

ICT Management for Global Competitiveness and Economic Growth in Emerging Economies (ICTM)

**International Conference on ICT Management for Global
Competitiveness and Economic Growth in Emerging Economies
Wrocław, Poland, September 17-18, 2012
Proceedings**

ICT Management for Global Competitiveness and Economic Growth in Emerging Economies (ICTM)

Series Editors

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The College of Management "Edukacja", Poland

AIS Special Interest Group on ICT and Global Development (SIG GlobDev), USA



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(ICTM 2012)**

**College of Management EDUKACJA
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**Sponsored by AIS Special Interest Group
on ICT and Global Development (SIG GlobDev)**

Edited by the Conference Co-Chairs
Jolanta Kowal, College of Management EDUKACJA, Wrocław, Poland
Narcyz Roztocki, SUNY at New Paltz, USA

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1. From the Conference Co-Chairs

Fast growing emerging economies, including transition economies, are often considered the growth engine of the global economy. Unfortunately, despite the fast growth of emerging economies, the economic gap between emerging economies and the mature, developed countries still exists. It seems that in order to truly close this gap, new management techniques, new business models, and new regulatory policies, among other factors are needed. Moreover, it could be expected that information and communication technologies (ICTs) will play a vital role in this process. Thus, the objective of this conference is to provide a forum for interested researchers and practitioners for exchanging their creative ideas on these issues. Possible contributions regarding the ICT management for global competitiveness and economic growth in emerging economies may include, but are not limited to, the following:

1. Social, political and legal frameworks and ICT Management in emerging and transition economies
2. Unique ICT management techniques for emerging and transition economies
3. Methods for measuring the benefits and costs of projects involving the adoption of ICT
4. The role of human and social capital
5. Innovative ways for generating revenues creating commercial knowledge products in emerging and transition economies
6. Educational systems and ICT Management in emerging and transition economies
7. ICT to support small and medium firms in emerging and transition economies
8. ICT management in small businesses as a path to economic growth
9. ICT productivity studies at the country, industry or firm level, with specific reference to the social and business conditions prevalent in emerging or transition economies
10. Global supply chain management and its contribution to emerging and transition economies
11. Country specific case studies, with specific reference to the social and business conditions prevalent in emerging and transition economies
12. IT off-shoring / IT outsourcing into emerging and transition economies
13. International ICT project management, with specific reference to the social and business conditions in emerging or transition economies
14. Digital divide in emerging and transition economies
15. E-commerce effect on emerging or transition economies
16. E-government in emerging or transition economies

We hope that you have a productive and enjoyable conference.

Jolanta Kowal and Narcyz Roztocki

2. Biographies of Conference Co-Chairs



Jolanta Kowal is Vice Rector and a professor at Wroclaw College of Management "Edukacja" in Wroclaw, and a tutor and researcher at the Institute of Psychology of Wroclaw University. She is a Member of scientific associations PTS and PTPA accredited by IAAP. A researcher and lecturer, Jolanta is the author of over 60 scientific publications (published among others in University College London, C.G. Jung Institute of San Francisco, PWN and ENETEIA) and delivers lectures and seminars on methodology of management, applied statistics in socio-economic, psychological and multicultural research. She reviewed also papers and books for(among others)

ECMLG PROCEEDINGS 2010-2011 (ACI, Reading, UK), Information System Management, Taylor & Francis Comp, Scholar Manuscript, US, UK, Hawaiian International Conference on System Sciences-HICSS-44, 2011, US, Hawaii, Journal of European Psychology Students, EFPSA. Her interests and research specializations are: organization and management, information technology in organization, methodology, quantitative and qualitative research, analytical psychology, cross-cultural research. Jolanta acted as the conference chair for the 6th European Conference on Management Leadership and Governance (ECMLG) hosted at the College of Management "Edukacja" and the Professional Development Center "Edukacja", Wroclaw, Poland, 28-29 October 2010. <http://academic-conferences.org/ecmlg/ecmlg2010/ecmlg10-home.htm>



Narcyz Roztocki is a Professor of Management Information Systems at the State University of New York at New Paltz, USA. His research interests include IS/IT investment evaluation, IS/IT productivity, IS/IT investments in emerging economies, technology project management, and e-commerce. He has published in numerous journals and conferences including: the European Journal of Information Systems, the Journal of Computer Information Systems, the Electronic Journal of Information Systems in Developing Countries, Electronic Journal of Information Systems Evaluation, International Journal of Service Technology and Management, Journal of Global Information Technology Management, Journal of Information Science & Technology, and proceedings of the AMCIS, DSI, ECIS, ECITE and HICSS.

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Alexandra Kwiatkowska holds an MBA and is a Phd student of Pedagogy at University of Wrocław and is International Relations Coordinator at College of Management "Edukacja" in Wrocław. She has lectures on knowledge of learning and modern pedagogy. Her specialisations: popular culture, sociology, society changes, quantitative and qualitative researches, activism, employability, gender, management. She is interested in films, classic literature and travelling.

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4. Biographies of Contributing Authors



Dr. Anza Akram, doctorate (private) in Management Information Systems Sciences, is presently running her consulting firm, Anza Management Consulting Firm. She researches and consults in the area of Management Information Systems, Decision Support Systems, Knowledge Management Systems, Management, Security, Privacy and TeleDemocracy to discover and develop new business processes and applications. She presents her work in various national and international conferences and her work is published in various conference proceedings and CIIMA journal. She also hold M.B.A. in Finance from Quaid-i-Azam University, Islamabad, Pakistan and M.B.A. in Management Information Systems from California State University San Bernardino, San Bernardino, California. Before starting her consulting business she also worked in the industry for few years and taught in various Universities and Community Colleges.



Yousuf S. AlHinai is an Assistant Professor of Information Systems at the , College of Economics and Political Sciences, Sultan Qaboos University, Oman. He is also the Assistant Dean for Training and Community Service in the college of economics. He completed his PhD in Information Systems from The University of Melbourne, Australia. Dr. AlHinai is experienced in both teaching, research and administration. He has a number of published and under-review conference and journal research papers. He continues to work with a recognized network of scholars and researchers in different countries.



Dr. Mazen Ali is an Assistant Professor at the Department of Information Systems, the University of Bahrain, Kingdom of Bahrain. He completed his MSc and PhD in Information Systems from the University of Melbourne, Australia. Prior to that, he obtained his Bsc in Business Information Systems from the Department of Information Systems, University of Bahrain. His main research areas are electronic commerce, adoption of information technology in developing countries, inter-organisational information systems, enterprise systems, knowledge management and supply chain management.



Antonio Diaz Andrade. Auckland University of Technology, New Zealand: Antonio is a Senior Lecturer in Business Information Systems at Auckland University of Technology, New Zealand. His main research interest is in Information and Communication Technology for Development (ICT4D). His work has been published in international journals. He is currently serving as the Australasian Vice-Chair for IFIP 9.4 – Social Implications of Computers in Developing Countries.



Wojciech Bożejko is an assistant professor at Wrocław University of Technology. He obtained M.Sc. in University of Wroclaw, Institute of Computer Science in 1999, Ph.D. in Wroclaw University of Technology, Institute of Computer Engineering, Control and Robotics in 2003 and D.Sc. (habilitation) in Wrocław University of Technology, Faculty of Electronics, in 2011. He is an author of over 120 papers (and over 50 citations on ISI Web of Knowledge) in journals and conference proceedings from the field of parallel processing, scheduling and optimization. He is also a reviewer of journals in this field: *European Journal of Operational Research*, *Journal of Intelligent Manufacturing*, *Journal of Parallel and Distributed Computing*, *Computers & Industrial Engineering*, *IEEE Transactions on Automation Science and Engineering*, *International Journal of Advanced Manufacturing Technology*. He is interested in parallel algorithms, GPU computing, scheduling and discrete optimization. He is also a qualified musician. He graduated (M.A.) from the Academy of Music in Wroclaw in a specialization of piano.



Sean Cox. After attending university with a concentration in mathematics as well as philosophy, Cox returned to his native New York to work in Finance. Sean currently splits his time between his day-job at a neuroscience think-tank and his own company, Mathematicians Anonymous, which focuses on incorporating mathematics into artistic realms such as music and film.



Łukasz Haromszki

Department of Human Resources Management in University of Economics in Wroclaw.

Interdisciplinary trained specialist of human resource management. Research interests include organizational leadership, management by values, strategic human resource management, employee motivation, activity leaders in local communities. Author and co-author of over 30 scientific publications, popular and professional publications. Consultant and teacher training of projects and investment. Traveler



Dr. Jolanta Kowal is Vice Rector and a professor at Wroclaw College of Management "Edukacja" in Wroclaw, and a tutor and researcher at the Institute of Psychology of Wroclaw University. She is a Member of scientific associations PTS and PTPA accredited by IAAP. A researcher and lecturer, Jolanta is the author of over 60 scientific publications (published among others in University College London, C.G. Jung Institute of San Francisco, PWN and ENETEIA) and delivers lectures and seminars on methodology of management, applied statistics in socio-economic, psychological and multicultural research. She reviewed also papers and books for(among others) ECMLG PROCEEDINGS 2010-2011 (ACI, Reading, UK), Information System Management, Taylor & Francis Comp, Scholar Manuscript, US, UK, Hawaiian International Conference on System Sciences-HICSS-44, 2011, US, Hawaii, Journal of European Psychology Students, EFPSA. Her interests and research specializations are: organization and management, information technology in organization, methodology, quantitative and qualitative research, analytical psychology, cross-cultural research. Jolanta acted as the conference chair for the 6th European Conference on Management Leadership and Governance (ECMLG) hosted at the College of Management "Edukacja" and the Professional Development Center "Edukacja", Wroclaw, Poland, 28-29 October 2010. <http://academic-conferences.org/ecmlg/ecmlg2010/ecmlg10-home.htm>



Igor Kruglyak formed CoreValue with his partners in 2004 to leverage the technology and business knowledge he had gained during 22 years in IT. Prior to CoreValue Igor was Head of Engineering executive at AP3 Solutions, provider of technical solutions for a variety of Legal Networks, Chief Technology Officer for venture-funded intellectual property management company, and in this capacity Igor had overseen multi-million dollar on-shore/off-shore development projects. In 1997 Igor joined InterWorld Corporation, a 60-employee startup at the time and was a key contributor to the IPO of that company in 2000. He served as a Senior Product Manager for Micro Focus LTD, Assistant Vice President at Merrill Lynch. Igor has been a featured speaker at several national and international technical conferences, published several articles at Kobb Publications focused on the software and application development.



Dr. Tom Kwanya is a Knowledge Management specialist with several years of practical work experience. He holds PhD in Information Studies. His areas of research include social networking and media, innovation in research libraries, knowledge management, and public relations in libraries. He is an honorary lecturer in the Information Studies Programme, University of KwaZulu-Natal, South Africa.



Alexandra Kwiatkowska holds an MBA and is a Phd student of Pedagogy at University of Wrocław and is International Relations Coordinator at College of Management “Edukacja” in Wrocław. She has lectures on knowledge of learning and modern pedagogy. Her specialisations: popular culture, sociology, society changes, quantitative and qualitative researches, activism, employability, gender, management. She is interested in films, classic literature and travelling.



Dr Mieczysław K. Leniartek is an architect and a town planner, a graduate of the Faculty of Architecture in the Technical University in Cracow, Poland (MA 1970). He has practiced in Poland, England and Australia, completed a doctoral dissertation in the Technical University in Cracow on the revitalization of historic small towns (PhD 2003). He has been a manager of a regional studies bureau in Lower Silesia and a technical director in a development company in Cracow. He has been a chairman of several international conferences on cultural tourism and an editor of publications in this field ("Commercialism of Cultural Tourism", "Exploration of Historic Environment", "Terra Incognita in Tourism"). He lectured in the Faculty of Tourism of the College of Management "Edukacja" in Wrocław, Poland, in the subject of development for hospitality, and held a position of a dean.



Athraa Al Mosawi is assistant professor in Information System department at University of Bahrain. she received her B.Sc. in Computer Science from University of Bahrain, M.Sc. in Information System from University of East Anglia and Ph.D. in Computer Science from University of Manchester. Her research focuses on Enterprise Application Integration and Enterprise Architecture.



Jana Riedel works in different projects at Hochschule für Technik und Wirtschaft Dresden, University of Applied Sciences; where she creates trainings for soft skills and social media. She studied communication and media science as well as cultural studies at the University of Leipzig. Her research interests are social media, e-learning and media literacy.



Prof. Dr Hab. Eng. Ryszard Rohatynski has been Full Professor of Engineering at the University College of Management "Education", since 2006. He was appointed by the President of Polish State Council (1994, Poland), member of the Board of International Design Society till 2006, for nine years, initiator and chairman of bi-annual International Conferences 'Engineering Design in Integrated Product Development', EDIProD's, held in 1998, 2000, 2002, 2004, 2006, 2008 which are official events of the 'Design Society' and the Committee of Mechanical Engineering, Polish Academy of Science, manager of numerous engineering research projects for industry, referee of the Sections of the Polish Committee of Scientific Research. Assessment of numerous applications for research grants and final research reports, member of the Scientific Committees of numerous national conferences on engineering design, CAD, Fluid Flow Machinery and the like.



Narcyz Roztocki is an Associate Professor of Management Information Systems at the State University of New York at New Paltz. His research interests include IS/IT investment evaluation, IS/IT productivity, IS/IT investments in emerging economies, technology project management, and e-commerce. He has published in numerous journals and conferences including: the European Journal of Information Systems, the Journal of Computer Information Systems, the Electronic Journal of Information Systems in Developing Countries, Electronic Journal of Information Systems Evaluation, International Journal of Service Technology and Management, Journal of Global Information Technology Management, Journal of Information Science & Technology, and proceedings of the AMCIS, DSI, ECIS, ECITE and HICSS.



