Vlado Dimovski[1]

ORGANIZATIONAL LEARNING AND INFORMATION-COMMUNICATION TECHNOLOGIES – A PROMISING LINK[3]

ABSTRACT

Highly turbulent and competitive business environment has directed a focus of many researchers as well as practitioners on to the field of organizational learning as a way of gaining and sustaining competitive advantage. One of the most important issues is its relation to information-communication technologies. The purpose of this paper is to examine prior research and propose a model linking Organizational Learning construct (OL) to Information-communication technologies (ICT). Using structural equation modeling methodology, we tested this relationship based on the data from 220 questionnaires received from top managers of 867 Slovenian companies with more than 100 employees in the year 2003. Our research demonstrates statistically significant positive correlation between OL and ICT.

Key words: *Organizational learning, Information-communication technologies, Slovenian companies, Structural equation modeling.*

1. Introduction

Highly turbulent business environment requires modern businesses to rapidly adapt to change. In this context, a thorough understanding of the process of organizational learning is vital. Organizational learning has emerged as one of the most promising concepts in strategic management in late 1980s. As a premier researcher in the field of organizational learning stated: ”the ability to learn faster than your competitors may be the only sustainable competitive advantage” (De Geus, 1988). At the same time Information-communication technologies became almost ubiquitous and are seen as a

[1] Associate professor of the Faculty of Economics University of Ljubljana

[2] Assistant of the Faculty of Economics University of Ljubljana

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major facilitator of business activities in the modern world (Tapscott and Caston, 1993; Gill, 1996) and the main catalyst of fundamental changes in structure, operation and management of organizations (Dertouzos, 1997). From this origin stems the need to understand the relationship among organizational learning and information-communication technologies.

For above reasons we intend to develop a conceptual model relating those two issues and provide an empirical test in this article. In order to do so, we first systematize and present definitions and process of organizational learning and present the most often used taxonomy of information-communication technologies and introduce constructs Organizational Learning (OL) and Information-communication technologies (ICT) as well as their measurement variables. Second, previous research relating ICT to OL is outlined in order to develop a conceptual model. Third, we test our hypothesis empirically, using structural equation modeling (LISREL) and fourth, results are discussed. We conclude by indicating some limitations of our work and providing future research propositions.

2. Organizational learning and information-communication technologies - a model conceptualization

First section of this article focuses on the development of a conceptual model to test the relationship between organizational learning (OL) and information-communication technologies (ICT). We approached this task in two steps – first, conceptualisation of structural sub-model and second, conceptualisation of measurement sub-model.

2.1. Information-communication technologies and organizational learning – constructs and relationship

In order to develop a sound model, a structural framework needs to be developed. This phase consists of two steps: presentation of constructs, and examination of possible relationships among them.

Two constructs of our concern are Organizational learning (OL) and Information-communication technologies (ICT). Former could well be the most ambiguous part of the model due to absence of common understanding of the concept and virtual non-existence of unique definition. This statement can be supported with findings of Shrivastava (1983) and Dimovski (1994). According to the first author, a vast majority of research in the area has been fragmentary and incomplete. The second author adds that research in the field of organizational learning resulted in numerous definitions and models (e.g. Nonaka and Takeuchi, 1996; Wall, 1998) that can be differentiated through criteria of inclusiveness, width and focus. Most definitions are only partial, because they deal with organizational learning from one theoretical perspective. To present just a few of them, Senge (1990) defines organizational learning as ‘a continuous testing of experience and its transformation into knowledge available to the whole organization and relevant to their mission’, while Huber (1991) sees it as a combination of four processes: information acquisition, information distribution,

information interpretation and organizational memory. Argyris and Schön (1996) are even less restricting in their definition, declaring that organizational learning emerges when organizations acquire information (knowledge, understandings, know-how, techniques and procedures) of any kind by any means. Jones (2000) emphasizes the importance of organizational learning for organizational performance defining it as 'a process through which managers try to increase organizational members' capabilities in order to better understand and manage the organization and its environment to accept decisions that increase organizational performance on a continuous basis'.

Dimovski (1994) provides an overview of previous research and identifies four perspectives on organizational learning. His model manages to merge informational, interpretational, strategic and behavioural approach to organizational learning and defines it as a process of information acquisition, information interpretation and resulting behavioural and cognitive changes, which should in turn have an impact on organizational performance. The purpose of information acquisition is to decrease uncertainty (Daft and Lengel, 1986), which is defined as a lack of information by Shannon and Weaver (1973). Meaning, uncertainty and quantity of information should be negatively correlated (Daft and Lengel, 1986). We would like to add that there is an optimal quantity of information. Namely, information overflow probably limits organizations' capacity to interpret information at hand.

