any family member from outside the household, any friend or neighbor. Help in this context incorporates personal care (e.g. help with dressing, bathing, eating, getting out of bed, and using the toilet), practical household help, and help with paper work such as settling financial or legal matters. The considered countries vary considerably in terms of this type of aid. The percentages of caregivers range from about 13% to 46%. Poland (17.1%) is one of the countries with the lowest participation of people helping others in this way. In the case of assistance provided in own household, this situation is reversed. In Poland, we have a relatively large number of households in which family members look after the people living with them. This kind of aid includes personal care (e.g. help with dressing, bathing, eating, getting out of bed, and using the toilet).

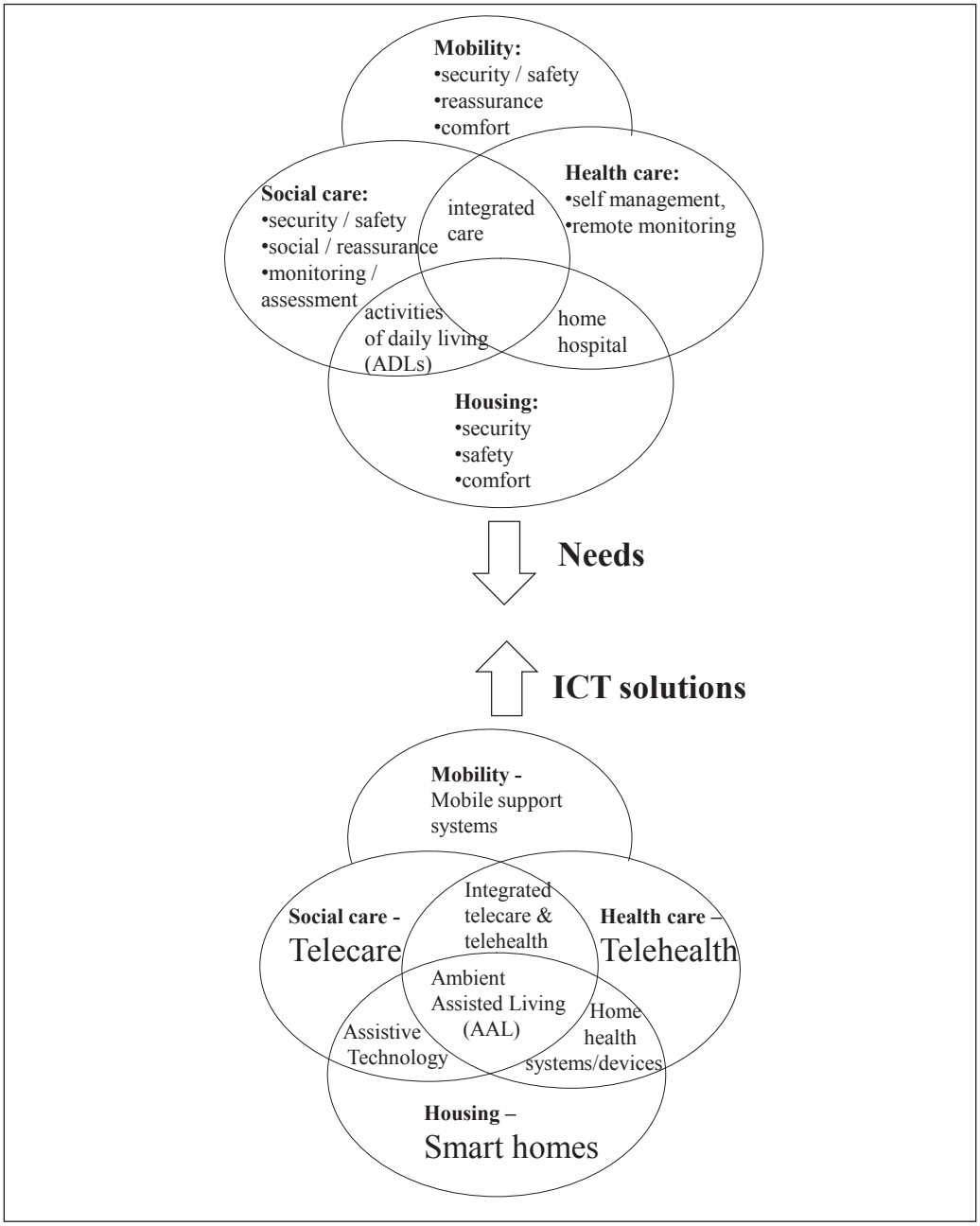
It should be noted that the values we have estimated are intended to indicate the scale of the problem of elderly care. In order to more accurately assess the needs of long-term assistance, the results should be further triangulated by using other databases, for example EU-SILC (Survey on Income and Living Conditions).

3. ICT Solutions for an Ageing Society

To counteract the effects of an ageing population and to close the gap between growth in long-term care needs and stagnant or shrinking resources, various strategies and polices are now being developed (e.g. Walker & Maltby, 2012). The policy of the European Commission focuses on enabling older people to continue to live independently with functional limitations, raising the productivity of care delivery and reducing the incidence and prevalence of frailty and disability. The particular attention is paid to ways of increasing the capacity of people to live independently even when they are frail or have contracted multi-morbidities. These include a more age friendly environment and ICT technologies to increase the older people's functional capacity, and also raising the productivity and quality of long-term care delivery (European Commission, 2013a, 2013b). In this context, ICT solutions could play an important role by helping older people to live independently for longer at home, improving their quality of life and health, providing more qualified care, and improving the cost-effectiveness of public spending in long-term care (e.g. Soja & Soja, 2015a; Billings et al., 2013; Carretero, 2014).

Kubitschke and Cullen (2010) have developed and proposed a framework that identifies and connects the areas of needs for homecare and independent living with the corresponding ICT solutions. However, they pointed out that these ICT applications can support other domains, including more general social inclusion of older people in everyday social life and fostering active ageing in the context of work and employment. This framework is presented in Figure 1.

Figure 1. Framework for different areas of needs and relevant ICT solutions



Source: own elaboration based on (Kubitschke & Cullen, 2010).

ICT solutions have been organized in terms of three main clusters: telecare, home telehealth, and smart homes. A new cross-cutting element, Mobility, was added to provision of mobility services and supports. These three main clusters of solutions correspond to three core service domains: social care, health care, and housing.