Sofiane Sahraoui is the Assistant Director General of the Institute of Public Administration in Bahrain, and Associate Research Fellow at Brunel Business School in the UK. He holds a Ph.D from the University of Pittsburgh and a MSc. from the University of Oxford. His research interests are mainly in Information systems governance and organizational design.



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Benjamin Shao is Associate Professor at Arizona State University. His research interests are IT impacts and security. He has been serving on the editorial boards of six IS journals. He was recognized for teaching excellence as the DISC Professor of the Year and the finalist for the John W. Teets Outstanding Teaching Award at ASU.



Piotr Soja is assistant professor in the Department of Computer Science at the Cracow University of Economics (Poland). He holds a Ph.D. in economics from the Cracow University of Economics. His research interests include enterprise systems adoption, ICT for development, and inter-organizational integration. Piotr has published in numerous journals including Enterprise Information Systems, Industrial Management & Data Systems, and Information Systems Management.



Ralph Sonntag is professor for marketing, especially multimedia marketing, at the Hochschule für Technik und Wirtschaft Dresden, University of Applied Sciences. After studying business administration in Würzburg, he was a researcher at the University of Technology Dresden. Subsequently he held positions at the strategy/technology consulting Diebold and advertising agencies. His research interests are social media, word of mouth and e-learning.



Margaret Tan is Associate Professor at the Wee Kim Wee School of Communication and Information as well as the Deputy Director of the Singapore Internet Research Centre at Nanyang Technological University in Singapore. Her research focuses on the building of electronic governance, trust and security, data protection and privacy, e-Government and the digital societies.



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5. Papers

Information Technology Research Trends in Transition Economies

by

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ABSTRACT

In this paper we assess the publication base and the research trends in information technology specifically in transition economies. A transition economy is an economy that is in the long-term process of moving from a centrally planned to a market driven system. Although information technology is the principal enabler for global connectedness and critical for firms in transition economies to maintain competitiveness, only relatively little research is being reported that addresses the issues specific to effectively employing information technology in transition economies. By reviewing current publications and identifying the research trends we try to point to existing gaps and the needs and opportunities for further research.

Keywords:

Information and Communication Technologies, Transition Economy, Research Trends

INTRODUCTION

A transition economy is an economy that is in the process of moving or has recently moved from a centrally planned economic system to a market driven system (Roztocki and Weistroffer 2008, 2009; Roztocki and Weistroffer 2011). This includes primarily the countries that resulted from the dissolution of the Soviet Union as well as its former satellite countries—the countries of the former Eastern (or Soviet) Bloc. In addition, it includes the countries that resulted from the break-up of Yugoslavia, which though politically neutral during the cold war, had retained a communist political and economic system. Furthermore, it includes Albania, which had aligned itself with communist China after the Chinese-Soviet split in 1960. The People's Republic of China and the Socialist Republic of Vietnam, which still retain communist political systems, are also considered transition economies, as they are gradually liberalizing regulations and allowing for increased private sector business activities.

Sometimes, the terms transition economy, emerging economy, and developing countries are

use interchangeably. However in spite of similarities and the fact that most transition economies could also be classified as either emerging or developing, there are specific characteristics that distinguish transition economies from other emerging or developing countries. The long history of a centrally planned economy has had a substantial impact on business and organizational culture in transition economies.

The research questions we ask in the current study are: (1) What is the current status of the research on IT in transition economies, and (2) what are the main topics of investigation in current IT research in transition economies? The answers to these questions will provide guidance to other researchers as to what the important issues are that need further investigation and thus where to focus their attention.

Our paper is organized as follows. After describing the background of transition economies, we present the methodology of our research. Description of inclusion and exclusion criteria guiding our literature search is followed by the description of our sample. Discussion of our results provides ideas for future research and leads to concluding remarks.

BACKGROUND

A transition (or transitional) economy is an economy that is in a long-term transition process from a centrally planned economic systems to a market driven system (Roztocki and Weistroffer 2008, 2009). This process may take place within three dimensions of transformations (Offe 1991): territorial transition, political transition and economic transition.

Territorial transition (Offe 1991) includes redefinition of borders, establishment of new political entities, and clarification of citizenship. Examples include the transitions that took place in the countries that resulted from the break-ups of the Soviet Union, Yugoslavia, and Czechoslovakia.

Political transition (Offe 1991) includes the dissolution of the power monopoly of a single, usually communist or socialist, political party and the move to democracy. An example is Poland, where the socialist party monopoly was broken in 1989 by the Solidarnosc movement, starting the democratic transformation.

Economic transformation (Offe 1991) includes the abolishment or downsizing of economic central planning and allowing market forces to drive economic development. Examples include China and Vietnam that are gradually liberalizing economic regulations while allowing and even encouraging business activities in the private sector (Roztocki and Weistroffer 2011).

Thus, transition economies or countries can be classified as single-transition, double-transition or triple transition as depicted in Table 1.

Transition Level	Characteristics	Example Countries
Single	Gradual abolition of centrally planned economic system. Gradual increase of private sector business activity and creation of a class of entrepreneurs.	China, Vietnam
Double	Abrupt abolishment of centrally planned economic system and one-party controlled political system. Simultaneous creation of a new class of entrepreneurs and replacement of political elites.	Bulgaria, Hungary, Poland, Romania
Triple	Abrupt abolishment of centrally planned economic system and political system. Simultaneous creation of new class of entrepreneurs and establishment of political elites. Dramatic changes in political entities and redefinition of borders.	Russia, Slovakia, Ukraine

Table 1. Classification of Transition Economies by their Level of Transformation

RESEARCH METHODOLOGY

The main research methodology in this study is literature search. We use the framework discussed in the following section in our review and analysis of the identified literature.

Analytical Framework

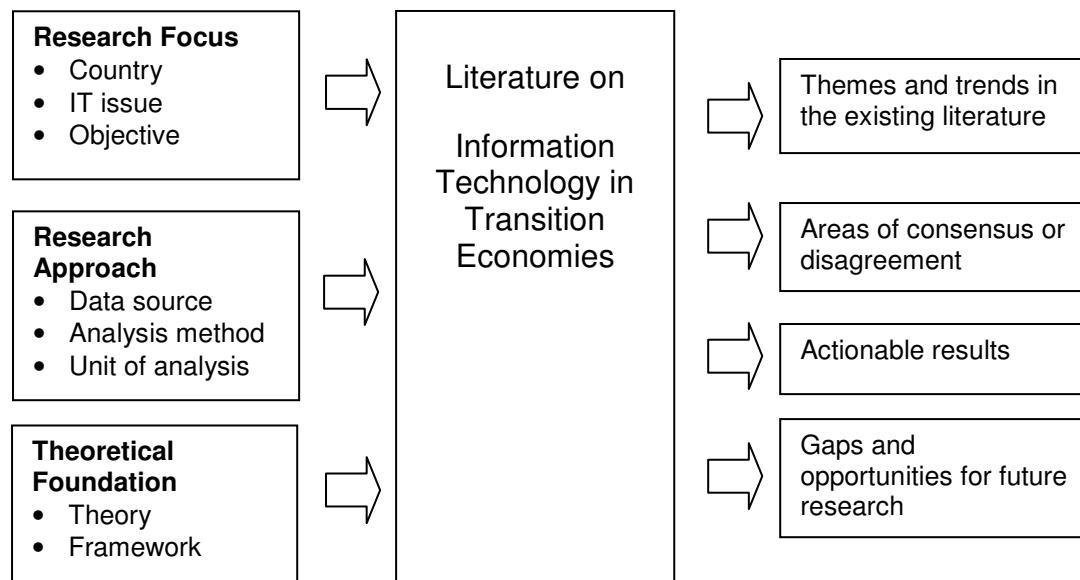


Figure 1. Analytical Framework – Perspectives and Outcomes

Review Procedure

As research procedure, we used key word search in library databases for titles of papers that include keywords such as information technology, information systems, transition economy, or specific country names (e.g. Czech Republic, Russia, Ukraine).

To be included in our study, the publication needed to fulfill the following criteria:

- (1) It had to be an academic paper (e.g. research paper, editorial, review) published in an academic journal.
- (2) It had to deal with information technology in a double or triple transition economy (i.e. we excluded China and Vietnam).

In our investigation, we excluded single-transformation economies, such as China and Vietnam, because unlike publications on IT in other transition economies, there is quite an abundance of literature dealing with IT specifically in China and related regions, and China and Vietnam have characteristics that differ substantially from the other transition economies that have experienced a greater magnitude of transformation (see Table 1).

In our literature search, whenever we came across a dissertation, working paper, or conference proceedings that seemed relevant from the topic area, we searched for publications by the same authors in journals, to see if some of their work had migrated into an academic journal.

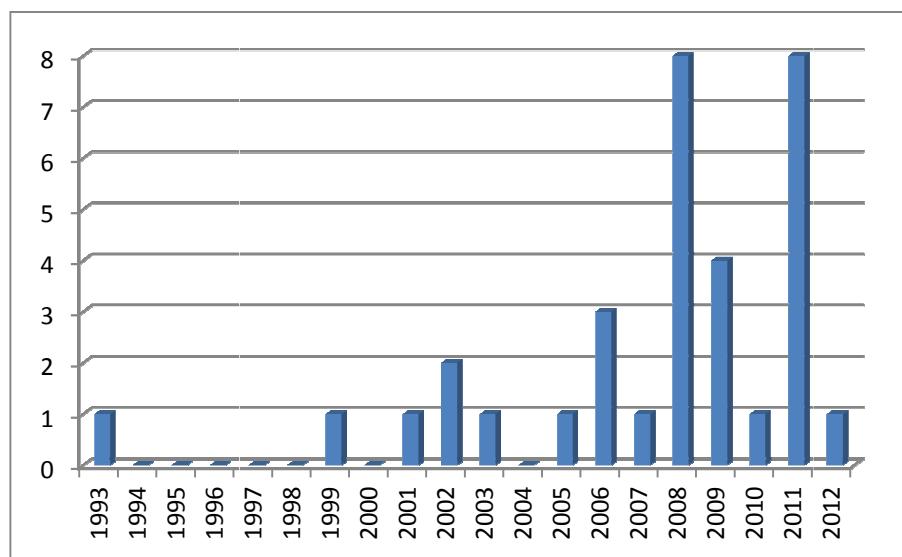
SAMPLE DESCRIPTION

We were able to collect 33 papers published in the years 1993 to 2012. The papers in our sample are listed in Table 2.

As can be seen from Table 2, the majority of the papers (22 out of 33) were published in 2008 or later. To some extent, this may be attributed to two special issues published in 2008 and 2011 respectively. The papers in our sample were published in 24 different journals. The journals that published the most papers were the *Journal of Global Information Technology Management (JGITM)* and *Information Systems Management (ISM)* (5 papers each). These two journals are also the journals that published the special issues, JGITM in 2008 and ISM in 2011. The distribution of the papers by journal is depicted in Table 3 while the distribution of the papers by year of publication is shown in Figure 1.

Authors	Focus of investigation	Countries	Source/method of data collection
Adelman (2001)	IT certification	Australia, France, Germany, Russia, Spain, UK	Multiple
Arogyaswamy and Nowak (2009)	Level of innovation	Poland	Secondary data sources
Batagan, Marasescu and Pocovnicu (2010)	E-commerce usage and consumer rights	Romania	Survey, questionnaire
Bernroider, Sudzina and Pucihar (2011)	ERP absorption	Austria, Slovakia, Slovenia	Survey
Cecez-Kecmanovic, Janson and Zupancic (2008)	Organizational Learning	Slovenia	Case study, secondary data
Dexter, Janson, Kiudorf and Laast-Lass (1993)	Issues encountered in IT environment	Estonia	Delphi method, round of questionnaires
Ghibutiu (2003)	E-commerce adoption	Romania	Secondary data, databases
Griffith (1998)	Implantation of new technology	Bulgaria, USA	US/Bulgarian students
Gurau (2002a)	On-line banking	Romania	Multiple (interviews, reports review)
Gurau (2002b)	On-line banking	Romania	Multiple (secondary data, questionnaire)
Hawk and McHenry (2005)	Offshore Software Industry	Russia	Case studies and literature analysis
Horvathova and Davidova (2011)	Talent management in IT companies	Czech Republic	Survey, phone interview
Harindranath (2008)	ICT industry	Hungary	Field research
Hovelja (2009)	IT deployment	Slovenia	Questionnaire
Ifinedo (2006)	IS management issues	Estonia, Norway	Delphi method
Ifinedo (2011)	E-government maturity	Multiple (16 transition economies)	Databases
Janson, Cecez-Kecmanovic and Zupancic (2007)	IT supported organizational learning	Slovenia	Multiple (interviews, document reviews, observation)
Luckman, Hackney, Popovic, Jaklic and Irani (2011)	Business intelligence	Slovenia	Questionnaire
Lonkila (2006)	Social networks of IT professionals	Russia	Web questionnaire
Lonkila and Gladarev (2008)	Cell phone use	Russia	Interviews
Piatkowski (2006)	IT for development	Multiple	Databases
Roztocki and Weistroffer (2008)	Research reports on IT in transition economies	Multiple	N/A
Roztocki and Weistroffer (2009)	Status of research on IT in developing, emerging, and transition economies	Multiple	Literature review
Roztocki and Weistroffer (2011)	Research on IT in transition economies	Multiple	N/A
Samoilenko (2008)	ICT investments	Multiple (18 transition economies)	Databases
Samoilenko and Osei-Bryson (2008a)	ICT investments	Multiple (18 transition economies)	Databases
Samoilenko and Osei-Bryson (2008b)	ICT investments	Multiple (18 transition economies)	Databases
Soja (2008)	Difficulties in enterprise systems implementation projects	Poland	Questionnaire responses
Soja and Paliwoda-Pekosz (2009)	Problems in Enterprise System adoption	Poland	Interviews
Soja (2011)	Enterprise System adoption	Poland	Interviews, semi-structured questionnaire
Themistocleous, Soja and Rupino da Cunha (2011)	Enterprise Systems life cycles	Poland, UK	Interviews
Weerakkody, El-Haddadeh, Sabol, Ghoneim and Dzupka (2012)	E-government implementation	Slovakia, UK	Case study a country level, secondary sources
Zoroja (2011)	Internet usage, e-commerce and e-government	Multiple	Databases