Information acquisition is determined by two variables: data sources and intrusiveness of organization (Daft and Weick, 1984). Data sources can be internal or external (Daft and Lengel, 1986), with external sources representing managers' direct contacts with information source outside firm boundaries, and internal sources including employee data collection conveyed later (in the form of information) to managers using internal data channels. Recently, in this context, a very important role has been taken by information-communication technologies (such as intranet, enterprise resource planning systems, and e-mail). Intrusiveness of organization is defined as an extent to which organization is capable of actively penetrating its environment with browsing and searching for desired data and information. By this criterion organizations can be clustered as active or passive. On the one hand, active organizations allocate resources to search for information (e.g. they have employees to deal with research activities, hire external experts, actively use the Internet in order to obtain information for decision support, use extranet or ERP II systems[4] as a form of connecting to external partners – suppliers and major customers). On the other hand, passive organizations accept all information offered by its environment at a certain moment in time (King, 1980). We would like to think of the distinction between active and passive organizations as a continuum (rather than a dichotomy) - and will treat it as such in further research.

The purpose of information interpretation is to reduce ambiguity related to information. Ambiguity can be defined as existence of multiple, contradictory,

[4] ERP II systems or extended enterprise resource planning systems are an extension of enterprise resource planning systems (ERP) and are aimed at incorporating major suppliers and customers of the company in its integrated information system (Gartner Group, 2000).

explanations of situation at hand (Daft and Lengel, 1986). Two variables describe information interpretation: richness of media (Daft and Weick, 1984) and 'top-down' processing (Martello, 1993). Richness of media relates to capabilities of various forms of media to process information. The richest medium is personal contact, followed by telephone conversations, written memorandums and letters, special reports, and formal chain of command as the 'poorest' medium (Daft and Lengel, 1986). Modern media for instance involve videoconferences as a 'richer' media and electronic mail or intranet as 'poorer' forms of media for information interpretation. The 'top-down' concept of processing assumes that individuals past experiences, and the context in which they were obtained, reaffirm valid analytical framework to understand future developments. The purpose of 'top-down' processing is to improve information understanding of employees at lower levels of organizational structure and it is dependant of the level of details (Martello, 1993) and frequency of information cycles or information dissemination using various communication channels (Daft and Weick, 1984).

Organizational learning reflects in 'accompanying changes' (Garvin, 1993). If no behavioural or cognitive changes occur, organizational learning has in fact not occurred and the only thing that remains is unused potential for improvements (Fiol and Lyles, 1985; Garvin, 1993). When discussing cognitive changes two levels of learning can be observed. Lower-level learning reflects changes within organizational structure, which are short-term and only partially influence organization. Higher-level learning reflects changes in general rules and norms (Fiol and Lyles, 1985). Argyris and Schön (1978) classify learning similarly: single-loop and double-loop learning, Dodgson (1991) discusses tactical and strategic learning, while Senge (1990) uses terms of adaptive and generative learning. By all means, at lower-level learning organization acts passively and only adapts to environment, while higher-level learning involves active influence on business environment.

ICT have become a major facilitator of business activities in the modern world (Tapscott in Caston, 1993; Gill, 1996) and are also a main catalyst of fundamental changes in structure, operation and management of organizations (Dertouzos, 1997). One of the most often used taxonomies for ICT for business is the one that differentiates among software, hardware and telecommunications (Turban et al., 2001; Beynon-Davies, 2002). Main components of hardware do not involve only computers but also several attached technologies that take care of data (or information) flow into and from computer. Turban et al (2001) define hardware as physical equipment, applied for following activities of the computer system: input, process, output and storage of data. Main components of hardware are central process unit (CPU), memory (primary and secondary storage), input technologies, technologies to display results and communication technologies. What needs to be noted is that communication technologies play such a crucial role that they are very often regarded as an entity per se and discussed in relation to networks. Central process unit performs actual computation within the computer. Interesting thinking is the one of Gordon Moore, Intel co-founder, who predicted in 1965 that complexity of microprocessors would double approximately every 18 months. This prognosis proved to be very accurate and

was named Moore law. Consequentially, capability of hardware equipment is mounting and prices are diminishing.