The term "telecare" is used to refer to provision of social care from a distance supported by telecommunications. These ICT solutions are based on an evolution of the traditional "social alarm" model. The following solutions can be distinguished (Kubitschke & Cullen, 2010):

- first-generation telecare: uses a simple telephone unit and a pendant with a button that can be triggered when help is required by the user; monitoring centre systems receive the call and identify the caller and their address; initial diagnosis of the nature and urgency of the need can be explored by voice link; nominated response personnel (informal or formal carers) are alerted as required by the situation, following an established protocol,
- second-generation telecare: this adds a "passive" or automatic alarm dimension (no need for the older person to actively trigger the alarm) enabled by the implementation of sensors such as smoke, fire and flood detectors, among others, in the older person's home; when activated, these trigger an alert to the call centre and initiate the necessary response,
- third-generation telecare: these are a more advanced type of telecare service, which collect everyday activity data automatically through various sensors such as front door open/close detectors, fridge open/close detectors, pressure mats, bed/chair occupancy and electrical usage sensors; data is presented to care personnel or family carers to monitor wellbeing and assess the need for help and support.

Broadly understood telehealth delivers services from a healthcare provider to a citizen, from one health professional to another, or between citizens and family members. In the field of health of long-term care needs, home telehealth refers to a range of support, typically including not just clinical monitoring and intervention, but also a broader range of homecare support that more traditionally falls within the scope of social/homecare services (Stroetmann et al., 2011).

The field of Smart homes and assistive technologies covers a broad range of "domotics" technologies and applications, from standalone devices that address particular needs (such as communication devices), through various types of environmental control system to fully integrated smart homes (Kubitschke & Cullen, 2010). Smart homes include remote-controlled home automation systems, which have various sensors (e.g. for doors, microwaves, lighting), and an on/off switch for various appliances and home entertainment. The ICT components are programmed to react and communicate with each other through a local network, and with the surroundings via the Internet, telephone lines or mobile phones. The technology can be used to monitor, warn and carry out functions according to selected criteria. Assistive technologies include devices and equipment that compensate for sensory, physical/mobility, and cognitive impairments (e.g. voice recognition software, speech recognition) (Carretero, 2014).

4. Conclusion

A large number of solutions in the field of ICT for an ageing society have already been designed. However, until now, this industry development has been small-scale, particularly in Europe. Only few such ICT solutions are on the market and are used by the elderly, their caregivers or professional caregivers. Practitioners and researchers indicate different barriers to deployment

of ICT solutions for healthy ageing (e.g. Porcari et al., 2015). We suggest that these barriers can be divided into two groups.

The first group comprises the "classical" barriers such as costs, complexity for implementation, and lack of fit. The problem with costs is very difficult because there is still a lack of information and robust studies on the effectiveness and efficiency of these technologies. This, in turn, generates obstacles to public and private investment to implement solutions on a wider scale (Carretero, 2014; Porcari et al., 2015).

The second group consists of barriers associated with the development of the digital society. These are, among other things, limited awareness about the potential benefits of such technology, lack of appropriate digital skills, and new ethical concerns (e.g. Soja & Soja, 2015b; Kolkowska, 2016). The problems with new technologies are primarily a concern for older people who need particularly strong motivation to start using ICT solutions (Wagner, 2010). Moreover, professional caregivers also are reluctant to new technologies, mainly because such ICT solutions require gaining new competences and adapting to new working conditions (Carretero, 2014). Ethical issues reflects on, among other things, such concerns as: the lack of transparency that may be brought to the work of healthcare professionals and its effects on the doctor/patient relationship, the difficulty in respecting privacy and confidentiality when third parties may have a strong interest in getting access to electronically recorded and stored personal health data, and the difficulty in ensuring the security of shared personal health data (Kubitschke & Cullen, 2010).

The issues presented in this paper illustrate, on the one hand, the growing need for elderly long care as a result of ageing populations. On the other hand, the findings show the potential of ICT solutions to promote and support independent living for older people. However, in order to make use of such solutions on large scales, further interdisciplinary research and cooperation between practitioners and researchers are needed.

In the context of Polish economy, an important direction for future research refers to the role of a country's level of economic development while implementing the ICT solutions. In this context, prior research indicates that countries such as Poland might experience different ICT adoption-related considerations than highly developed countries (e.g. Soja & Cunha, 2015). An interesting research question in this respect is connected with the idea how less developed economies might efficiently use ICT-related solutions while addressing the problem of population ageing.

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Chapter 15

Password Selection in Computer Systems – A Comparison of the Results of Research Conducted in 1998/1999, and 2016[1]

Jan Madej

1. Introduction

Presently, the need for using passwords and codes, indispensable to operating various devices, programs, accounts and services, is greater than ever. Practically, everybody uses PIN codes or passwords. Passwords are not the only methods for access protection, but they are most commonly used because of their ease and low costs of implementation. Unfortunately, the weakness of the method results from the risk of the unauthorised use of leaked passwords.

The paper presents the issue of computer access control based on the use of passwords, referring to the results of research studies conducted in 1998/99, and in 2016.

The 1998/99 study aimed to analyse the ways in which inexperienced users create passwords. The objective of the study conducted in 2016 was to describe changes in user attitudes to creating passwords in the period of nearly 20 years. The reasons for undertaking this area of research include the greater need for password protection in an increasing number of devices and services, the increased number of reported cases of password weaknesses, as well as the cases of threats posed to password security in computer systems.

Apart from the use of password generators[2], password storage programs[3], "third service" authentication (e.g. Facebook, Google, and Yahoo), or the possibility of retrieving passwords (by email or SMS), the increasing number of passwords to be remembered by users, and the need for their transfer between various devices (smartphones, laptops or desktops) increase the complexity of the selection and protection of passwords. Such incidents as the theft and leak of more than 400 million passwords from MySpace (Whatsmypass, 2016), and over 100 million passwords from

[1] The publication was financed from the statutory research funds of the Department of Computer Science of the Cracow University of Economics.

[2] e.g. https://identitysafe.norton.com/password-generator/.

[3] e.g. Dashlane, https://www.dashlane.com/.

LinkedIn (Whatmypass, 2015), as well as the rankings of "worst passwords" published by SplashData provide information on the cases of weak user passwords for protecting specific services[4].

Because users find it difficult to remember their passwords, which is confirmed by the fact that 2/3 of them could not remember a long or complex password at least once in the past two years (Ponemon, 2013), nearly half of them use the same password to access most internet services (Ofcom, 2016). One third of e-banking users (36%) do not change their password more frequently than once a year, or they do not remember if they ever do it (PasswordResearch, 2014a). Nearly half of users (43%) do not change their access password to private emails in the period of more than one year, or they do not remember if they ever do it (PasswordResearch, 2014b). A similar percentage of corporate users (44%) use passwords which do not exceed 8 characters (Trustwave, 2015). All the above considerations confirm the significance of issues related to password selection and protection.