Table 2. List of the Papers in Sample

**Figure 1. Papers by Year**

	Journal	# of Papers
1	Digest of Electronic Commerce Policy and Regulation	1
2	Economic Annals	1
3	Electronic Journal of e-Government	1
4	Industrial Management & Data Systems	1
5	Information Systems Journal	1
6	Information Systems Management	5
7	Information Technologies & International Development	1
8	Information Technology for Development	2
9	Interacting with Computers	1
10	Interdisciplinary Description of Complex Systems	1
11	International Journal of Information Management	1
12	International Journal of Production Economics	1
13	Journal of Economics and Business	1
14	Journal of Financial Services Marketing	1
15	Journal of Global Information Technology Management	5
16	Journal of Information Technology for Development	1
17	Journal of Strategic Information Systems	1
18	New Media & Society	1
19	Post-Communist Economies	1
20	Roczniki Kolegium Analiz Ekonomicznych (Annals of the Collegium of Economic Analysis)	1
21	Tertiary Education and Management	1
22	The International Journal of Bank Marketing	1
23	Theoretical and Applied Economics	1
24	World Academy of Science, Engineering and Technology	1
	Total	33

Table 3. Papers by Journal

FINDINGS AND IMPLICATIONS

Our analysis of 33 papers reveals several interesting findings. First, there seem to be only relatively few key topics of investigation: adoption of enterprise systems, e-commerce, e-government, and payoffs from IT/ICT investments. Second, there are many authors who co-authored multiple papers in our sample. Third, while the 33 papers are distributed over 24 journals, with the exception of *JGITM* and *ISM* that published special issues on the topic, most journals published only a single paper. Fourth, as can be gleaned from Figure 1, only a few papers on the topic appeared in the 1990s while the majority of the papers in our sample appeared in the second half of 2000s. Fifth, most papers in our sample focus on transition economies that are now members of the European Union (EU) (Russia is the one transition economy not part of the EU that is the context of investigation in several of the publications). Sixth, the prevalent sources of data are surveys and databases. This stands in contrast to much of the published research on IT in developing countries, where the most common methodology used is case studies.

FUTURE RESEARCH AND CONCLUSIONS

The results presented in this paper are preliminary. We plan to continue with our research and expand our sample of papers and extend the scope of our analysis to more factors. By the time of the conference, we hope to provide a more complete picture on the topic. In summary, our intention is to assess the current state of the research on IT in double or triple transition economies and we believe that our paper will provide a solid foundation to guide scholars interested in this topic with their future research agendas.

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SELECTED THEORETICAL AND PRACTICAL ASPECTS OF STATISTICAL METHODOLOGY OF QUALITATIVE RESEARCH IN INFORMATION SYSTEMS

by

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ABSTRACT

Information technology (IT) is one of the fields of science (including computer hardware and software used to create, transmit, display and secure information), combining telecommunications, utilities, and other technology-related information. It provides to the users the tools by which they can obtain information, select it, analyze, process, manage and communicate to other people.

Information technology media may support very well the qualitative research, which is often essential and special in developing economies and transition circumstances. Special conditions and activities are needed to identify the situation, market, individual analysis and diagnosis. Simple structured surveys and questionnaires give not always full and accurate answers. Users may find good theoretical approach in information systems (IS) concerning qualitative research and tools helpful in research interpreting.

In the presented below article there appears a review of qualitative methods with respect to informative, statistical and philosophical aspects. One can find here the idea of qualitative research, including consideration over some methods of its application, evaluation and verification with the use of classic statistics and statistical optimization methods. Thus, on one side, the article serves as a review but on the other it is a proposal of how to utilize statistical methods (if its considered a matter of its own merits) in a qualitative research. The question – ‘Can one apply quantitative methods and statistics in qualitative research?’ is a subject matter in various discourses concerning methodology and ethics of qualitative research at different conferences as well as in literature. Ethics of qualitative research is connected with methodological, psychological (in reference to respecting the rights of research participants) and other aspects linked to use of the results in a social circulation.

KEYWORDS:

Information systems (IS), qualitative research, methodology of qualitative research

REVIEW AND CLASSIFICATION OF SCIENTIFIC METHODS.

Qualitative methods developed in social science during analyses of socio-cultural phenomena. The examples of qualitative methods could be among many: action research, case study research or ethnographic research. The sources of qualitative data are among many: observation or participant observation, surveys and questionnaires, documents, texts, opinions – participants monologues or impressions and reactions of a researcher.

From the beginning of the seventies of the previous century qualitative methods did not belong to the mainstream of examinations, nevertheless they were more often applied in social or pedagogical research or in the examinations over human resources management, informatics, medicine or in other fields. There were also other, alternative qualitative methods designed which put emphasis on the issues of reliability and analysis of data as essential factors in exploratory studies (Myers, Avison 2002, Stake 1994).

Scientific methods are classified in different ways but one of the most general is a division into qualitative and quantitative research (Myers, Avison 2002, Stake 1994).

Quantitative methods began to be used in life sciences – in physical phenomena analysis. At present quantitative methods are applied in socio – economical and psychological sciences e.g. in survey measures, experiments carried out in laboratory environment in so called formal methods (among many including also econometrics) or in methods of mathematical modeling (Straub et al. 2004).

The idea of creation and division of qualitative methods as opposed to quantitative ones emerged as a result of a statement that man as a human being is different to the rest of the world taking into consideration his capability to express himself not only in a verbal way but also e.g. through body language. According to some scientists, especially in the field of psychology, experimental manipulation (which can be treated as quantitative method) is not ethical because it trespasses the privacy of participants, undermines their self respect or jeopardizes health. Moreover, reduction of nature of human actions to measurements, numbers and physiology is ‘a distortion of the things experienced by people’ and experiments do not take into consideration such subjective factors as individual life history of participants (Paluchowski, 2000). Others believe that the authenticity of explanation in experimental model results from objective – statistical and practical – criterion.

Qualitative methods are designed to enable researchers to understand attitudes, behaviors, way of thinking and emotions in a social, cultural and economical context of life. Many scientists believe that if the aim of the research is to understand certain phenomena and to put it in a socio-institutional or cultural context, then carrying out the analysis only on the basis

of questionnaires, in which there appear fixed, already quantified textual answers, may lead to loss of valuable information or even may render the research meaningless (Kaplan, Maxwell 1994).

In humane sciences there is room for considerations over qualitative model whose sense lies in interpretation of content. Such model of cognition in science studies is defined as understanding. In psychology the qualitative research is justified with thesis acknowledging variety and irreducibility of psychological phenomena which can be divided into facts of nature and facts of culture. The subject of the qualitative research are first of all the facts of culture (material and spiritual reality created by a man), specific problems of unitary character which result from individual experience of a person and relate to experience of consciousness, world of personal meanings, expression, organization and intentional acts connected to reflection, will and conscience of an individual (Stras-Romanowska 2000).

A matter of argument in qualitative research is generalization of results, problem of authenticity and credibility of results. One can verify the authenticity of qualitative research e.g. interpretive (semantic) on the basis of mutual understanding (between researcher and participant or recipient of text and its author), feeling of palpability of researcher and his certainty of interpretation accuracy (Stras-Romanowska 2000), thus, it is an objective criterion. One of the methods of objectification is help of competent judges (competent interpreters) who can reach consensus in the matter of interpretive findings (Straś-Romanowska 2000). In statistical meaning the results can be objectively generalized to population only under certain conditions, enabling for instance application of statistical inference and statistical optimization (Kowal 2000, Kowal 2003 - see: 'Algorithm of elimination of ambiguous objects', examples 1-2 in chapter entitled ' Possibility of application of chosen methods of classical statistics and optimal experiments planning in qualitative research' in a current monograph) or some elements of mathematical theory of fuzzy sets if the shape of distribution of variables is difficult to define which can happen in case of small samples in qualitative research, with bigger dispersal and ambiguity of statements.

Majority of researchers decides to choose only one sort of method: qualitative or quantitative research. There is also a group advocating use of both at the same time during the same examination (Gable 1994).

Apart from diversification of the research into qualitative and quantitative one, among many, the division can be also made into:

- objective and subjective (Burrell, Morgan et al. 1979),
- connected with discoveries of general laws (nomothetic) and concerning uniqueness of individual situations (idiographic research),
- research oriented towards explaining and understanding phenomena which lead to prognostic (predictive) studies whose aim is description, forecast and modification;
- research considering external perspective (etic, outsider and researcher's perspective and taken from this perspective theory – for instance – in psychology – case study, psychographic method, psychological model) and internal perspective (emic, participant's perspective and his system of subjective meanings, for instance in psychology hermeneutical dialogue, autobiographical method – Bartosz 2000, Stras-Romanowska 1997).

NOTION OF QUALITATIVE RESEARCH IN THE FRAMES OF INFORMATION SYSTEM

Qualitative methods are more often used in socio-economical studies (in marketing, human resources or while examining of organization culture, Kuraś 2006)¹. In the presented paper the problems connected with 'qualitative research' are considered in the frames of information systems, in reference to applied methods, techniques and examination tools.

TECHNIQUES AND METHODS OF RESEARCH

Scientific research refers to studies and analysis which aim at proposing objective answers and formulate laws and regularities. Scientific research starts from formulating a scientific problem which can be understood as a question or a set of questions to which an answer is brought as a consequence of carried out research. The questions refer to objects, phenomena or processes which lie in the field of interest of researcher (Nowak 1970). In the process of scientific research the choice of methods, techniques and research tools are of crucial importance. First of all, it is crucial to define the subject matter, for what reason the examinations will be conducted, the method in which the research will be carried out in order

¹ The class of SI system is defined as a human activity system, thus a social system constituted not only by people but also by artificial (data, technical means) and abstract components (methods, organization, cf. Kowal 2006)

to obtain solution to posed problems and check the authenticity of connected to them hypothesis.

Scientific method can be understood as a strategy to obtain results, starting from philosophical theories, through scientific projects (defining primarily object of research, aims, assumptions, questions and hypothesis or target population) to methods of collecting and analysis of data. Most commonly, a chosen method requires specific abilities, conditions and measurements connected with examinations. The definition ‘method’ itself (often used interchangeably with such notions as ‘cognition model’ or ‘research methodology’) refers to a set of general assumptions having influence on the way of examinations, adjusted to its object and aim (Straś-Romanowska 2000). According to Kotarbiński a method can be defined as a strategy used systematically with intention to be repeated in a similar case (Kotarbiński 1957). Scientific technique (always connected to specific method) is often characterized as a way of realization of planned tasks as practical activities, regulated with a thoroughly created instructions allowing to obtain optimally verifiable information, opinions, facts (Kamieński 1974). Methods and techniques do not exclude each other but stay in a close relation and complement each other, whereas research tools (e.g. questionnaires, surveys, interviews, observations, statistical data, publications, personal documents) are instruments used in order to realize chosen scientific technique (Pilch 1977).

UNDERSTANDING OF QUALITATIVE RESEARCH

In psychological and sociological science some scientists consider qualitative research among many only as a verbal example and psychological analysis of patients, narrative research including analysis of content and finding hidden meaning or forecasting methods without taking into consideration quantitative aspect.

Many scientists define ‘qualitative’ as research of ‘qualitative phenomena’ e.g. such phenomena which in mathematical sense cannot be measured or weight but can be described verbally (for instance sex, color, type of mind or temper, kind of advertisement, reactions of recipients to promotional materials). However, separate objects can be ascribed to certain categories, the latter can be given numbers in an arbitral way and one can apply adequate quantitative methods. Research objects according to Stevens (1930) can be characterized with three kinds of properties (features): qualitative (e.g. sex or color), ordinal (level of education, number in ranking) and quantitative (weight, age, height). Properties can be ‘measured’ in proper scales – qualitative (nominal), ordinal, interval and ratio one. In many scientific works ‘qualitative’ is understood as research concerning qualitative properties of objects measured in categorical scales (Zajac 1988).

DIFFERENT PHILOSOPHICAL APPROACHES TO QUALITATIVE RESEARCH

Independently from the chosen kind of research its basics should always derive from universal philosophical assumptions. Among many, crucial importance is ascribed to epistemological foundations concerning knowledge and ways of acquiring it.

Science philosophers define scientific paradigms and categories that should build theoretical foundations for research. The most preferred in qualitative research is epistemological three-category approach: positivist, interpretive and critical. In literature concerning the subject matter there often appears discourse whether taken scientific paradigms or epistemological assumptions must be opposed or they can be used parallel.

Sometimes scientists identify qualitative research with interpretive one, however it is not always the truth, but it might result from taken theoretical assumptions. Character of the research results as well from the taken theoretical assumptions (e.g. case study) and can be independent from philosophical foundations. For instance a case study might be of a positivist, interpretive or critical character, whereas in research of activities one can apply a positivist, interpretive or critical approach (Kowal 2005, Orlikowski 2002, Richard and Boland 2002, Walsham 1993).

Positivist approach. In positivist approach the determinant of scientific knowledge is a method allowing for objective and unambiguous description and explanation of reality (Straś-Romanowska 2000). In this approach the assumption is that the reality is objective and can be described with use of measurable properties which are independent not only from the scientist or observer but also from the used research tools. In this approach the research is a trial of test or verification of theory, a trial of understanding the phenomena which allows for predictions. According to theory of information systems a positivist research is characterized with formal proposals (scientific and research hypothesis were formulated), analyzed variables were measurable, taken hypotheses were verified and results drawn on the basis of empirical data can be generalized. This kind of research differs from quantitative research with small number of populations and with not always complied condition concerning randomness of sample. If the above mentioned conditions are satisfied the research can be considered as positivist one including case study.