User value of most of hardware equals zero if not combined with software. Beynon-Davies (2002) divides application and system software and sees later as a link between hardware and application software. At this point, we address enterprise resource planning (ERP) systems, which represent important development for modern businesses, because they integrate data and information from transaction-processing systems, decision support systems and executive information systems. At present, their essence is business-level data and information integration. However, we can expect that this integration will exceed firm boundaries and will be used for inter-firm collaboration (i.e. connection to firms' main suppliers and customers). Not alike hardware, power of computer software doubles approximately every 8 years (Turban et al, 2001). Reason for that can be probably contributed to market structure of software providers that can be best described as monopoly or oligopoly at certain segments. It will be interesting to monitor future advances in this area in regard to open-source software. In segments where there are open-source alternatives, quality of commercial products is rising and their prices declining.

The third component of Information-communication technologies, which has allowed for expansion of various networks are communication technologies. Internet is by all means the most important network. It has had an impact to the birth of so called 'new economy' mainly due to its inter-connectivity of various systems.

Robey et al. (2000) provide an overview of research related to the relationship between our two exogenous latent variables ICT and OL. They identify two main streams of research (i.e. one is related to ICT as a facilitator or even disabler of OL and the other is aimed at OL concepts to help develop and implement ICT in companies). Especially within the first stream, mainly qualitative body of empirical research provides no common understanding of what the impact of ICT on organizational learning should be like. The majority of case studies show that ICT act as enablers and facilitators of better organizational learning. Nevertheless, there are some cases where ICT caused rigidity in the systems and acted in exactly the opposite direction as desired. Despite this duality, stream that proposes positive relationship is prevailing. Based on this research following hypothesis can be put forward:

H_1: Correlation between ICT and OL is positive.

2.2. Towards operationalisation of OL and ICT

In Table 1 model operationalisation is presented through the inclusion of constructs, matching measurement variables, number of items involved and sources for underlying theories and measurement instruments.

Table 1

Specification of constructs – latent variables, their indicators, number of measurement items and their sources

Latent variables (constructs)	Measurement variables (indicators) and number of items aggregated into each variable	Sources
• Organizational learning (OL)	• Information acquisition (INFOACQ) – 12 • Information interpretation (INFOINT) – 11 • Behavioural and cognitive changes (BCC) – 14	• Dimovski, 1994 • Nonaka and Takeuchi, 1996 • Senge, 1990 • Wall, 1998
• Information-communication technologies (ICT)	• Hardware (HW) – 3 items • Software (SW) – 6 • Telecommunication equipment (TKM) – 5	• Turban et al, 2001 • Beynon-Davies, 2002 • Andersen in Segars, 2001

OL construct will have 3 measurement variables: Information acquisition (INFOACQ), Information interpretation (INFOINT) and Behavioural and cognitive changes (BCC). When reporting on INFOACQ, respondents were asked about the importance of different sources of information (e.g. employees, previous decisions, external experts, clipping, competition, and external data sources). Perceived importance of several ways to interpret information (personal contacts, teams, phone contacts, reports, and memos) will be used to measure INFOINT. Behavioural and cognitive changes (BCC) will be aggregated using 14 items asking about last three-year changes in several areas (e.g. adaptability to pressures from external environment, quality of products and services, general atmosphere in company, efficiency of team meetings, and speed of business).

ICT will have 3 measurement variables: hardware (HW), software (SW) and telecommunication equipment (TCM) with 3, 6 and 5 five-scale items aggregated. We will be interested in the frequency of enterprise resource planning (ERP) systems usage, frequency of groupware, intranet, database management systems (DBMS), e-forums usage, portion of employees with the Internet access and its speed, portion of employees with PC or terminal and mobile computers or palms in their workplace.

3. Methodological framework

Methodology utilised to test our model will be structural equation modelling (SEM). This is a combination of confirmatory factor analysis (CFA) and econometric modelling, which aims to analyse hypothesized relationships among latent constructs, measured with observed indicators (measurement variables). Complete SEM model has 2 parts – structural and measurement sub-model. Important advantage that SEM

has over multiple regression is that it allows for simultaneous testing of multiple endogenous (dependent) variables. On the other hand, SEM requires relatively large samples. Diamantopoulos and Siguaw (2000) propose at least 200 units as a rule of thumb, even though required sample size depends largely upon the number of parameters to be estimated.