2. Password selection and protection, and password security attacks

Throughout the period of operating and protecting computer systems with the use of passwords, no significant changes have been recorded in the area of protection systems and security attacks (see: Hoffman, 1977; Stallings, 1997; Michalczyk, 2013). Attacks remain the same: *sniffing*, cracking a file with passwords, the use of viruses, watching a user while he/she enters a password, the use of insidious techniques), or *guessing* (e.g. through comparing them with a dictionary of possible passwords, created on the basis of users' data − so called *dictionary attack*, or creating all possible passwords − *brute force attack*).

On the other hand, the general guidelines for data protection in computer systems based on passwords include the following:

- an appropriate selection of user passwords,
- supervision of the system over the use of passwords,
- the user's concern with the security of passwords.

The above guidelines are briefly discussed below.

An appropriate selection of user passwords is a significant component of the entire protection system. Frequently, password users underestimate hackers' abilities, or they assume that strong passwords are not worthwhile if the hidden information is of no significance, so no attacks will be attempted (and even if it happens, the resulting losses will not be so harmful). This is the wrong attitude − any attempt to break into a user account is likely to lead to further attacks. A person who is convinced about the need for selecting an appropriate password is able to create a stronger password that is also easier to remember.

A strong password should have the following characteristics:

- an appropriate length (a minimum of 8 characters),
- contain both small and capital letters,
- contain digits and additional signs (e.g. "!", "+", "["),
- easy to remember,
- easily entered from the keyboard (preventing insidious activities).

[4] For example, the following passwords are among the top ten worst password SplashData rankings: "123456", "password", "qwerty" (Teamsid, 2015).

Moreover, passwords should not include the following:

- own and relatives' and friends' first and last names,
- dates of birth, nicknames or patronymics − own or the above mentioned persons' data,
- personal details (address or hobby),
- names of pets,
- phone numbers, vehicle plate numbers and other identifiers,
- names of favourite personalities (actors, singers, athletes, film characters, etc.),
- simple keyboard sequences, e.g. *qwerty*, *123456*,
- name of the applied operating system or the name of a computer.

The above guidelines may seem to be too restrictive, especially when users have several passwords. However, when they follow certain patterns, password creation should not pose any problems.

In order to create a safe and easily remembered password, its creators should do the following:

- combine several words and separate them by a sign (e.g. secret&password), or repeat the same word several times (e.g. homehomehome),
- create a password composed of parts of several words – e.g. *economics university* could be converted to *univecon*,
- include in a password an acronym known exclusively by its user, e.g. *idkwptu* (*I don't know what password to use*),
- replace specific letters with "similar" ones, e.g. letter O (letter "o") replaced by digit 0 (digit 0), or (); S replaced by $ or 5; E replaced by 3; G replaced by 6; H replaced by u # or |-|; C replaced by [; t replaced by +; M replaced by /\/\, etc. As a result the simple password *HOME* is converted to, for example, *#()/\/\3*,
- enter digits after pressing Shift, e.g. *4231* is converted to *$@#!*.

A number of similar solutions can be applied – they are available in research papers and on the internet (see: Gozdek, 2015; Żal, 2014; Skrylec, 2013).

Supervision of the system over the use of passwords mainly involves the checking of passwords by the system (protection against creating weak passwords), the secure manner of entering passwords (protection against persons who watch users while entering a password), restricting the number of attempts to log in (by blocking an account or extending the time between several erroneous entries of passwords), restricting the time of validity (enforcing users to periodically change their passwords).

Users' concern with password security plays a major role in the entire protection system − passwords are often cracked by intruders as a result of simple mistakes or negligence of which users may not be even aware. Table 1 presents examples of situations posing threats to password security.

Table 1. Situations posing a threat to password security

Type of situation	Characteristics and remarks
Recording a password	Users should record a password as part of an insignificant piece of text. It should not include the name of the user, computer, or IP number, and the text should not be placed near the computer.
The use of only one password	One "standard" password is often used to access several systems (accounts). The same password should not be used for systems representing different security levels.

The use of "unreliable" computers	Unreliable computers should not be used for accessing password-protected systems – they may have programs for stealing passwords.
The system's unusual behaviour	Users should act cautiously when the system requires aa repeated entry of password – it could be an indication of the existence of a system for stealing passwords.
Making passwords available to other persons	Users should be aware of the fact that a person using somebody else's password may pose a threat to its security even unintentionally.
The use of "save password" function	This function can be applied when physical access to the computer is protected.
The use of services which transfer non-encrypted data	It poses a threat due to the ease of stealing data or passwords. It is recommended that encrypted transmissions of data be used.
Failure to change a password after setting up or unblocking an account	Users may have to submit a written application for setting up an account in which they provide information on their temporary password. Unfortunately, this password is not changed, and it should be remembered that unauthorised persons may have access to the application. Also, a threat can be posed when users forget their passwords and request administrators to change them. It happens that administrators always create one password which can be accessed by other persons.
Uncontrolled access to an account	Most systems record significant events, e.g. log-in time and computer address. Users should, from time to time, check such information in order to detect other persons' log-ins.

Source: own study.

As already mentioned, selection and protection methods and password attack techniques have not changed significantly in the period of several last decades, while there is a greater need for the use of a larger number of passwords (which poses new problems).

3. The results of research

All the first year students of the Cracow University of Economics have university server accounts (for the needs related to the teaching process). Account names (logins) are created on the basis of the adopted pattern (the letter "s" and student identification number), and they are protected temporarily by a random password composed of small and capital letters, as well as digits and additional signs. In the beginning, the names of accounts and temporary passwords were printed and circulated among students; presently, students receive logins and passwords after filling out an online form, which contains their personal data. Information on student accounts and access to internet forms is usually provided during IT classes. During these classes, students replace temporary passwords with their own passwords.

In 1998, and in 1999 (the academic years 1999/1998, and 1999/2000) the author conducted surveys among students who were given access to their accounts and who replaced temporary passwords with their own ones. Student responses were collected during the class during which students changed

their passwords, or during the next class (the number of responses totalled more than 700). The main objective of the study was to offer an answer to the following question: *How does an inexperienced user create his/her (first) password?* The questions mainly referred to passwords used by students to protect their university server accounts. Because the research study was conducted nearly 20 years ago, and respondents did not attend IT major programmes, the assumption that they were not experienced users was justified. Also, the surveyed students were directly asked to comment on their previous experience in protecting passwords and the use of relevant mechanisms in creating them. The results of the study and conclusions are published in the paper (Madej, 2001).