In order to obtain results in positivist approach there is a number of statistical methods used from statistical description, through point or interval estimation to verification of statistical hypothesis, as variables are measurable and hypothesis are formulated. A researcher can generalize the results on general population for instance through verification of statistical hypotheses and application of tests of differences significance, tests of

concordance or independency. Many scientists believe that such sort of qualitative research is more objective in the meaning of reliability and accuracy of the results.

Interpretive approach. In interpretive approach there always appears assumption that access to reality (given, functioning or constructed by some community) can be done only through some social constructions such as language, consciousness or common for some community way of thinking. Philosophical foundations for interpretive approach are hermeneutics and phenomenology. During interpretive analysis the researcher tries to understand certain phenomena through meanings given to them by people. Methods of interpretive research are directed to:

- creation and understanding of information system context, as well as
- description of a process according to which information process has influence on context and in reverse – the context has influence on the system.

In interpretive research there is no predefinition of dependent variable. In this type of research the most crucial thing is concentration on complexity of meanings which man gives to happening situations (Orlikowski 1991).

Critical approach. One variety of interpretive approach is a critical approach. Representatives of critical approach assume that socio – economical reality was constituted historically and results from activities of men. Reality is created and reconstructed by societies.

Authenticity of interpretive, semantic research is verified on the basis of agreement (between the researcher and researched, text recipient and its author) or feeling of obviousness of researcher towards defined relationship of sense, conviction of interpretation accuracy drawn from epistemological experience, knowledge, intuition, insight, authority (subjective criterion). Relationship of sense can be explained on the example of analytical therapy. Let us assume that motive of a black dog appears in dreams of a patient. The patient and his therapist together should find the meaning of the symbol appearing in dreams of the examined for instance whether a black dog symbolizes fears connected to certain kind of real situations. The method of objectification is help from the side of competent judges (competent interpreters) who should reach consensus in the field of interpretive establishments. The results can be generalized objectively to population only under certain conditions enabling application of methods of statistical inference and statistical optimization (Kowal 2006, por. Wawrynek 1977).

Utilization of statistical methods can sometimes help in clarification of a problem, despite the fact that in majority of qualitative approaches bigger importance is given to the

fact of appearance of certain fact rather than frequency of its appearance. Qualitative analysis on the basis of substantial assumptions should bring the answer to the question whether there appears a logical relationship between considered features. Quantitative methods for instance correlation or regression analysis cannot only describe the correlation between variable X and variable Y due to mathematical model but also characterize tightness of this relationship. Essential analysis (in fact, in the sense of philosophy of science, deductive one), often called qualitative or qualitative analysis, based on induction should give the answer to the question whether co-variableness or other cause/effect correlation can take place between the variables. There may appear some symptomatic relations between variables, which can serve as a base to forecast certain phenomena, nevertheless cause and effect correlation does not exist between them.

For instance, symptomatic correlation appears between the way people dress and snow melting. Most commonly, when spring comes, people wear lighter clothes, the snow melts, however, it does not mean that the kind of clothes is the cause of snow-melting. Nevertheless, we can forecast this process when we see people dressed in spring clothes. What causes the snow to melt is undeniably high temperature which appears during certain seasons of the year. It is a fact that we know from experience and it has its grounds in knowledge connected to physics or climatology. The forecast whether the cause and effect correlation exists can be done on the basis of experiments and substantive knowledge from literature on the subject matter. The results of statistical procedures cannot show unambiguously if a given relationship is of a cause/effect character. They only include information if data ‘fit’ tested model or whether certain variables can ground the base to forecast certain phenomena. On the other hand, an experiment, supported by substantive knowledge, can indicate a cause and effect correlation. For instance, we can conclude that certain method of memory training improves students’ perception if after a monthly training the results of memory tests in experimental group will be better than in control group which did not participate in trainings. The justification of the results must be, nevertheless, of substantive, qualitative and deductive character.

QUALITATIVE RESEARCH IN INFORMATION SYSTEMS IN METHODOLOGICAL AND PHILOSOPHICAL ASPECTS OF SCIENCE.

In many information systems (IS) qualitative research is presented in the frames of philosophical assumptions, however most commonly, it appears as studies in which qualitative data (such as interviews, surveys, documents, results of observations or case study) are analyzed in a substantive way

In such a perspective the aim of qualitative research is to gather understanding and explain socio-economical or psychological phenomena. In qualitative psychological research in hermeneutical version understanding is perceived as a form of explanation called explanatory, deductive or instrumental understanding (Straś-Romanowska 2000). Qualitative research allows us to give answers to such questions as 'why', 'for what reason', 'which are', 'what are', after the analysis of individual, free statements of respondents, analysis of behavior, gestures or creations. Such analysis is an arduous and time-consuming procedure, thus qualitative research is often carried out on a small scale, but can serve as grounds to formulate hypotheses which then can be verified in quantitative research realized on big populations (see table 1). In socio-economical examinations the most frequently used qualitative research is focus group interview (FGI) or in-depth interview (IDI). They are usually used to characterize some community (target group of for instance some market segment), not only in reference to inner motivations or emotional sensitivity threshold but also to attitudes, assessment of some phenomena or higher-order needs.

Table 1. Comparison of quantitative and qualitative research

Qualitative research	Quantitative research
Aims of the research: Theoretical aims: They result from substantive assumptions of researched problem concerning studied field, expressed in the language of words or pictures: 1) understanding, agreement, explanation (understanding, deductive, instrumental) and phenomena interpretation; 2) defining the object of research; 3) defining cognitive and practical aim; 4) posing cognitive questions concerning: a) features (properties) of examined phenomena (objects) b) kinds of relationships between features of phenomena c) correlations between examined phenomena d) formulating complementary questions of creative character (beginning with such expressions as 'what', 'with what reason', 'what are', 'which', etc., with structures which do not include information about researcher's thesis, nevertheless requiring elaborate answers (Straś-Romanowska 2000, Pilch i Bauman 1988, Such 1972, Ajdukiewicz 1928). Practical aims: Expansion of consciousness, improvement in quality of life	Aims of the research: Theoretical aims: The main aim of scientific cognizance is to gain the most compact, reliable, general, simple and containing maximum information knowledge (Such, 1972). On the basis of such cognizance it is possible to prove certain regularities and laws that govern them (Pilch, 1998). The aims of quantitative research result from the aims defined earlier on the basis of qualitative research and proper substantive assumptions expressed in language of logics and mathematics: 1) Description of object population, phenomena, their features and dependencies between them with use of mathematical, statistical functions, numbers; generalization of results to general population 2) Explaining and forecasting Formulation of directional 'wh-questions' (also starting with auxiliary verbs – do, does, etc., and 'whether', 'why', 'how') whose aim is to confirm or deny given thesis Practical aims: Control, interference in the course of events, forecasting
Subject matter: The world of human spirit, thoughts, facts of culture (Stras-Romanowska 2000)	Subject matter: The world of nature, facts of nature, natural, physical and socio-economical phenomena
Method of formulating scientific hypothesis. This method gives answers to complementary questions;	Method of formulating scientific hypothesis. This method gives answers to directional 'wh-questions' (also starting

'what', 'for what reason', 'why', 'in what way', 'what are', 'which', etc., but first of all they deal with 'why-questions' (cf. Ajdukiewicz 1928) but in understanding and interpretive approach, without references to numbers	with auxiliary verbs – do, does, etc., and 'whether', 'why', 'how') in reference to numbers, in the language of logics and mathematics: <ul style="list-style-type: none"> - which mathematical or statistical functions characterize objects, phenomena, their properties and dependencies between the features or groups of phenomena, - whether representative for general population data, gathered in quantitative research confirm hypothesis posed on the basis of qualitative research, - how we can interpret the obtained quantitative result
Character of cognition: Contextual, historical (ascribing sense) cognition (Stras-Romanowska 2000)	Character of cognition: Linear, sequential (describing causes) cognition
Size of examined population Usually small population, rarely random, chosen in purposeful manner	Size of examined population Usually statistically big object samples, chosen randomly, according to defined scheme
Connection type: Sense (semantic association: part – whole)	Connection type: Cause and effect, correlation, symptomatic
Criterion of truth: Phenomenological, semantic	Criterion of truth: Empirical, statistical
Generalizing of results to general population: In interpretive approach the results are usually not generalized to population. Whether the interpretive, semantic cognition is authentic can be decided on the basis of mutual understanding (between the researcher and the participant, the text recipient and its author) or the feeling of conviction of interpretation accuracy towards defined sense relationship drawn from epistemological experience, knowledge, intuition, insight, authority (subjective criterion). The method of subjectivization is help of competent judges (competent interpreters) who must reach consensus in interpretations (Straś-Romanowska 2000). The results can be objectively generalized to population only under certain conditions which enable application of methods of statistical inference or statistical optimization(Kowal 2000).	Generalizing of results to general population: Numerical results can be generalized to the general population with previously assumed probability, on the basis of methods of statistical inference (point estimation, confidence intervals, verification of statistical hypothesis)
Research scenario: Flexible scenario, dependent not only on research method but also on situation, mood or instant idea of researcher or examined person.	Research scenario: Most commonly based on secondary sources, physical measures or structured questionnaire in which respondents tick the answers on scales e.g. Likert, Thurstone, Stampil scale, etc.
Influence of researcher on course of research – quite big	Influence of researcher on course of research – substantially smaller, as the research should take the course defined by created phases of the project, in the realization process there are at least a few thoroughly qualified persons employed
Character of interpretation of results - Big objectivism not only of the researcher but also of participants (especially in hermeneutical approach)	Character of interpretation of results – the interpretation is more objective, usually based on methods of statistical inference.

Source: own work and on the basis of literature: (Paluchowski 2000, Brzeziński 1996, Straś-Romanowska 2000, Pilch and Bauman1988, Such 1972, Ajdukiewicz 1928) and own research

SUMMARY

Qualitative researches are more and more often carried out in socio-economical, humanities sciences and in practice, in different theoretical approaches (positivist, interpretive or critical) and with use of miscellaneous methods and techniques (most frequently in focus group interview, brain storming, individual in-depth interviews, copy tests, experiments or observations).

This process can be seen in information systems on the Internet where at www pages we can encounter advertisements of firms - public opinion research centers which offer carrying out of qualitative marketing research, creation of new look for companies, products or forecasting of changes in management and organization (e.g. analysis of managers' consciousness and sensitivity to changes in management, identification of examined problems or projections of results utilization in counseling concerning planning of operating strategy (Ragin, 2007). In western culture a dominant politics of globalization of economy and culture takes into account national and cultural diversity which can be better understood due to help of qualitative rather than quantitative research (Paluchowski 2000). This is why many research projects within the frames of the European Union applies, at least in some part, a qualitative paradigm. Qualitative and quantitative methods can co-exist and be mutually completing. The choice of proper procedure is made, in majority of cases, with help of researcher's paradigm and his ontological and epistemological assumptions. If we assume only different methods, for instance in-depth interview, observations and questionnaires carried out in a parallel way, then opposing qualitative and quantitative method is unjustified as the methods used in them are empirical, based on data acquired from respondents.

On the other hand if we assume different research paradigms (with different ontological and epistemological assumptions) then the two approaches can be treated as opposed.

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Empirical analysis of ICT, economic growth and competitiveness in the EU

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ABSTRACT

For the time being, the digital revolution represents a key factor for a competitive and sustainable global economy and the Information and Communication Technologies bring an important contribution to the economic recovery. In the emerging economies, ICT play a decisive role in the economic, social and personal development.

Worldwide, all types of technologies have progressed but ICT represents a key factor for the economic growth in emerging countries.

The paper aims to accomplish an analysis of ICT sector in the EU Member States during 2006 – 2010 period. The comparative study is investigating the relation between the global competitiveness and the ICT sector share in national economies in the EU27.

Keywords: ICT, economic growth, competitiveness, emerging economies

INTRODUCTION

The digital era or the information era has a significant influence on society and organizations, involving important changes both at organizational and individual level.

The ICT use “becomes essential for the largest part of active population in the developed and emergent countries” (Baltac, 2011).

The emerging economies faced the financial and economic crisis storm in 2008-2009 by making fast and effective measures at fiscal and monetary level.

According to IMF analyses concerning „emerging Europe”, within the framework of the EU, one may speak about EU emerging state, thus referring to Bulgaria, Hungary, Latvia, Lithuania, Poland, Romania.

“Growth in emerging Europe is projected to remain unchanged from last year—at 4.4 percent in 2011—and then to decline to 3.4 percent in 2012”, as stated by IMF study.

According to the World Bank studies on a sample of 20,000 businesses in 50 developing countries, “companies using ICT see faster sales growth, higher productivity, and faster employee growth.”

All national economies are significantly shaped by the opportunities concerning the information generation and communication. These activities are essential in view to create and disseminate knowledge. The continuous improvement of ICT – internet, mobile phones, electronic banking services – are significantly transforming how the knowledge is generated and communicated, implicitly how the institutions, markets are operating or how the economies are developing. In the 21st century, they are providing a new electronic communication infrastructure for economy, able to transmit all forms of information –data, pictures, voice, music, movies, video – by means of global networks at reduced costs, triggering the increase of the number of opportunities, their diversification in light to generate and communicate information in the national economies.

Taking into consideration the broad and intensive use of ICT, the economies are transforming into knowledge economies where the activities related to the generation, dissemination and application of knowledge represent the main factor for economic growth and development.

Knowledge becomes a “public-private” good and it “incorporates the characteristics of a public good with decisive impact on the economic development” (Matei and Matei, 2011). This transformation is expressed both by “the rapid increase and development of new ICT and their application in the sectors of economy” (Freeman C., Louca E., 2001).