3.1. Model specification and identification

The model specification determines nature and number of parameters to be estimated. We used LISREL (SIMPLIS) syntax. Next phase in the process is model identification, with which we check whether do we have enough information to estimate desired number of parameters (Diamantopoulos and Siguaw, 2000). The model can be non-identified (i.e. too few observed variables to estimate all parameters), identified (here we can have problem with model testing) and over-identified, which is a desired state. Necessary, although not sufficient prerequisite for model identification, can be tested using the following formula:

$$t<s/2$$

where t represents number of parameters to be tested (in our case 13) and s number of variances and covariances among indicators. s can be computed as

$$(p+q)*(p+q+1)$$

where p stands for number of indicators to measure exogenous latent variables (in our case 3) and q number of indicators for endogenous constructs (in our case 3). This means that s/2 equals 21, so our model can be regarded as over-identified and we can proceed to parameter estimation phase.

3.2. Parameter estimation

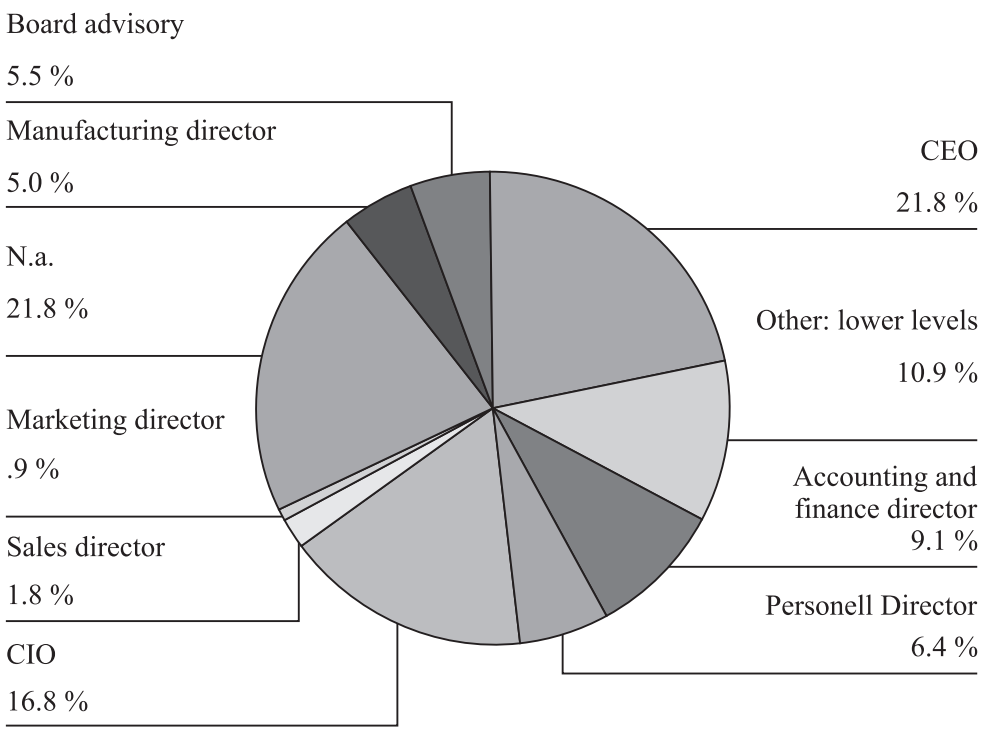
Next phase in the process is parameter value estimation using LISREL (SIMPLIS) tool for structural equation modelling. Prior to data analysis, sample and data collection process are briefly presented.

3.2.1. Data gathering and sample

Based on model conceptualisation, a measurement instrument – questionnaire was developed in June 2003 and sent to members of top management teams of all Slovenian companies with more than 100 employees, which accounted for 867 companies. We received 220 fully administered questionnaires (response rate was 25.4%), which can be considered as success in Slovenian context (using our primary data collection technique). This implies the fact that after 20 years, organizational learning still remains a very important issue for practitioners as well as academia.

Our respondents needed to have a strategic and to some degree even interdisciplinary perspective on the company in question. We need to be aware though that there will always be some degree of discrepancy between the desired and actual structure of respondents. In Figure 1 we show actual respondent structure.