In 2016, because of the reasons presented in the introduction, the author conducted the same survey among students who did not major in Information Technology. Students were supposed to answer very similar questions. The number of respondents amounted to 121. The comparison of the results of the two surveys is presented below. To facilitate comparison, results are presented in tables, and additional remarks refer to the most interesting results. The results are presented on a percentagewise basis, which should be understood as the share of a given answer in the total number of responses.

In 1998/99, half of respondents (48%) had never protected their computer system with password (Tab. 2), and they could be regarded as inexperienced users. In 2016, all users were acquainted with the idea of creating passwords for accounts, technical devices, or computer programs. Moreover, nearly all respondents (95%) reported the use of at least 5 types of protection techniques (Tab. 3). It clearly shows the increasing use of computer devices and systems, as well as the need for appropriate password protection systems.

Table 2. Responses regarding password creation (1998/99)

Question	**answers**
Have you ever created a password for computer systems?	
– Yes, several times	32.4%
– Yes, once	19.5%
– No, never	48.2%

Source: own study.

Table 3. Responses regarding experience in creating passwords (2016)

Question	**answers**
How many of your accounts (programs, devices, services) are protected by a password?	
– none	0.0%
– 1-4	4.9%
– 5-10	42.7%
– 11-20	29.3%
– more than 20	23.2%

Source: own study.

Interesting insights are provided by a comparison of results related to "standard" passwords (used several times − Tab. 4). In 1998/99, the distribution of results for the particular answers was

very similar (1/3 of respondents created new passwords each time, 1/3 of them used one standard password, and the remaining 1/3 had several standard passwords).

In 2016, merely 6% of users created new passwords each time, the majority of them (more than 80%) had several standard passwords, and 12% of users had one password. A large number of users with several standard passwords can be explained by a great number of systems that they protect. This behaviour can be justified, but it causes concern − the stealing of one password poses threats to a number of systems.

Table 4. Responses regarding "standard" passwords

Question	1998/99	2016
When you created a password:		
– did you create a new password each time	35.47%	6.1%
– you had several "standard" passwords	32.56%	81.7%
– you had one "standard" password	31.98%	12.2%

Source: own study.

In the subsequent questions respondents indicated *all* the elements that they used in creating passwords, as well as the adopted techniques (small and capital letters, digits, replacements, etc.). Because respondents could mark several answers, partial data can be only comparable on the basis of the most frequently indicated elements.

With regard to protection techniques in creating passwords in 1998/99, more than 56% of respondents used combinations of capital and small letters, nearly 32% used other signs apart from letters and digits, while 15% of them used replacements or different orders of characters (Tab. 5). The results presented in this way represent a positive picture of user behaviour, but an analysis of passwords from the perspective of "combined protection techniques" (Tab. 6) indicates that only 6% of respondents used all techniques, 1/3 of them did not use any techniques, and the remaining 1/3 merely resorted to combinations of capital and small letters. A large percentage of respondents who did not use any protection techniques, or merely resorted to small and capital letters (60%) presents a less optimistic picture of their diligence in creating passwords. In the first survey it can be attributed to the lack of user experience. However, the results obtained in 2016 are even worse. Nearly 3/4 of respondents (73%) behaved in a similar way, and nearly half of them (45%) did not use any protection techniques. Such results can only be attributed to a large number of used passwords. However, users should be aware of the fact that passwords are sensitive to dictionary attacks, which − in the context of the frequently used "standard" passwords − poses threats to protected systems and devices. It should be noted that servers do not use any mechanisms which enforce the use of additional protection techniques. If such mechanisms were implemented, respondents' answers could be different.

Table 5. Protection techniques used in passwords

Question	1998/99	2016
Did you use a combination of capital and small letters?	56.6%	42.7%
Did you use replacements or different order of characters?	15.1%	17.1%
Did you use other signs apart from letters and digits?	31.8%	13.4%

Source: own study.

Table 6. The combined techniques used in passwords

Protection techniques used in passwords:	1998/99	2016
all techniques	6.5%	2.4%
no techniques	29.3%	45.1%
only combinations of capital and small letters	29.7%	28.0%
only replacements or change of order	3.0%	4.9%

Source: own study.

Interesting insights are also provided by questions related to relations between passwords and the personal details of their creators. In 1998/99, one out of 5 passwords (22%) was related to the creator's *name*, and a similar number of respondents derived them from their *nicknames* (21%), 14% − the *surname*, and 10% − the *date of birth* (Tab. 7). The common use of *name* and *surname* is not surprising − one of the most commonly used user associations. Interestingly, a large number of respondents used *nicknames*, which can be attributed to the young age of respondents.

With regard to name and surname, similar results were recorded for 2016 (despite an 8% increase in the use of name). Simultaneously, a large increase was recorded in the use of *date of birth* (more than twofold − from 10% to 23%). Simultaneously, the use of *nicknames* decreased (from 21% to 11%), and the same trend was recorded for *permanent address* (from 8% to 0%). An increase was recorded in the use of *telephone numbers*. The changes over the years cannot be explicitly explained. Certainly, *date of birth* is closely related to the common use of logins which refer to the user's date of birth. Such logins relate to various services (emails or discussion forums) and social networks, and the inclusion of date of birth is caused by the previous use of the same login by a different user. An increase in the use of *telephone numbers* is the obvious effect of the availability of mobile phones.

Table 7. Relations between passwords and respondents' personal details

Question	1998/99	2016
Was your password related to your personal details?		
– name	21.9%	30.5%
– surname	13.6%	14.6%
– date of birth	9.8%	23.2%
– phone number	2.2%	6.1%
– address of residence	7.7%	0.0%
– nickname	21.1%	11.0%

Source: own study.

In the results obtained in 1998/99, friends' personal details, as well as password creators' details, were mostly determined by *name* (nearly 12%), *nickname* (more than 7%), and *surname* (nearly 6% − Tab. 8). Interestingly, similar results were obtained in 2016. The only major difference is recorded for the use of friends' *nicknames* (a decrease by nearly 5%), but this trend corresponds to a decreasing number of respondents using their own *nicknames*.

Table 8. Relations between passwords and the personal details of respondents' friends

Question	1998/99	2016
Was your password related to the personal details of your friends?		
– name	11.8%	12.2%
– surname	5.8%	4.9%
– date of birth	3.4%	6.1%
– phone number	1.6%	0.0%
– address of residence	2.7%	1.2%
– nickname	7.2%	2.4%

Source: own study.