In this context, it is important to understand that ICT represent new products, services and also factors aimed at transformation of the economic and social processes and activities. Firstly, ICT leads to the increase of the speed and number of modalities aimed at the transfer of information. Secondly, ICT may store and transfer various types of information in electronic format. These two aspects of ICT trigger the change of modalities for the

information use in the processes of production and consumption. As stated by Bresnahan and Trajtenberg (1995), they represent „genuine engines of the economic growth”, as they dispose of a broad range of users and at the same time they are complementary to other activities.

The Central and Eastern European countries are facing significant challenges concerning the adaptation of their economies in light to compete efficiently on the European and world markets. Among these challenges, it is worth to remark the necessity to increase productivity, to adapt the structure of economy in a global knowledge economy, to intensify innovation and develop new products and services which should meet the changing demand at national and international level.

ICT may support all the above challenges by: increasing the productivity, increasing the component „knowledge” for goods, services and production processes, enhancing the capacity of organisations to identify and respond in real time to the changing demands on the national and international markets, enabling the innovations for products and services, leading to start up of new companies, improving the skills and adaptability of labour force.

ICT sector has a powerful impact on the economic performance as it is characterised by a high degree of technological progress and productivity and it has also an important social impact. According to the World Summit on the Information Society (WSIS), the objectives envisaged by 2015 comprise the Internet connection of schools, health institutions, libraries, the introduction of ICT in school curriculum.

At the same time, ICT is also considered as an important factor in view to accomplish the Millennium Development Goals especially in the following fields: health, education, promotion of gender equality.

On one hand, Berndt et al. (1992) analysed the contribution of ICT capital to US productivity growth and presented a negative relation. Parsons et al. (1990) stated that the banks in Canada did not have good benefits further their ICT capital investments. Also Morrison (1997) described a weak relation between ICT and the economic growth in US.

On the other hand, other studies in the field literature described a positive and important relation between ICT and economic growth. Lau and Tokutsu (1992) analysed the contribution of ICT investment on economic growth in the US for 1960-1990 period, revealing that half of the economic growth in the US was due to ICT investment. Schreyer (2000) achieved an analysis concerning the impact of ICT on labor productivity in the G7

nations, stating that countries as Germany, France, Italy, UK, Japan, US and Canada, had important benefits from ICT investment, mentioning the average annual labour productivity growth during 1990 - 1996. Daveri (2000) extended Schreyer's (2000) study to other eleven OECD countries, concluding that ICT contribution to the economic growth was significant. Poh (2001) analysed the impact of ICT investment on productivity in Singapore during 1977 – 1997, revealing that ICT capital triggered an important contribution to the economy. Kim (2003) investigated the impact of ICT on productivity and economic growth in Korea during 1971-2000, revealing the significant contribution of ICT to the economic growth and labor productivity growth. Kuppusamy and Santhapparaj (2005) investigated ICT impact in Malaysia during 1975 – 2002 while Kuppusamy and Shanmugam (2007) analysed ICT development during 1983 – 2004, concluding that ICT investment had an important role in the country's economic growth. Also Kuppusamy investigated the impact of ICT investment achieved by the private and public sector on the economic growth in Malaysia during 1992 – 2006.

Various studies have analysed the effects of ICT investments on the economic performance worldwide. The „Socio-economic Impact of Internet in Emerging and Developing Economies” study (Boston Consulting Group, 2009), estimates that the Internet penetration increase by 10% in emergent economies leads to a GDP incremental increase by 1% or 2%. Similarly, the GDP growth rate in a developing country may reach 0.59% annually, corresponding to an increase of 10 mobile telephones/100 inhabitants.

“ICT is an essential factor for productivity and economic growth” highlights Leonard Waverman (2010), the dean of Haskayne School of Business, Calgary University. “ICT should be used in view to accelerate the global development, as it represents the essential infrastructure of the 21st century”.

For the developed countries, the impact of the broadband penetration is very important for their economic growth. According to “Economic Impacts of Broadband, Information and Communications for Development, 2009”, the increase of the broadband access in developed countries by 10 subscribers/100 inhabitants corresponds to an increase by 1.2% of GDP per capita.

Europe 2020 Strategy emphasises Information and Communication Technologies (ICT) as an important factor in light to overcome the financial and economic crisis and to enhance the EU economic growth and competitiveness.

Based on the wide range and intensively use of ICT, the economies are transforming into knowledge economies, where the activities concerning the generation, diffusion and application of knowledge represent a key aspect for the economic growth and development.

The EU Member States are facing significant challenges concerning the adaptation of their economies and the increase of their competitiveness both on the European and international market.

Taking into consideration the need of the EU Member States to increase the productivity, to increase the components of knowledge for goods and services, to enhance the capacity of businesses in view to respond to changing demands, to facilitate the innovation of goods and services, to improve the skills and adaptability of labour force, ICT can bring a relevant contribution.

1. ICT sector size in the EU area

The complexity of the actual global economic environment acknowledges and fosters the qualitative and quantitative aspects of growth, triggering the integration of ICT.

As specified in the field literature (Mansel et al., 2009), as well as in the recent academic researches, ICT represents a *General Purpose Technology*, revealing the following characteristics:

- “it has a powerful impact on competitiveness as it constitutes an *enabling technology*;
- it leads to process and product *innovations*;
- it improves the *business processes* along the whole value chain”.

ICT represents “a collection of technologies and applications, enabling electronic processing, storing, retrieval and transfer of information to a wide variety of users or clients” (Matei and Savulescu, 2012).

According to Cohen, Salomon and Nijkamp (2002), the main features of ICT are as follows:

- “very dynamic technological changes, with rapid penetration and adoption rates;
- decreasing costs for new equipment;
- a rapidly increasing range of applications and penetration in an increasing number of realms of professional and personal life;

- an intertwined institutional market place, with the private sector acting in a decreasingly regulated environment (in most countries);
- a production and services package dependent on a range of qualities of skilled human resources, and
- a convergence of technologies".

As defined by OECD, ICT sector comprises ICT manufacturing and ICT services (OECD, 2011).

The most important benefits of ICT derive from their effective and efficient use. At the same time, ICT investments are enhancing the labour productivity. The use of ICT allows the companies to enhance their efficiency and to make them more competitive. Making efficient the channels of distribution, intensifying the collaboration and partnerships, by a rapid pace of financial transactions, by achieving more dynamic and transparent processes, ICT can speed up the flow of products and services.

It is worth to remark that ICT constitutes one of the leading sectors in the EU, influencing powerfully the economic growth. In this respect, it is worth to mention:

- For the EU as a whole, the percentage of the ICT sector on GDP, in other words the value added at factor cost in the ICT sector as percentage of Total value added at factor cost represents 4.74% as average for the 2006 – 2010 period (Table 1).
- In 2011, above three quarters of 16-74 aged persons have used the computer in the EU Member States. The highest weight of the 16-74 aged persons who have used the computer is in Sweden (96%), Denmark, Luxembourg and the Netherlands (94%), and the lowest is in Romania (50%), Bulgaria (55%) and Greece (59%). In most EU Member States the share of young people who used a computer was above 95%. The weight of individuals in the EU who designed a computer software was 10% among the 16-74 aged persons (Eurostat, News release 47/2012).

Table 1 GDP, ICT sector size and the share of ICT sector in national economies in the EU Member States during 2006-2010 period

Country	GDP 2006*	ICT 2006*	%ICT on GDP. 2006	GDP 2007*	ICT 2007*	%ICT on GDP. 2007	GDP 2008*	ICT 2008*	%ICT on GDP. 2008	GDP 2009*	ICT 2009*	%ICT on GDP. 2009	GDP 2010*	ICT 2010*	%ICT on GDP. 2010	Ave. GDP*	Ave. ICT*	Ave. %ICT on GDP
Austria	259.00	11.42	4.41	274.00	10.30	3.76	282.70	9.07	3.21	274.80	9.21	3.35	286.20	9.99	3.49	275.34	10.03	3.64
Belgium	318.70	15.94	5.00	335.60	16.38	4.88	346.10	16.82	4.86	340.40	16.27	4.78	354.40	16.98	4.79	339.04	16.48	4.86
Bulgaria	26.50	1.54	5.81	30.70	1.84	5.98	35.40	1.90	5.36	34.90	1.98	5.67	36.00	1.99	5.52	32.70	1.85	5.67
Cyprus	14.70	0.66	4.50	15.90	0.63	3.97	17.20	0.60	3.48	16.80	0.63	3.73	17.30	0.62	3.60	16.38	0.63	3.86
Czech Rep	118.30	5.68	4.80	131.90	6.11	4.63	154.30	7.07	4.58	141.50	6.52	4.61	149.30	6.86	4.59	139.06	6.45	4.64
Denmark	218.70	11.13	5.09	227.50	11.92	5.24	235.10	12.30	5.23	223.90	11.72	5.24	235.60	12.33	5.23	228.16	11.88	5.21
Estonia	13.40	0.62	4.64	16.10	0.74	4.57	16.30	0.74	4.52	13.90	0.63	4.55	14.30	0.65	4.53	14.80	0.68	4.56
Finland	165.70	13.60	8.21	179.80	16.42	9.13	185.60	13.10	7.06	172.50	13.96	8.10	179.70	14.52	8.08	176.66	14.34	8.12
France	1798.10	79.84	4.44	1886.80	83.40	4.42	1933.20	80.03	4.14	1889.20	79.54	4.21	1932.80	82.72	4.28	1888.02	81.15	4.30
Germany	2313.90	107.60	4.65	2428.50	114.63	4.72	2473.80	103.16	4.17	2374.50	98.78	4.16	2476.80	106.75	4.31	2413.50	106.24	4.40
Greece	208.80	5.72	2.74	222.70	6.04	2.71	232.90	5.87	2.52	231.60	6.06	2.62	227.30	5.84	2.57	224.66	5.91	2.63
Hungary	89.60	5.74	6.41	99.40	5.80	5.84	105.50	6.24	5.91	91.40	5.37	5.88	97.10	5.72	5.89	96.60	5.78	5.99
Ireland	178.30	12.55	7.04	189.90	12.00	6.32	179.90	11.10	6.17	160.60	10.03	6.25	155.90	9.68	6.21	172.92	11.06	6.40
Italy	1493.00	58.82	3.94	1554.20	59.99	3.86	1575.10	56.07	3.56	1519.70	55.32	3.64	1553.20	57.62	3.71	1539.04	57.59	3.74
Latvia	15.90	0.49	3.11	21.00	0.65	3.09	22.80	0.66	2.89	18.50	0.51	2.78	17.90	0.49	2.76	19.22	0.56	2.93
Lithuania	24.10	0.78	3.22	28.70	0.77	2.70	32.50	0.71	2.19	26.60	0.65	2.43	27.50	0.76	2.78	27.88	0.74	2.66
Luxemb.	33.90	1.80	5.31	37.40	1.93	5.17	39.40	1.98	5.03	37.40	1.91	5.10	40.30	2.04	5.07	37.68	1.93	5.14

Malta	5.00	0.24	4.70	5.40	0.25	4.60	5.80	0.26	4.56	5.80	0.27	4.58	6.10	0.28	4.57	5.62	0.26	4.60
Netherlands	540.20	36.73	6.80	571.70	36.59	6.40	594.50	36.92	6.21	571.10	38.89	6.81	588.40	36.83	6.26	573.18	37.23	6.50
Poland	272.10	10.34	3.80	311.00	10.64	3.42	363.20	11.95	3.29	310.40	10.31	3.32	354.30	11.90	3.36	322.20	11.08	3.44
Portugal	160.80	6.42	3.99	169.30	6.74	3.98	171.90	6.58	3.83	168.50	6.50	3.86	172.60	6.77	3.92	168.62	6.60	3.92
Romania	97.70	3.51	3.59	124.70	4.31	3.46	139.70	4.67	3.34	118.20	4.02	3.40	124.00	4.18	3.37	120.86	4.15	3.43
Slovakia	44.50	2.11	4.74	54.80	2.64	4.81	64.40	2.90	4.51	62.80	2.88	4.59	65.70	3.06	4.66	58.44	2.72	4.66
Slovenia	31.00	1.27	4.11	34.50	1.41	4.08	37.20	1.27	3.41	35.30	1.32	3.75	35.40	1.27	3.58	34.68	1.31	3.78
Spain	985.50	37.45	3.80	1053.10	40.65	3.86	1087.70	40.79	3.75	1047.80	38.04	3.63	1051.30	38.79	3.69	1045.08	39.15	3.75
Sweden	318.10	21.92	6.89	337.90	22.10	6.54	333.20	21.52	6.46	292.40	18.63	6.37	349.20	22.38	6.41	326.16	21.31	6.53
UK	1943.80	162.70	8.37	2054.20	181.80	8.85	1008.70	84.23	8.35	1564.50	132.67	8.48	1706.30	146.74	8.60	1655.50	141.21	8.53
EU 15	729.10	39.23	5.38	768.17	40.87	5.32	711.99	35.39	4.97	724.59	37.03	5.11	754.00	38.53	5.11	737.57	38.19	5.18
EU 25	462.60	23.08	4.99	489.65	23.80	4.86	459.96	20.97	4.56	463.68	21.65	4.67	483.80	22.64	4.68	471.94	22.43	4.75
EU 27	432.94	21.52	4.97	459.14	22.27	4.85	432.37	19.63	4.54	435.00	20.27	4.66	453.89	21.15	4.66	442.67	20.96	4.74

* The data are in billion of euro.

Source: Matei and Savulescu, ICT Market in the EU Member States – key factor for the knowledge economy, IAPNM 2012, based on data from Eurostat

According to Table 1, the national trends concerning the dynamics of ICT sector are quite different in comparison with the national economic performance. For example, in 2006 the ICT sector contributed with 4.97% to the EU GDP, in 2007 with 4.85%, in 2008 with 4.54%, in 2009 with 4.66% and in 2010 with 4.66%.