Figure 1
Structure of respondents



In our case, we managed to 'capture' successfully 67.3% respondents, while 21.8% did not reveal their identity and only 10.9% completed questionnaires failed to reach at least functional managerial level. The structure of our sample by company size is a good representation of population of large Slovenian companies. Based on average number of employees criterion, in year the 2002, 51.4% of the companies had between 100 and 249 employees, followed by 24.6% of the companies with 250 to 499 employed persons, 11.8% had 500-999 and 12.2% of the companies had 1,000 and more employees.

3.2.2. Parameter value estimates

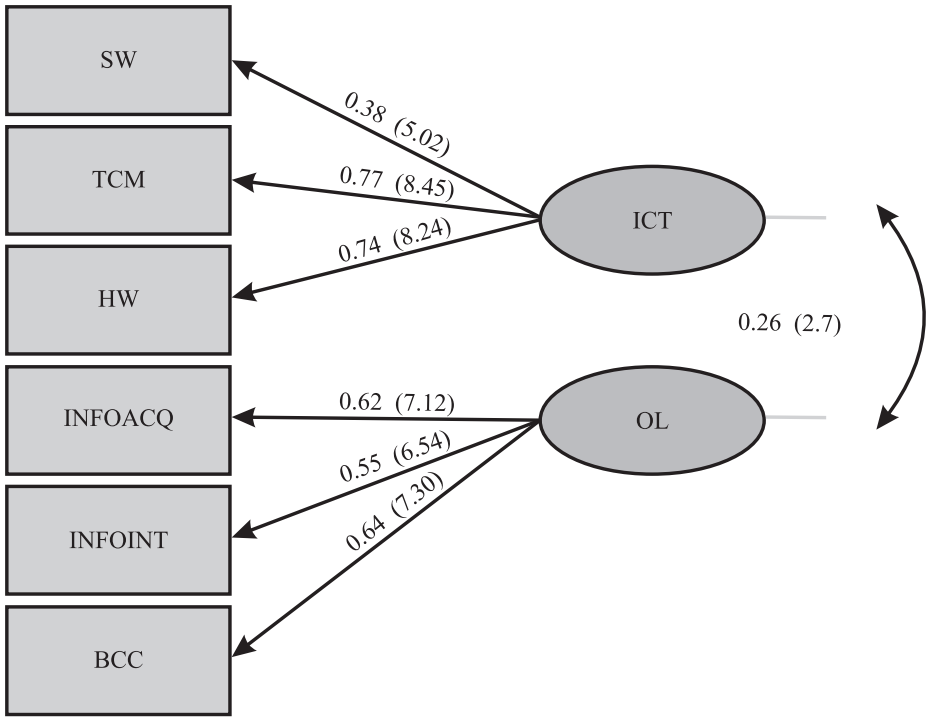
Maximum likelihood (ML) method was used to estimate parameter values. In this phase hypotheses set in conceptualisation phase are tested. Even though several methods can be used for this purpose, ML is the most often used and has an advantage of being statistically efficient and at the same time specification error sensitive, because it requires only complete data and does not allow for missing values. All methods will, however, lead to similar parameter estimates under the condition that sample is large enough and that the model is correct (Jöreskog and Sörbrom, 1993). Figure 2 shows

path diagram of our model (with completely standardized parameter estimates and corresponding t-values). Our particular attention is directed towards correlation between constructs Organizational learning and Information-communication technologies, where completely standardized values exceeding 0.30 can be regarded as strong in size.

Organizational learning (OL) and Information-communication technologies (ICT) constructs proved to be statistically significantly correlated. This correlation is moderate in size and positive in its direction, which confirms our hypothesis. Better organizational learning contributes to better use, deployment and management of modern information-communication technologies. At the same time ICT can be seen as enablers of higher-level organizational learning.

Figure 2

Research model (completely standardized parameter values and t-values)



3.3. Global-fit assessment

Aim of global-fit assessment is to determine the degree to which the model, as a whole is consistent with data gathered. One of the most often used global-fit indices is Goodness-of-fit (GFI) index which directly assesses how well covariances based on

parameter estimates reproduce sample covariances (Gebring and Anderson, 1993). GFI in our case equals 0.96 and exceeds reference value of 0.90 as suggested by Diamantopoulos and Siguaw (2000). This can lead us to a conclusion that the model at hand can be regarded as an appropriate approximation of reality (at a global level).