With regard to favourite people, animal and things used in creating passwords, both 1998/99 and 2016 surveys indicated the greatest role played by favourite *animal* (7% and 11%, respectively), and *music band*. No significant changes were recorded for the remaining elements (Tab. 9).

Table 9. Relations between passwords and respondents' "favourites"

Question	1998/99	2016
Was your password related to your favourite:		
– animal	6.9%	11.0%
– actor	1.3%	2.4%
– music band	3.4%	1.2%
– car	3.0%	5.3%
– meal	1.3%	3.9%

Source: own study.

Apart from the above, respondents could choose *something else* and propose other solutions not included in the survey. Not all respondents indicated associations with their password (some of them merely marked this answer), so it is difficult to draw any comparisons. It should be noted that most respondents referred to *titles of songs and films* in the 1998/99 survey, while in 2016 − to *computer games*.

However, the most interesting insights are provided by the percentage of passwords created *exclusively* on the basis of selected elements (Tab. 10). The analysis of answers leads to the conclusion that in 1998/99 more than 8% of passwords were created *exclusively* on the basis of *nickname*, more than 12% on the basis of personal data (*name*, *surname*, *date of birth*), more than 5% − friends' personal data, and nearly 3% − *favourite animal*. It implies that it was possible to crack more than 1/5 of passwords, having a minimum knowledge of the user's data (*name*, *surname*, *date of birth*, *nickname*). This situation is considered to be a negative phenomenon − passwords created in this way are weak.

Table 10. Relations between passwords and selected elements

Password only related to:	passwords 1998/99	passwords 2016
name	3.6%	8.5%
surname	4.4%	3.7%
surname or name	2.7%	14.6%
nickname	8.6%	6.1%
name or surname, date of birth	12.3%	30.5%
friend' name	3.3%	8.5%
friend's nickname	1.8%	1.2%
friend's name, surname or date of birth	5.5%	17.1%
Favourite animal	3.0%	8.2%

Source: own study.

The results of a similar survey conducted in 2016 are even worse − nearly 2/3 of passwords (63%) are created exclusively on the basis of the combination of basic data (*name, surname, date of birth, and nickname*). The majority of passwords (30%) are based on *name, surname, and date of birth*.

3. Conclusion

The paper presents a brief review of selection and protection methods in computer systems, as well as a comparative analysis of the results conducted in the period of nearly 20 years. The main conclusion is that the manner of creating and protecting passwords has deteriorated. Presently, password users – despite their experience and awareness of the need for creating strong passwords − tend to create passwords which are confined to their own or close relatives' data (30% of passwords refer to the user's name, surname or date of birth). Nearly half of users (45%) do not use any protection techniques, and the need for protecting a large number of systems and devices results in the use of the same standard passwords by 92% of users.

In conclusion, it should be stressed that all the above recommendations for creating passwords remain valid, and the most significant one is making users aware of possible threats and the need for a cautious selection and protection of their passwords.

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Chapter 16

Model Based Description of Different Approaches to the IT Project Management[1]

Dariusz Dymek

1. Introduction

IT project management methodologies integrates components from two disciplines: software engineering and (project) management methodology. Components from software engineering are responsible for the process of computer software development and cover such activities as specification, analysis, designing, coding, testing, etc. The number of distinguished activities, relation among them and their repeatability are the basis on which the different software development models are defined. The literature points out many models such as waterfall, evolutional, incremental, spiral, V-shape and other ones. All these model have been designed for illustration and explanation the process of software development according to different points of view and needs. Based on these models a new one was created as a hybrid or variation to emphasis some specific aspects e.g. W-model. Even a brief analyse shows that some of these models point out activities that are not directly connected with software engineering (e.g. planning or risk analysis) or a single phase in one model becomes the several phases in other model.

The similar situation is in case of project management methodology. There are several models of the project management process which were created for different purposes based on different experiences and approaches. Some of models such as waterfall (traditional) or incremental ones are treated as a basic models and are used as a reference models.

The combination of the software development models, project management models and some additional components (paradigms, methods, tools, etc.) set up the software project management methodologies (SPMM). So, in case of each of the SPMM we can identify the basic models of software development and project management which are the basis of that SPMM. On the other hand, each of the SPMM is assigned to the one of "so called" approaches to software development such as traditional or agile ones. Is there any relation between these approaches and mentioned models of software development and project management process?

[1] The publication has been financed from funds granted to Faculty of Management, Cracow University of Economics, for supporting scientific research capability.

The answer on this question is the main goal of this work and can be found in section 4 and 5. Earlier, in sections 2 and 3 respectively, the characteristics of software development models and project management models are presented. In conclusion (sections 6), based on discovered relations and properties of the identified models the different approaches to the SPMM are characterized.

2. Models of software development process

Software engineering divides the process of software development into several phases. Every phase covers the activities of similar characteristic with respect to engineering aspects of software development. Such created set of phases covers the process of software development starting from setting the problem though discovering the solution and ending with the running software. Typically, the software development process is divided into following phases:

- Specification − phase responsible for answer the questions: "what is the problem?" and "what (software) we need to solve the problem?". At this phase the computer software has a form of description of requirements on the business and users levels expressed with different techniques and methods from natural language to such graphic notation as Use Case Diagrams or Using Scenarios.
- Analysis − phase responsible for answer the question: "how it (this software) should work?". As a result of this phase the requirement are converted into form of software specification.
- Design − phase responsible for answer the question: "how it (this software) should be build?".
- Coding − this phase is responsible for translation the results of previous phases into form of source code with using some programming languages.
- Integration − is the last[2] phase of development process in which the all component are integrated into running computer software.

This sequence of phases can be treated as a sequence of transformation of the computer software forms from the natural language of business and users' needs by the requirements and the different intermediate forms including source code to the executable code and running computer programme.

In presented model of software development phases existing of such transformation is treated as the necessary condition for distinguishing the phase − activities which are not connected with software form transformation can be a part of any phase but do not establish a separate phase. For example, some models description distinguish the testing phase (SWEBOK, 2004, pp. 5-1:16) placed between coding and integration phases or after the integration phase. But the testing as an activity do not change the form of computer software. It is intended to find and localize the potential errors (bugs) in already developed software. Generally, testing is one kind of activities connected software quality assurance similar to verification or validation. One can ask "Why so many model points out the testing as separate phase?". The answer is simply. It depends on the criterion of phase distinguishing. When this criterion is based e.g. on time consumption or spending on given kind of activities, the distinguished of the testing phase is reasonable. Similar situation is in case of distinguishing the planning phase. Planning as a activity is necessary and have to be a part of every carried out software development process but this activity do not affect the software itself and is connected with management of this process.