In fact, if we accomplish a correlation analysis between the variables described in Table 1, we obtain:

Table 2 Correlations on the evolution and contribution of ICT sector related to the economic growth

		mean GDP	mean ICT	mean W_ICT
mean GDP	Pearson Correlation	1	.928(**)	.129
	Sig. (2-tailed)		.000	.496
	N	30	30	30
mean ICT	Pearson Correlation	.928(**)	1	.366(*)
	Sig. (2-tailed)	.000		.046
	N	30	30	30
mean W_ICT	Pearson Correlation	.129	.366(*)	1
	Sig. (2-tailed)	.496	.046	
	N	30	30	30

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Source: the authors

From Table 2 we obtain a powerful correlation between the size of ICT sector and GDP evolution (average 2006 – 2010). Simultaneously, the correlation between ICT contribution (mean ICT) to GDP is very small (0.129) and at the same time, between ICT and its contribution to GDP (mean W_ICT) (0.366). The explanations derive both from the methodology in view to determine ICT contribution to GDP and the influence of the economic and financial crisis which have determined constraints to ICT potential in GDP evolution.

In 2008, the economic and financial crisis has diminished the European economy and the same trend is valid for the ICT sector. During 2006-2010 period, the average of ICT sector size is higher in UK, Germany, France, Italy, Spain, Netherlands and lower in Malta, Latvia, Cyprus.

As shown in Table 1, the highest average share of ICT sector in economy is recorded in UK (8.53%), Finland (8.12%), Sweden (6.53%), Netherlands (6.50%), while the lowest average

value is registered in Greece (2.63%), Lithuania (2.66%), Latvia (2.93%), Romania (3.43%), Poland (3.44%). The average share of ICT sector in national economies in EU15 is 5.18%, in EU25 is 4.75% and in EU27 is 4.74%.

According to Professor Baltac, President of CEPIS and Vice-Chairman of WITSA, nowadays, ICT development is shaped by several trends: spread of mobile applications, communication in broadband, increase of content in networks and Internet, web services represent platform of transactions (Baltac, 2011).

2. Empirical comparative analysis

2.1 Competitiveness

According to the European Commission (1999), the competitiveness represents “the ability to produce goods and services which meet the test of international markets, while at the same time maintaining high and sustainable levels of income”. Porter (2007) sustains that “the most intuitive definition of competitiveness is a country’s share of world markets for its products”.

The annual *Global Competitiveness Reports* of World Economic Forum accomplish an analysis concerning the factors highlighting the national competitiveness. The World Economic Forum has substantiated its competitiveness analysis on the Global Competitiveness Index (GCI), which measures the microeconomic and macroeconomic fundamental elements of national competitiveness.

GCI comprises 12 key elements: institutions, infrastructure, macroeconomic environment, health and primary education, higher education and training, goods market efficiency, labour market efficiency, financial market development, technological readiness, market size, business sophistication, innovation. They are powerfully interrelated and tend to reinforce each other, and a weakness in one area often has a negative impact on other areas. For example, a strong innovation capacity will be very difficult to achieve without a healthy, well-educated and trained workforce, which is keen to assimilate new technologies, and without sufficient financing for R&D or an efficient goods market that makes possible to undertake new innovations to market.

Table 3 Global Competitiveness Index (GCI) in the EU Member States during 2006-2011 period

Country	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	Average	Country	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	Average
Austria	5.3	5.2	5.2	5.1	5.1	5.18	Lithuania	4.5	4.5	4.4	4.3	4.4	4.42
Belgium	5.3	5.1	5.1	5.1	5.1	5.14	Luxembourg	5.2	4.9	4.9	5	5	5.00
Bulgaria	3.9	3.9	4	4	4.1	3.98	Malta	4.5	4.2	4.3	4.3	4.3	4.32
Cyprus	4.4	4.2	4.5	4.6	4.5	4.44	Netherlands	5.6	5.4	5.4	5.3	5.3	5.40
Czech Rep	4.7	4.6	4.6	4.7	4.6	4.64	Poland	4.3	4.3	4.3	4.3	4.5	4.34
Denmark	5.7	5.6	5.6	5.5	5.3	5.54	Portugal	4.6	4.5	4.5	4.4	4.4	4.48
Estonia	5.1	4.7	4.7	4.6	4.6	4.74	Romania	4	4	4.1	4.1	4.2	4.08
Finland	5.8	5.5	5.5	5.4	5.4	5.52	Slovakia	4.5	4.4	4.4	4.3	4.2	4.36
France	5.3	5.2	5.2	5.1	5.1	5.18	Slovenia	4.7	4.5	4.5	4.6	4.4	4.54
Germany	5.6	5.5	5.5	5.4	5.4	5.48	Spain	4.8	4.7	4.7	4.6	4.5	4.66
Greece	4.3	4.1	4.1	4	4	4.10	Sweden	5.7	5.5	5.5	5.5	5.6	5.56
Hungary	4.5	4.3	4.2	4.2	4.3	4.30	UK	5.5	5.4	5.3	5.2	5.3	5.34
Ireland	5.2	5	5	4.8	4.7	4.94	EU 15	5.2	5.1	5.1	5.0	5.0	5.0
Italy	4.5	4.4	4.4	4.3	4.4	4.40	EU 25	5.0	4.8	4.8	4.7	4.7	4.8
Latvia	4.6	4.4	4.3	4.1	4.1	4.30	EU 27	4.9	4.7	4.7	4.7	4.7	4.7

Source: Matei and Savulescu, ICT Market in the EU Member States – key factor for the knowledge economy, IAPNM 2012, based on Global Competitiveness Reports 2006–2011

As revealed by Table 3, the top performers are Sweden (5.56), Denmark (5.54), Finland (5.52), followed by Germany (5.48), Netherlands (5.40), UK (5.34), Austria (5.18), acknowledging that they are the most competitive economies in the EU. At the other extreme, the weak performers are Bulgaria (3.98), Romania (4.08), Greece (4.10), Latvia (4.30), Hungary (4.30). As indicated by Table 3, the values for the average of GCI in the EU emerging countries, i.e. Bulgaria, Romania, Latvia, Hungary, Poland, Lithuania show their last positions concerning the global competitiveness in the EU ranking.

It is worth to mention that Estonia (4.74) is the best competitive economy among the EU accession 12.

2.2 Comparative analysis of share of ICT sector in national economy and competitiveness

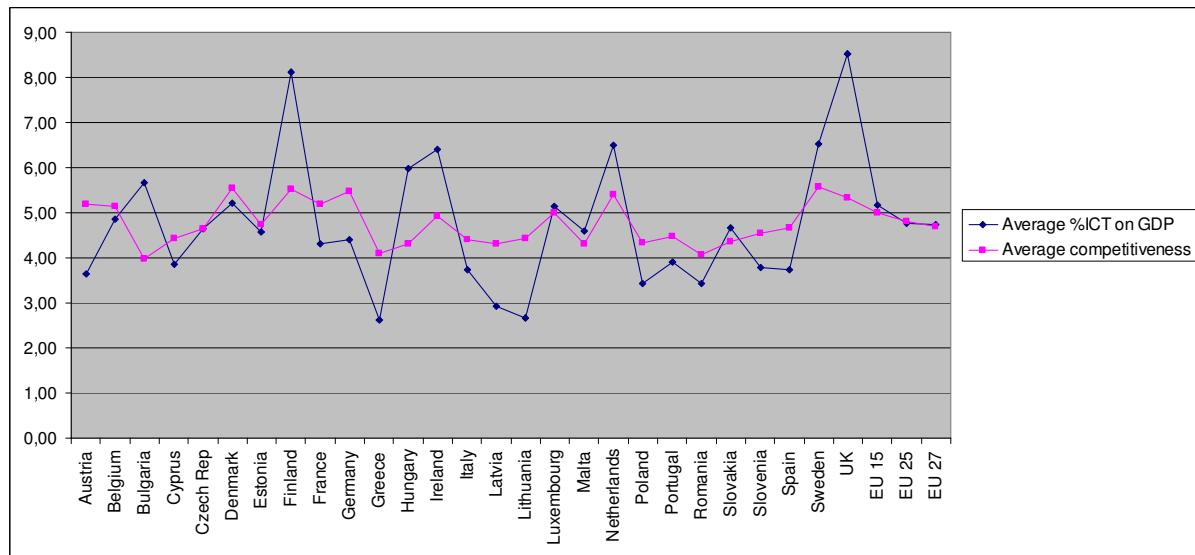
We accomplish a comparative analysis concerning the share of ICT sector in national economy and competitiveness in the EU 27 during 2006-2010 period.

Table 4 Averages for share of ICT sector in national economy and competitiveness
in the EU 27 during 2006-2010

Country	Average %ICT on GDP	Average Competitiveness	Country	Average %ICT on GDP	Average Competitiveness
Austria	3.64	5.18	Lithuania	2.66	4.42
Belgium	4.86	5.14	Luxembourg	5.14	5.00
Bulgaria	5.67	3.98	Malta	4.60	4.32
Cyprus	3.86	4.44	Netherlands	6.50	5.40
Czech Rep	4.64	4.64	Poland	3.44	4.34
Denmark	5.21	5.54	Portugal	3.92	4.48
Estonia	4.56	4.74	Romania	3.43	4.08
Finland	8.12	5.52	Slovakia	4.66	4.36
France	4.30	5.18	Slovenia	3.78	4.54
Germany	4.40	5.48	Spain	3.75	4.66
Greece	2.63	4.10	Sweden	6.53	5.56
Hungary	5.99	4.30	UK	8.53	5.34
Ireland	6.40	4.94	EU 15	5.18	5.0
Italy	3.74	4.40	EU 25	4.75	4.8
Latvia	2.93	4.30	EU 27	4.74	4.7

Source: Matei and Savulescu, ICT Market in the EU Member States – key factor for the knowledge economy, IAPNM 2012

Figure 1 Representation of the averages for share of ICT sector in national economy and competitiveness in the EU 27 during 2006-2010



Source: the authors

Analysing the averages for the share of ICT sector in national economy and competitiveness (Table 4, Figure 1), Finland and UK are the countries that have a much higher value for share of ICT sector in national economy in comparison with GCI. At the other extreme, Greece, Lithuania represent the countries recording a lower value for the share of ICT sector in national economy in comparison with GCI.

It is worth to mention that Estonia is the best performer among EU accession 12 at both competitiveness and ICT sector share in GDP.

Table 5 presents the correlation analysis between competitiveness (mean GCI) and ICT sector contribution to GDP.

Table 5 Correlation competitiveness/weight ICT/GDP

		mean W_ICT	mean GCI
mean W_ICT	Pearson Correlation	1	.588(**)
	Sig. (2-tailed)		.001
	N	30	30
mean GCI	Pearson Correlation	.588(**)	1
	Sig. (2-tailed)	.001	
	N	30	30

** Correlation is significant at the 0.01 level (2-tailed).

Source: the authors

We remark a positive correlation of average size (0.588), justified by the complex methodology in order to determine GCI, as well as different standard deviations (1.43 for mean W_ICT and 0.48 for mean GCI) under the terms of approximately equal means (4.75, respectively 4.76) of the two variables. The direct dependency between the two variables is also obtained from the following equation of linear regression:

$$\text{mean GCI} = 3.824 + 0.198 \text{ mean W_ICT}$$

$$(0.255) \quad (0.051)$$

In a concrete situation, one may estimate that an increase by 1% of ICT contribution to GDP could lead to an increase by 4.2% of competitiveness, precisely by a percentage comprised in the interval (3.27, 5.28).

Conclusions

As revealed by the paper, ICT are playing a significant role in the economic growth and competitiveness.

The ICT social and economic benefits are not confined by national borders as the latest technologies enable to the best and brightest people in each country to have access worldwide.

Governments, which once focused on the concrete issues of building infrastructure and providing access to citizens, are beginning to recognize that technology itself is not as important as the socio-economic achievements it can engender—for example e-health programs, e-government services. Both public and private organisations have also recognized that ICT is not just a factor for cost-cutting and more efficient activities, but it represents an essential factor in view to open the dialogue with consumers and other stakeholders through various types of digital communication: digital marketing, mobile advertising, social networks, e-commerce.

ICT in the knowledge economy will be successful through the huge joint efforts of all stakeholders in the EU countries: parliaments, governments, ministries, agencies, universities, industry, private sector, political parties, NGOs, media, individuals.

In this context, concerning Romania, Professor Baltac stated: “Romania should do efforts in light to increase its IT readiness, which refers to connectivity, information security, improvement of e-business environment and development of human potential. Thus,

Romania should encourage large-scale access to Internet and ICT in general on an affordable geographical and social base. Also it is important to improve the access and use of Internet for business and education, to develop the business environment through a better legislation, to speed-up the development of digital infrastructure, Internet, telecommunications, including e-commerce infrastructure, large scale investment in training and educating people, to promote digital literacy and e-education, to improve security of information and databases. The Government should continue to provide incentives for investments in the IT infrastructure, to make investments in the public education and continue e-government projects”.

In Romania, the most successful e-government projects comprise the national system of electronic payments, single electronic contact point, electronic system of public procurement, e-job, e-tax, info kiosks, computerised system for high-schools, computerised system for transport authorisations.

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An investigation of e-Government Services in China

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ABSTRACT

This objective of this research is to understand the adoption of e-government services in China, especially in the cities of Beijing, Shanghai and Shenzhen. An online survey was conducted to investigate the level of awareness, usage and satisfaction of e-government services in these cities. The survey questionnaire, translated in Chinese, was sent to some 330 participants (110 from each city). The findings show that e-government services in China are not that advanced to address the actual expectations of the communities. There is a general mismatch between what the governments wish to provide online with what the communities see value in. Inadequate promotion, lack of content and the design of the website are some of the factors that limit the value in the e-Government services. The paper also provides suggestions as to how the local governments of Beijing, Shanghai and Shenzhen can improve the adoption of e-government services.