4. Managerial implications

How to gain and sustain competitive advantage rests in sub consciousness of practically every top manager. In the current business environment where information and knowledge play a crucial role, it is extremely important make systematic efforts to achieve organizational learning of higher level, which we might name double-loop learning, strategic learning or generative learning. Our research demonstrated statistically significant positive and relatively strong relationship between organizational learning and information-communication technologies. Companies that will manage to develop organizational learning of higher level will gain in terms of better use, deployment and management of modern technologies, which may in turn provide them with an opportunity to achieve a better organizational performance.

This important finding should reflect throughout the whole modern paradigm of management process. In the planning phase, management needs to bear in mind the importance of strategic planning of information systems within and between the companies. It will be interesting to see, for instance, how inter-organizational systems such as enterprise resource planning systems II (ERPII) will evolve and be deployed within the companies. Supporting learning, cooperation and empowerment of employees are tasks of a modern leader in a learning organization. Modern leaders need to give their support to organizational culture of trust, cooperation and information sharing. This might be the place where ICT (e.g. intranet, virtual communities of employees etc.), reward systems and strong leadership can support organizational learning initiatives. To be able to perform efficient and effective control in a turbulent environment, characterized by the decentralization of knowledge and constant change, various information systems of control are compulsory to track results of organizational learning.

5. Conclusion

Rationale of our contribution was to design a theoretical and empirical framework to test the relationship among organizational learning process and modern information-communication technologies in business environments. Within the empirical framework of data from 220 Slovenian companies with more than 100 employees gathered in June 2003 we tested the hypothesis that organizational learning and information-communication technologies correlate positively. Companies that invest more efforts in achieving higher-level organizational learning find it easier to use, deploy and manage information-communication technologies such as ERP, which in many cases despite very high investments do not result in desired quality, they exceed cost limits and postpone implementation-time framework. At the same time,

information-communication technologies act as enablers of better organizational learning processes. We are aware of that fact that this is a generalization and that there might be also the cases where ICT introduce some rigidity into the organization and thereby impede organizational learning. Hence, there is only moderate positive correlation. These results are consistent with previous empirical research (Robey et al., 2000).

We are aware of some limitations of our research and propose directions for future research. First, sample size and context always pose important limitations. We used a sample of Slovenian companies with more than 100 employees in year 2003. It would be very interesting and useful to introduce a cross-cultural dimension in the context and cross-validate the model in different settings. Second, the longitudinal study could provide additional insights into the issue of performance from higher-level organizational learning. Time lag might have an influence in this context. Third, we need to be aware of problems at operationalization of the Organizational learning construct. By all means, measuring such an elusive concept poses a big challenge to the research community. Nevertheless, we hope and believe that the model we developed and tested presents a relatively well-balanced relationship between the complexity of organizational learning process and information-communication technologies on the one hand, and simplicity of its formulation on the other. Future research will need to address these and some other issues related to organizational learning and information-communication technologies in order to contribute to understanding of this challenging and promising area of research.

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Vlado Dimovski [1]
Miha Škerlavaj [2]

ORGANIZACIJSKO UČENJE I INFORMACIJSKO-KOMUNIKACIJSKE TEHNOLOGIJE- OBEĆAVAJUĆA VEZA

SAŽETAK

Visoko turbulentno i natjecateljsko poslovno okruženje usmjerilo je mnoge znanstvenike i ljude iz prakse prema području organizacijskog učenja kao načinu dobivanja i održavanja konkurentne prednosti. Jedan od najvažnijih čimbenika jest odnos prema informacijsko-komunikacijskim tehnologijama. Svrha ovog rada je ispitati prethodno istraživanje i ponuditi model koji objedinjuje Organizacijsko učenje (OL) i Informacijsko-komunikacijske tehnologije (ICT). Primjenjujući metodologiju stvaranja modela strukturalnog poravnavanja, ispitali smo vezu koja se temelji na podacima 220 upitnika, primljenih od top menadžera iz 867 slovenskih kompanija s više od 100 zaposlenika u 2003. godini. Naše istraživanje ukazuje na statistički značajnu pozitivnu korelaciju između OL i ICT.

Ključne riječi: *Organizacijsko učenje, informacijsko-komunikacijske tehnologije, slovenska poduzeća, model strukturalnog poravnanja*

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[1] Izvanredni profesor Ekonomskog fakulteta Sveučilišta u Ljubljani

[2] Asistent Ekonomskog fakulteta Sveučilišta u Ljubljani