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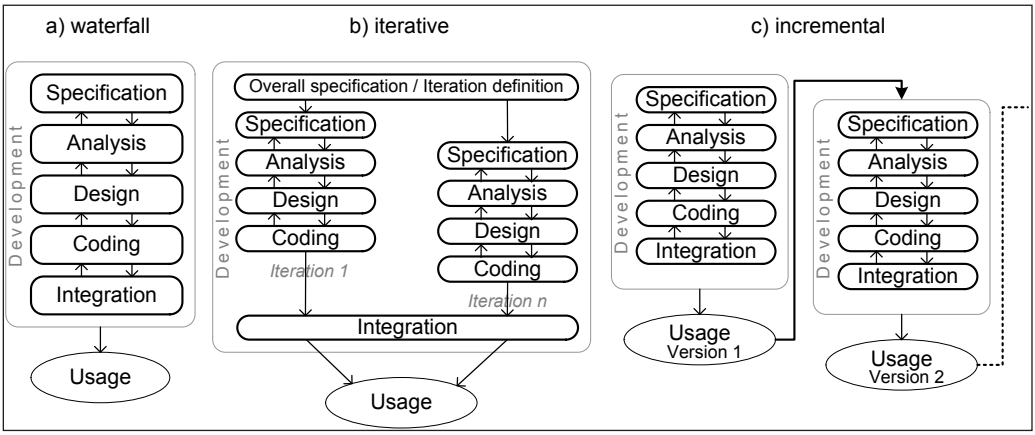
[2] In the software life cycle model there is distinguished at least one more phase: maintenance − covering the activities undertaking during usage of computer software. The range of activities covered by maintenance partially goes beyond the software project methodology so it is not included to further considerations.

Presented list points out only 5 different phases but more detailed approaches defined even over the dozen phases. Typically, we obtain more phases by dividing the identified phase into few new ones. For example, the design phase is sometimes divided into architecture (or overall) design and detail design phases. Sometimes, the two phases are connected into one e.g. Vliet (Vliet, 2008, p. 11) has connected the specification and analysis phases into requirement engineering phase. The number of distinguished phases is connected with presented approach and detail level of consideration. Figure 1 presents the basic models of software development process based on 5-phases approach.

The waterfall model (schema (a) on Figure 1) is the historically oldest model. It presents totally linear approach to software development process in which each of phases appears only one time and the whole software is created in single sequence of phases. As the worst disadvantage of this model is considered its linearity which force to develop whole software at once and make difficult to introduce any changes especially at late phases.

Figure 1. The basic models of software development process



Source: own work.

To avoid these weakness the iterative model (schema (b) on Figure 1) was established. In this model the specification phase is divided into two steps. First one is responsible for defining the scope of development process at the high level of generality and distinguishing the parts of the future software which can be developed partially[3] independent. Based on this the whole software development process is divided into *n* parts called iterations. The second step of specification phase opens every iteration and is carried out on the level of detail needed for software development. In this model the software is developed part by part. Each of these parts can but not have to be passed to usage phase as a fully functional software (that's why the integration phase on schema is common for all iterations and there are more than one connection between development and usage stages.

[3] In some cases (not always) the software system (application) can be divided into several pieces (programs, modules, elements, etc.) which are based (and have to fulfill) on the same requirements but can be developed independently by different teams which only coordinate the common parts of works.

The iterative model is the only one in which the possibility of work parallelization is not limited to only one phase – some iteration can be carried out simultaneously.

The weakness of both presented models is that whole software have to be anticipated at the beginning of development process – one must know exactly what is needed and based on this all processes are carried out. But in the real world there are often situation in which such an anticipation is very hard or even impossible to make. As a solution of this problem the incremental model (schema (c) on Figure 1) was established. In this model the whole process of software development is divided into a sequence of independent processes. Such division into independent sub-processes make this model similar to iterative one but in opposite to the iterative model every sub-process called increment have to end with working and fully functional software which is passed to usage stage. The specification phase of the next increment takes into account the results of previous increment. So the whole development process can be easily modified according to users requirements. At the beginning of the whole process of software development there are no assumption about numbers of increments and software functionality, the process ended when the users are satisfied (or the resources have ended).

These three models are basic ones − every other models as V-model, W-model or Spiral model are based on one of these models and is formed typically by introducing the new phases (like e.g. testing or verification) or by pointing out the specific method (or methods) to use in a given phases. For example, the well known the Boehm Spiral model is a hybrid model based on waterfall and incremental models in which the specification, analysis and partially design phases are using the prototyping methods and are repeated cyclically.

3. Models of project management process

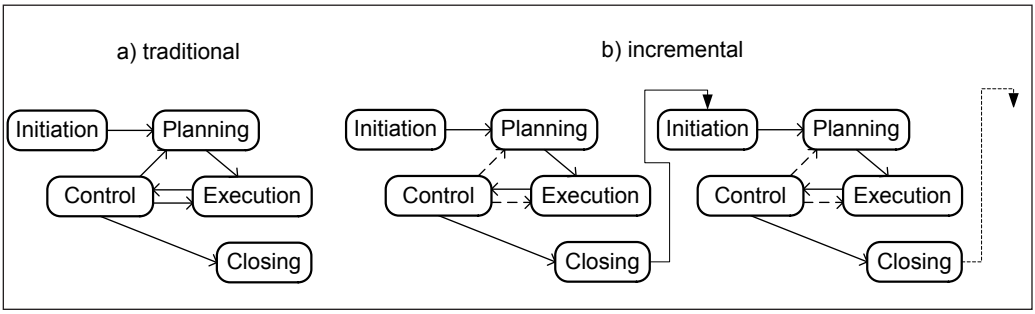
Beside the development activities every IT project includes also the management activities such as planning, controlling, resource allocation, etc. Let's consider the characteristic of these activities. In general case of the project the five phases of management process are distinguished (Pietras & Szmit, 2003, p. 15; Pawlak, 2006, pp. 67-77). These are:

- Initiation is the phase responsible for identification of the project scope, work out the way of actions, preparation of organizational framework, etc. This phase has generally the conceptual characteristic and has to answer the question: "What should be done and in what way?".
- Planning is the phase responsible for resource (time, budget, team, etc.) estimation and preparation of the work schedule including the tasks sequences, resource allocation, etc. This phase covers both the development and the management activities. Planning has to answer the question: "How the project goals will be achieved?".
- Execution is the phase in which the project plan is implemented. Task after task based on prepared schedule the project is carried out.
- Control phase is responsible for evaluation of the achieved results with project plan in respect with the project goals and scope.
- Closing is the last phase and is responsible for project settlement including the verification of project goals achievement, release of project team and establish the basement for the future activities connected with project results utilization.