KEYWORDS:

Chinese e-government, government websites, Beijing, Shanghai, Shenzhen.

INTRODUCTION

The Internet has provided governments all over the world with the opportunity to deliver their services effectively through e-Government websites or portals. However, the objectives as well as the strategies to develop information and communication technology (ICT) differ in various types of economies – developing, emerging and transition economies (Roztocki & Weistroffer, 2009). For instance, in emerging economies, ICT is used to support its growth as a means to reach out to its rapidly growing customer base whilst in more mature economies, it is used to manage and enhance its services more effectively (*ibid*, 2009). In a similar manner, various governments in emerging or developing economies are tapping on ICT to serve its communities and citizens more efficiently and effectively. However, when governments build e-Government services, they need to understand and consider the

fundamental characteristics of its populations' digital literacy, economic status of its citizens, as well as the status of its digital infrastructure for successful or pervasive adoption by its citizens and communities.

In a way, China is no different from many other governments trying to deploy ICT to reach out to its citizens and communities effectively. Indeed, with the tremendous speed in economic, social and cultural developments in recent decades, the Chinese government needs to disseminate more information to its communities and citizens. In fact, arising from the rapid economic developments in China's main cities, its e-government plays a particularly important role in meeting the citizens' needs. For instance, with increased regulations that need to be disseminated and updated, it is necessary to build e-government services to bring about transparency and openness on such information as bidding for public projects, informing employment opportunities, updating price index of goods and services.

Indeed, for the part of improving government transparency and citizen outreach, e-government plays an important role (Li, 2006). The electronic space is especially useful for citizens' outreach, getting feedback from the community, or hearing out complaints and exposing public crimes and bad behaviors. For example, in some cities, the Governor's Mayor's mail box has been very successful with feedback and complaints. Some other features like discussion forums and public opinions surveys are also attracting people who wish to express their expectations as well as to connect with government departments. In recent times, e-government websites offer opportunities for the Chinese citizens to engage in political activities although it is still in its infancy (ibid, 2006). Because of the importance of this public interaction with government, it is critical to understand the effectiveness of and level of satisfaction in these e-government services.

In 1992, under the direction of the China Communist Party (CCP), the State Council general office developed the ICT plan to build an office automation system for national administration. A year later, the three "Golden Projects" were launched to establish a sophisticated information network across the country. The "Golden Project" is a series of separate information infrastructure initiatives aimed at developing an information economy and promoting administrative capabilities. The "Government Online Project" (GOP) started in 1999 and with a focus on "administrative reform" was aimed to provide better services to its citizens. Using information and communication technologies (ICTs), the objective was to improve administrative efficiency and effectiveness, so as to expand the economic development and administrative capacity. Thus, setting up government websites would

provide the public the chance to acquire information and procure services online quickly and efficiently.

The development of China's digital government can be viewed as an approach for its government to reform its mode of management, to optimize the administrative processes, to improve operational efficiency, and to reduce administrative costs (Zhang et al., 2005). As traditional administrative processes are usually department-oriented and can no longer meet the requirements of the modern society, future administrative processes should be customer-oriented, starting from request of services and ending with the delivery of public services. The redesigned processes are supposed to reduce unnecessary overheads and inefficiencies that tend to exist in traditional physical services. Modern digital government should provide reliable, convenient services to citizens anytime anywhere.

Indeed, the Chinese government identified four key objectives for developing its e-Government websites. The first objective is to provide information online, in other words, government information, news and events, such as the 2008 Olympic Games should be readily available. In other words, the links to newspaper, journals, government laws, regulation and major public agencies/department websites are important. The second objective is to provide online services, and indeed, many government websites have improved significantly in recently years, like Beijing e-government that provides e-services such as the filing taxes, applying business licenses and loans, applying for marriage certificates, passport and citizen ID cards. The third objective is to enable government transparency and openness and the fourth objective, is to reach out to the citizens as well as to enable feedback and comments from the communities.

E-GOVERNMENT WEBSITES IN CHINA

In this study, we selected the government websites of three cities, namely, Beijing, Shanghai and Shenzhen because these cities are considered to have relatively high levels of development in ICT. Located in the north, east and south of the country respectively, these cities have followed very different development paths over the past 20 years.

Beijing, the capital of China, is recognized as the political, educational and cultural center of the country. There are over 12 million people living and working in this city. Beijing is a vital inland transportation hub, connecting dozens of railways, freeways and international flights. The city is fast changing due to rapid economic development. In this environment, e-government has become a useful platform to deal with the enormous information exchanging

between public communities and government organizations.

Shanghai, on the other hand, is the largest modern city in China with a population of about 20 million people, and is seen as the “window to the world”, leading the way in construction, finance, and communications. With the busiest ports in China, and close proximity to Japan and Korea, Shanghai is often considered the most advanced city in China. With all of the diverse community needs, online governmental service in this city is promoted as a benchmark.

Shenzhen is the first of the Special Economic Zone (SEZ) cities, located in Southern China with a population of about 10 million people. It is the provincial capital of Guangdong province, situated north of Hong Kong. Since the late 1970s, Shenzhen has been one of the fastest growing cities in the world, and has been a long time destination of foreign investment. "Shenzhen Government Online" was built up to serve the rapidly increasing population from all over the world. Although e-government was established latter than the other two cities, its relative improvement is impressive.

To provide the context of the study, the government websites of Beijing, Shanghai and Shenzhen were established in 1998, 2002 and 2006 respectively (for the new version of "Shenzhen government online"). All of them have three language versions, simplified Chinese, traditional Chinese and English, so as to reach the greatest number of people. Because of the different cultures and focus of each government, the websites have different characteristics. Please refer to Appendix B (Beijing), C (Shanghai) and D (Shenzhen) to see the screenshots of the homepage of the three websites.

Beijing's e-government provides a comprehensive communication channel for collecting public opinions as there is a program where the government officers are invited to explain the policies online, and answer the questions that the public are concerned with. It is interesting that Beijing e-government also provide information such as folk stories, local food, which is very helpful, especially for foreigners. For instance, for the Olympic Games in Beijing, there was an introduction of the city of Beijing, including e-services such as flights booking and accommodation/hotel booking.

Shanghai's e-government provides e-services that are close to people daily life, e.g. information on water and electricity fees, payment of tax online etc. As the commercial center of China, the e-government services provide investment guide, governmental preferential policy, online business consultant etc. There is also a WAP version for users to access via mobile phone. Although the website provides e-services, however, it is not well designed, and

the layout can be confusing and messy. Also, some information is not updated and worse some links are dead.

Shenzhen's e-government has a tidy and clear layout, and the information is well organized, with different types of information color-coded or by title, e.g. information are in blue, e-services are in yellow. As the strongest growing city in China, its e-government provides abundant information for investors and visitors whilst there are no e-services for transactions.

Comparing the three e-government websites, Beijing provides the most comprehensive information, and its interactive communication with public appears the best, and the most updated. Shanghai provides the best e-services, as many services could be done online, however, the layout of Shanghai e-government website is a rather messy and the classifications are not very distinct, which can be confusing to users. Shenzhen has the best layout and user can locate information easily. The information is updated; however, the e-service is not very good, since users cannot do the online applications on this e-government site. Overall, there are still lot potentials to improve the e-governments in China, especially for most e-services, as only form downloading is available, users still cannot complete the whole process online. It is important that the websites be concerned about the type of information and quality of services they provide in order to increase the frequency of visits. However, the some of the current e-government websites tend to be "propagandistic"; they tend to provide superficial service, unverified or unscientific content and sometimes the classifications of services are problematic (Zhou, 2005). In order for the websites to be useful and to enhance government services, it is essential to strengthen the awareness of "user-centered", communicate with users frequently, understand the needs of users, analyze users' preference, explore service programs with strong practicability, as well as making more effort to improve service quality.

As each of these cities has different backgrounds, politics, economics and cultures which are also reflected in the style and positioning of the e-government solution, we are motivated to understand the e-government services in each of them. Thus the objectives of the research are as follows:

- To identify the types of online content and services provided for citizens,
- To understand the adoption, usage and satisfaction of the e-government services.
- To evaluate the problems, which affect the development of government websites

RESEARCH METHOD

An online survey was conducted to investigate the objectives of the research investigation. The survey questionnaire was developed based on research conducted by Lee et al. (2006). The questionnaire consisted of four components as follows: (1) demographics, (2) awareness of online government services, (3) usage in terms of frequency and duration of the websites, and (4) satisfaction of the online government services.

The questionnaire was translated into Simplified Chinese and went sent to a total of 330 individuals who live in Beijing, Shanghai and Shenzhen (110 participants in each city). The participants were randomly chosen by the researchers who invited each participant on email to respond to the questionnaire. This survey was conducted over a period of 3 weeks.

As the aim of the research is to understand the services that are provided in the government websites in the different cities - Beijing (www.beijing.gov.cn), Shanghai (www.shanghai.gov.cn) and Shenzhen (www.shenzhen.gov.cn), we reviewed the existing government sites to identify the types of services that were available, how the content was structured as well as to understand the distinctive characteristics of each e-government website. Appendix A provides the types of services that were indicated on the various websites of the cities.

FINDINGS AND DISCUSSIONS

Of the 330 participants, 238 responded, providing a response rate of 72 percent. The total 238 responses were as follows: 85 from Beijing, 53 from Shanghai and 100 from Shenzhen, thus giving the response rate as - 77 percent, 48 percent and 91 percent respectively. In terms of the profile of the respondents, 148 (62 percent) are female and 90 males (38 percent). Overall, most respondents (74 percent) are fairly young, between 18- 30 years, whilst 24 percent between 31-50 years old. The results show that overall, most respondents (81 percent) have relatively high education with qualifications of undergraduate degree; Shanghai having the highest percentage of degree holders, (90 percent) followed by Shenzhen (88 percent) and Beijing (68 percent). In terms of internet usage, 95 percent of the respondents have been using the internet for over one year, although 33 percent said that they do not own a computer. The probable reason for high internet usage is perhaps most of them are office workers and therefore they could get access to the internet from their workplace.

Overall most respondents are aware of the government websites (82 percent) with only a

small 18 percent not being aware of such websites. Surprisingly, Beijing has the highest respondents who are not aware (34 percent) and 66 percent being aware of e-Government website; whilst Shenzhen has only 5 percent people who do not realize there is a e-government website. A possible reason for this outcome could be that as the launch was only some 6 years ago in 2006, the Shenzhen e-government's promotion may be effective. Respondents from Shanghai has 86 percent being aware and 14 percent not being aware of the website.

In terms of visiting the e-Government websites, overall 80 percent have visited whilst about 20 percent have never visited the websites. We asked them the reasons for not visiting the websites and the results show 42 percent prefer to use other approaches to get government services, whilst 21 percent said that they do not know the website address and 21 percent said that they do not know how to use these e-services. Interestingly, some 16 percent said that they do not know what types of services are available. In other words, even though they use the internet, they do not use e-government services, the plausible reason could be the poor design of the website.

We asked the respondents what channels they used to obtain public information, and it is interesting to note that people in Beijing and Shenzhen prefer the internet (see Figure 1), whilst those in Shanghai tend to like the newspaper more as well as getting information from formal announcements. The reason for this phenomena is probably because the respondents in Shanghai tend to have more traditional habits. Google searching is another channel indicated by our respondents in the option of “Others”.

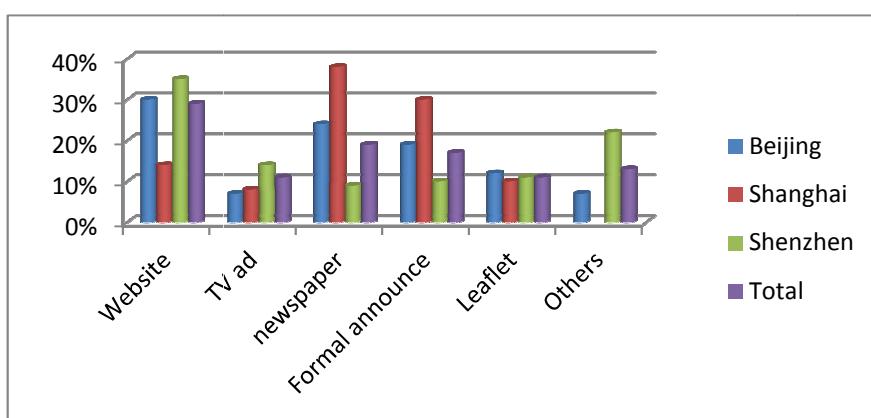


Figure 1: Channels for getting public information

Figure 2 shows the frequency of the respondents visiting the government websites. Overall, a large majority (65 percent) visit the websites few times a year, whilst 22 percent visit only a few times a month. This result implies that the engagement of e-government in

public life is very low. There are two plausible reasons; the first is that they realize the website is always not updated; and the second is that they are not having much confidence in online system.