Same as in the case of the development process phases, the phases of the management process can be established into the different models. There are two basic models: traditional and incre-

mental ones. The traditional model (schema (a) on Figure 2) assumes that Initiation and Closing phases appear only once but remaining phases create the cycle in which the all work are carried out (implementation cycle). For understanding the traditional model of project management processes the most important is remembering that the Planning phase is a part of implementation cycle and has a continues character (what means that it lasts for whole project)[4]. The emphasis in this model is placed on implementation cycle what means that the alternation of the Initiation phase results such as e.g. project scope can be made only in very limited scale. This is potentially the weakest side of traditional model because it means that at the beginning of project its scope and the way of acting shout be known.

Figure 2. The basic models of project management processes



Source: own work.

When there is a problem with identification of project scope or the way of acting the possible solution is using the incremental model. This model assumes that the all phases established the cycle in which after the Closing phase the next Initiation phase appears (schema (b) on Figure 2). The scope of next increment (the way of acting, etc.) is identified based on the results of the previous ones. This allow to alternate the scope of project much easier but makes harder to estimate the project resources like time, budget, etc. It must be noted that both models refer to all areas of project management activities. These areas were divided by PMI (PMI, 2003) into nine categories called Project Management Knowledge Areas. These categories covers such areas as integration, scope, time, cost, quality, human resource, communications, risk and procurement management. Regardless of model selection all these categories are existing and should be taken into account when the project management methodologies are developed.

4. Software project management methodology

Software project management methodologies try to work out and establish the proper procedures of project management in case when the project's results includes a significant elements connected with software development. Depending on the level of including the specific characteristics of software development process these methodologies can be divided into three categories:

[4] One of the most common mistakes concerning the traditional model is statement that the project must be carried out in accordance with plan without remembering that the project plan can be improved (modified according to present situation) continuously.

- The general purpose methodologies which are concentrated on the processes of project management and left the development process not described (in the meaning of pointing out the methods of development, etc.). These methodologies can be applied to projects from different disciplines, in particular to software projects. Example of such methodology is well known the Prince 2 (PRINCE 2, 2009).
- The software project management methodologies are the methodologies which are tailored to software development. Beside the definition and description of the management processes, these methodologies cover the process of software development by pointing out the software development methodologies. These methodologies can be used only in case of software development but leave the considerable scope of choice according to specific methods, techniques, paradigms, tools, etc. The examples of such methodologies are RUP or SCRUM (Koszlajda, 2010, pp. 73-104, 189-204).
- The special-purpose software project management methodologies are the sub-category of the software project management methodologies, typically developed by single firm or organization which is dedicated to specific kind of software or directly points out the complete set of tools and methods of software development. The examples of such methodologies can be MSF (Kerzner, 2005, pp. 159-167) or ASAP (Szyjewski, 2004, pp. 340-364).

All of SPMM should cover both the development and the management processes what means that they must be based on mentioned above models. Different model's combinations are based for defining different kinds of SPMM. The possible combinations of these models are presented at Table 1.

Table 1. The possible combinations of development and management processes models − kinds of SPMM

Model of development processes (MDP) / Model of management processes (MMP)	**Traditional**	**Iterative**	**Incremental**
Traditional	**Traditional Linear (TL) SPMM** Combination often called "the waterfall methodology". It represent the classical approach to software development. Typically used in small or rarely medium size project. It required the knowledge of goals and methods of its achievement.	**Traditional Parallel (TP) SPMM** This models combination allows to parallelization of project works. The final software system consists of separated modules which can be developed independently and parallel. Typically used in medium or large projects with well defined goals and known method of their achievement.	**N/A** Combination formally forbidden and impossible to implement. Traditional MMP means that the final project result is known and well defined while the incremental MDP means that the final result and the way of its achievement is not known.
Incremental	**N/A** Combination formally forbidden because the traditional MDV assume that the final result is known and well defined while the incremental MMP is based on lack of that knowledge. In practice such combination occur in one of the most common critical mistakes in usage of Scrum SPMM when every single phase of traditional MDP is treated as a separate increment (from management points of view). Such an improper combination is often called "Scrumfall".	**N/A** Combination formally forbidden because iteration MDP assume that the final result is known and well defined while the incremental MMP assume that this result is not defined and will occur during the project. In practice such combination can be met as a part of "Scrum of Scrums" (Sutherland et al., 2007; AlMutairi & Qureshi, 2015). SPMM in which every iteration is managed based on the incremental model. It is treated as a possible solution of some "agile approach" limitations such as size of team (and consequently size of project).	**Agile SPMM** Combination in which the project occur as sequence of "mini-projects" which ends with working and usable version of final software systems. The final results of project are the effect of the sequence of decision made during the project last and not known at the project beginning. Typically used in small or rarely medium project.

Source: own work.

Another distinction between different SPMM lays in the detail level of description of management and development processes. At the Table 2 the brief characteristic of the detail level description for some selected SPMMs is presented.

Table 2. Brief characteristic of detail level description of management and development processes for selected SPMMs

SPMM	Management Process Description	Development Process Description
Prince 2	Complete and detailed description of most of the aspect of project management. As an example of general purpose project management methodologies, Prince 2 concentrate on management process based on traditional model. Together with PMBooK, Prince 2 is treated as one of the most complete and detail project management methodology according to management process.	Methodology do not points out any aspects of software development except the traditional and interactive models. As a general purpose project management methodology, Prince 2 describe the development process on very abstract level, treating it as a black-box with input, output and some characteristic expressed in terms of time, resources, cost, information flow, etc.
RUP	Describe most of aspects of management processes pointing out the methods or criteria for methods selection. Based on traditional MMP RUP require quite accurate the vision of final results and according to this put an emphasis on planning process but with readiness for changes. Some aspects as procurement management are not mentioned.	RUP is based on hybrid iterative-incremental model of software development. It define the main aspects of development process pointing out: the programming parading (object-oriented only), the way of specification (Use Case Diagrams), software architecture (Component-Based), etc. In most of development aspects the freedom of choice is limited to particular software development tools.
Scrum	Describe only the chosen aspects connected with scope, resource and progress of work. One of the most characteristic properties of Scrum is communication based on direct interpersonal meeting and limitation of formal methods of communication. Based on incremental MMP Scrum put an emphasis on short period planning. In many aspects as e.g. risk management there is only a statement "carry out by every team member" without pointing out any methods or setting out the requirement criteria.	Scrum is based on incremental model of software development and do not points out the complete methodology of software development. It mention some techniques like "usage scenarios" as a method of requirements elicitation but choosing the complete set of methods for software development is leaved the project team choice.

XP – eXtreme Programming	According to management processes XP is based on incremental MMP. It describes some element connected with team (flat structure), scope (continues defining) and change management, putting special emphasis on quality management, and leaving freedom of choice in other aspects. XP do not points out any planning or scheduling methods.	XP is based on hybrid incremental-iterative model. It points out the test as a specification method and the crucial element used for development tracking, pair-programming as a method of software source code writing and refactoring (based on reviews and inspections) as a method of quality control . XP do not points out any specific software development tools which must be used.

Source: own work.

The detail level of description of management and development processes for different SPMM vary in significant way. It can lead to question: can we thread all these SPMM as equivalent? There is no common criteria for detail level description in methodology definition so it is hard to answer, but the problem still exist. For this reason someone said that e.g. Scrum is a project management methodology, someone said that it is only a management framework which must be tailored and filled out by specific methods according to needs but other said that this is only a management conception or even a philosophy which can be used as a reference point in process of development of the project management methodology (not necessary the software one).

5. Different approaches to software projects management

Presented characteristic of different SPMM can be used as a criteria for defining the different approaches to software project management. Let's realize that one on major criterion is connected with model of management process − typically methodologies which are based on traditional model belong to so called traditional approach while the methodologies based on incremental model belong to so called agile approach. Main reason of this is the treatment of the planning (phase) in the process of project management. The difference between planning in traditional and incremental MMPs lays in the possibility of planning: in traditional MMP the final result is known so we can plan how to achieve this result, in opposite to incremental MMP where the final result is not defined and only a possible way of acting is outlined so only first few steps can be planed. The "planning" criterion is a source of very common mistakes. Many descriptions assume that in the traditional MMP, the detailed project plan is created at the project beginning and later it is almost impossible to change it (so called "plan-driven project methodology"). Such a statement is not based on the traditional MMP properties, more over the planning phase in traditional MMP is a part of continues cycle of project implementation what points out its continues (similar to "control" and "execution" phases) character. The source of that mistakes is connected with the problem of distinguishing the changes in plan in traditional MMP with cyclic planning in incremental MMP. To emphasize this difference some practitioners incorrectly assume that in the traditional MMP the plan is almost unchangeable in opposite to incremental MMP where plan is following the users demands.

The possibility of planning range is strictly connected with the problem of defining the project scope what in case of software project is connected with the range and characteristic of specification phase in models of software development process. As a result of these interconnections some combinations of management and development process models are preferred and natural while the other are forbidden or look peculiar. Table 3 presents the brief model based characteristic for two the most popular approaches.

Table 3. The model based characteristic of approach to software project management

Approach	MMP	MDP	Examples
Traditional	traditional	traditional, iterative	Prince 2, RUP
Agile	incremental	incremental	Scrum, XP

Source: own work.

It must be mentioned that the approach issue is not the binary problem: between the traditional and agile approach there are many hybrid solution which try to use the best practice and methods from both approaches in the specific case (or kind of cases).

6. Conclusion

The approaches issue in software project management is very important problem which divided the practitioners into two groups basing on their approach preference. Proponents of the given approaches often try to use preferred by them approach to every case and forget that every approach has unique characteristic which determine the possibility of its usage. Such behavior connected with the marketing tendency leads to situation such as mentioned "scrumfall".

It is very important to understand the advantages and limitations of every approaches. For instance, the problem of the formality and hierocracy level in general is not a problem of approach but the attribute of given methodology of software project management or more often the problem of improper tailoring of this methodology to a given case (often met the problem of "tailoring" project to methodology). Similar situation is in case of change management and requirement flexibility. The characteristic of incremental model of management process allow to take decision about change much easier and with less workload (especially on planning) but it does not affect the level of rework connected with development process as the consequence of undertaken decision. Such a feature can be advantage when the solution must be discovered during the project but it can be a great disadvantage when the project goal is know and well defined.

Understanding the influence of properties of the management and development processes models on the software project management methodology is crucial in their development and later in tailoring for a given case because inconsistence in these properties can lead to serious and even sometimes unsolvable problems.

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Authors

Slavko Arsovski	University of Kragujevac, Serbia
Zora Arsovski	University of Kragujevac, Serbia
Dariusz Dymek	Cracow University of Economics, Poland
Dragomir Dimitrijević	University of Kragujevac, Serbia
Antonio Fabio Forgione	University of Messina, Italy
Roland Górnisiewicz	AdAc DFK Polska Sp. z o.o., Poland
Artur Hołda	Cracow University of Economics, Poland
Viktoria A.Izvarina	Plekhanov Russian University of Economics, Russia
Zoran Kalinić	University of Kragujevac, Serbia
Ryszard Konieczny	Cracow University of Economics, Poland
Jan Madej	Cracow University of Economics, Poland
Carlo Migliardo	University of Messina, Italy
Ivan Nania	University of Messina, Italy
Grażyna Paliwoda-Pękosz	Cracow University of Economics, Poland
Dragana Rejman Petrović	University of Kragujevac, Serbia
Przemysław Płyś	Cracow University of Economics, Poland
Ryszard Pukała	The Bronisław Markiewicz State Higher School of Technology and Economics in Jarosław, Poland
Jurij Renkas	Cracow University of Economics, Poland

Ewa Soja	Cracow University of Economics, Poland
Katerina A. Shestaeva	Plekhanov Russian University of Economics, Russia
Pavel A. Smelov	Plekhanov Russian University of Economics, Russia
Janusz Stal	Cracow University of Economics, Poland
Anna Staszel	Cracow University of Economics, Poland
Sławomir Szurmam	AdAc DFK Polska Sp. z o.o., Poland
Jan Trąbka	Cracow University of Economics, Poland
Paweł Ulman	Cracow University of Economics, Poland
Stanisław Wanat	Cracow University of Economics, Poland
Ryszard Węgrzyn	Cracow University of Economics, Poland
Jacek Wołoszyn	Cracow University of Economics, Poland
Paweł Wołoszyn	Cracow University of Economics, Poland
Katarzyna Wójcik	Cracow University of Economics, Poland
Piotr Wójtowicz	Cracow University of Economics, Poland
Artur Żuwała	Cracow University of Economics, Poland

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