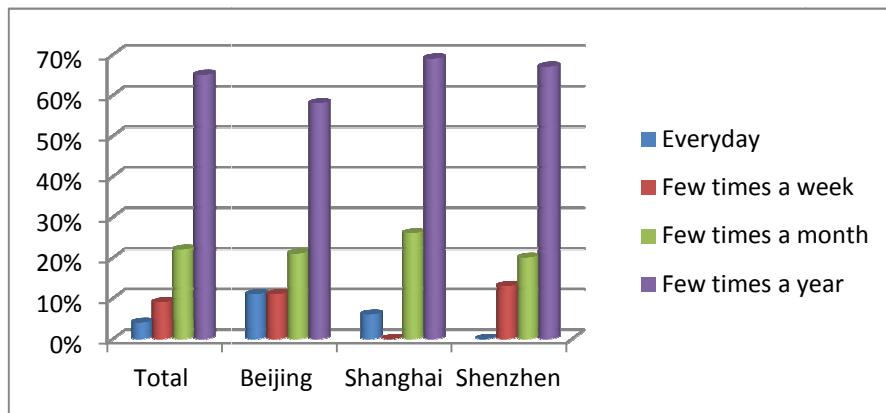


Figure 2: The frequency of visiting government webistes

Overall, only 15 percent of respondents have used e-service over three years as shown in Figure 3. Considering that the e-governent has been developed more than ten years ago, the results show that the public engagement of e-Government is quite low. Low accessibility and immature website system design could be the possible reasons for the problem. However, in the last 1-3 years, there appears to be an increased usage of e-Government in Beijing and Shanghai.

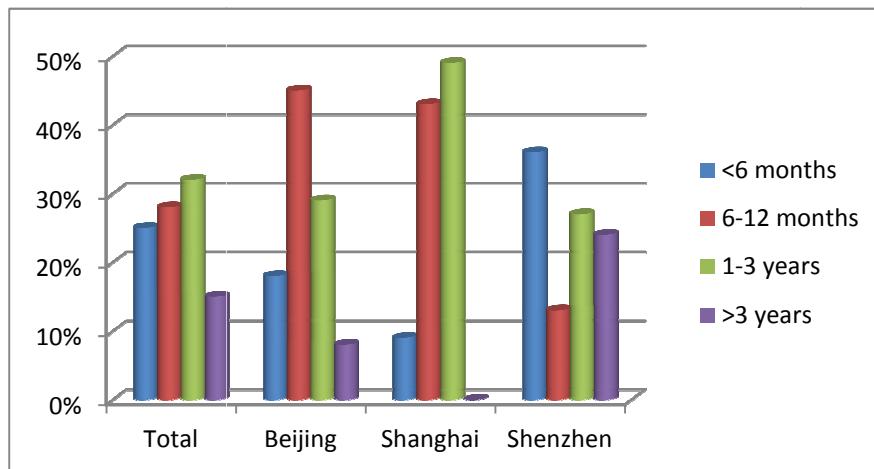


Figure 3: Duration of usage of e-service

Most repondents think the e-government websites are useful, and topping the factors (see Figure 4) include – accessing the services at any time (25 percent), do not have to queue (21 percent), much easier as there are no documents (21 percent). Saving time and high effectiveness are also major reasons for people to consider its usefulness, especially in rapidly developing cities. On the other hand, there are respondents who do not think that the websites

are useful giving the following reasons: the website is too complicated, (35 percent), lack of instructions to use the websites (33 percent) and the internet access is not always available. However, there is still a small proportion who prefer the traditional approach (14 percent). The online government mode is still not so acceptable, and it appears to be reflective of a common problem of government websites in China.

To evaluate the satisfaction of e-Government services, Figure 5 shows that from the point of view of information searching, "Shenzhen Government Online (SGO)" is the one with most satisfaction level of "OK" (67 percent), while 71 percent think the Shanghai government website is bad. Actually, this result fits well that SGO is simpler in content arrangement than that in Shanghai.

In terms of the friendliness of the website interface, Figure 6 shows that 50 percent of respondents in the three cities are only "OK". It is interesting to note that some 40 percent in Shanghai think that its website has a good interface. On the other hand, 44 percent in Shenzhen consider its interface has a bad website design.

Figure 7 shows that the flow of e-service in Shenzhen and Beijing websites are considered as "OK" with 59 percent and 53 percent respectively. However, the result shows that 49 percent of respondents in Shanghai think its e-government website is bad on processing online services. It indicates that the e-service quality in Shanghai needs to be improved.

In terms of online response speed, as shown in Figure 8, all three websites are comparable and were "OK" with 39 percent from Beijing, 49 percent from Shanghai and 60 percent from Shenzhen.

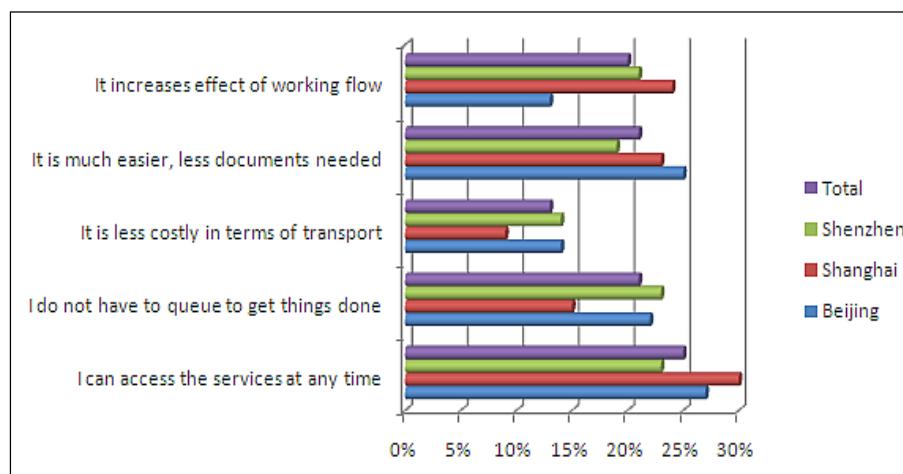


Figure 4: Opinion of usefulness

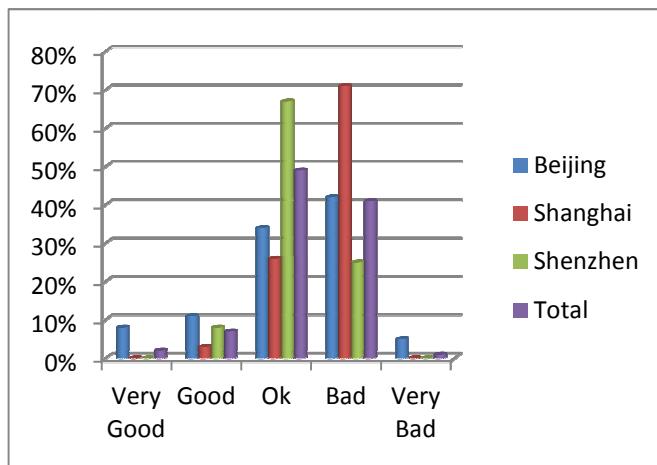


Figure 5: Easy to find information

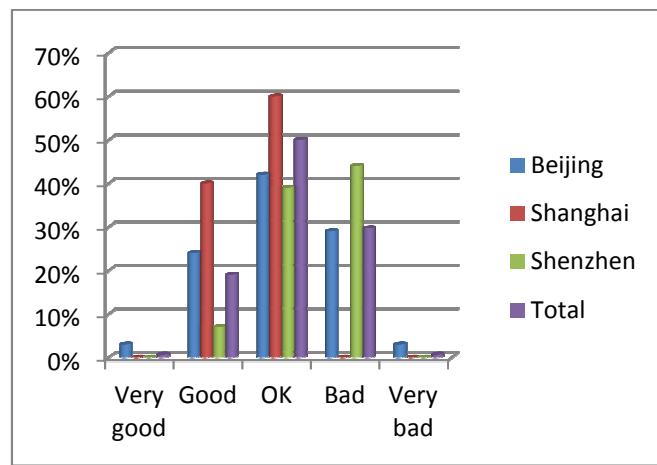


Figure 6: User-friendliness of the interface

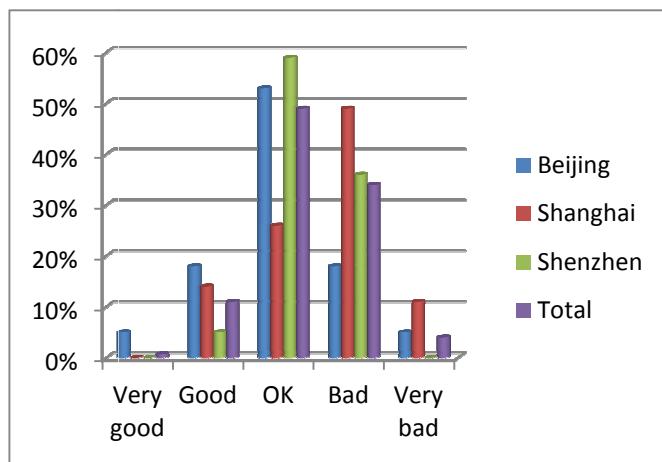


Figure 7: The process flow of online service

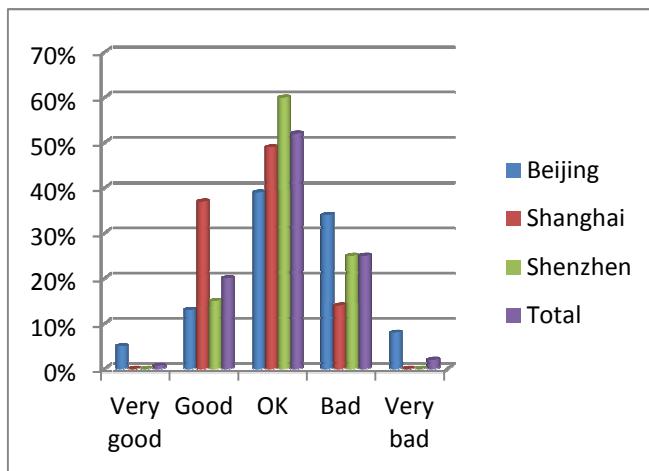


Figure 8: The response speed online

In terms of the types of e-services, and the satisfaction regarding the services, Table 1 shows the types of e-Services of the three cities. The findings show that only few respondents marked “very good” or “very bad” while they evaluated most e-service as “good”, “OK” and “Bad”. Online services of the “Senior citizen portal” had not been marked as “used” at all, which means this kind of service is of little use. Almost the same situation applies for “National Service” – only one vote is selected. The fact that senior citizens and soliders have very low usage to use internet and therefore the government should spend too much resources implementing such services. Yet, on the other hand, it may just be the respondents are fairly young working adults and yet to visit such website.

In Beijing, the commonly used items are education, housing, mailing service and online enquiry. In Shanghai, the popular items include tax services, social insurance and labour legal issues. In Shenzhen, the popular items include social insurance, visa service, education and labour laws. Overall, the e-services in all the three government website are just at the average level of ‘OK’. In fact, it appears that the satisfaction of both website design and e-service processes is just an "OK".

Service item	Amount of participants			VERY Good			Good			OK			Bad			Very Bad		
	BJ	SH	SZ	BJ	SH	SZ	BJ	SH	SZ	BJ	SH	SZ	BJ	SH	SZ	BJ	SH	SZ
Marriage Registration	2	2	20				2			1	16		1	4				
Temporary resident certification	1	13	10				1	9			4	5		5				
Register permanent residence	6	5	20	1			1	5	11	4		9						
Birth registration	3		5	1						2		5						
Housing (purchase/rental)	24	17	20	3			5	3	10	8	10	10	4	4		4		
Social Insurance	17	23	65		1		4	3	15	6	15	41	7	4	5		4	
Medical care	18	4	20				4	3		11	1	20	2			1		
Labour/legal	22	19	40				6	3	16	10	2	19	5	14	5	1		
Tax Service	12	24	15	1			1			8	15	10	1	9	5	1		
Education matters	27	21	50		8		13			9	8	33	5	5	17			
National Service	1						1											
Mailing service	25	14	45				10	11	13	11	3	21	3		6	1		5
Senior citizen portal																		
Visa service	14	17	65	1		5	4	2	24	8	6	23	3	9	13			
Online enquiry	27	17	20	1	1		8	1	6	8	2	4	7	10	7	3	3	3
Total votes	8	10	5	58	42	95	86	66	216	38	55	67	11	3	12			

Table 1: Types and rating of the e-services of Beijing, Shanghai and Shenzhen
 (Note: BJ-Beijing.gov.cn, SH-Shanghai.gov.cn, SZ-Shenzhen.gov.cn)

CONCLUSION

Overall, there are three basic principles of e-government development in China. The first principle is to support economic development, the second is to promote the transformation of government functions and the third is to provide transparent services to the citizens and communities. The research findings show that the e-government websites of Beijing, Shanghai and Shenzhen in China are developing along these three guiding principles to provide a good platform for public communication with the government. Although there is a rise in the numbers of people using e-government services, there are still a lot people who do not know that the e-government websites exists, or do not use e-government due to many various factors such as access to the internet, do not own a computer, do not see the need to go online etc. But the most important is the lack of promotion or publicity by the governments themselves to educate citizens on how to use e-government services.

It appears that currently the e-government websites in China are more focused on distributing information about political policies; they either lack e-services or have limited online services as in most instances the website only provide forms for downloading. A problem with bad website arises from dead links or that the information has not been updated.

In fact, most of the respondents who have experiences in using e-government services think the services are just “OK”. After almost ten years development since the nation-wide e-government initiative was launched in 1999 by the Chinese government, we still see the early forms of e-government infrastructure. Despite the development of e-government, especially in advanced cities such as Beijing, Shanghai and Shenzhen, it appears that the e-government services are just rudimentary. It appears that China has a long way to go in terms of providing effective digital services to its people.

Based on our findings, it appears that there are various problems that the Chinese government needs to address to provide more useful and effective e-government services. Even in the most advanced cities of China like Beijing, Shanghai and Shenzhen, there are still quite a large portion of citizens who are not aware of the existence of e-government services. Thus, China’s e-government services are still at the initial stage compared to some other developing countries which are also providing e-Government services. Unfortunately, in China, there are a number of significant barriers that need to be addressed to improve e-government effectiveness. For instance, it is very hard to change traditional views to accept and apply e-government services in a short timeframe. This of course requires the changing of mindset that will take time in terms of the providers, the government officials and the users or citizens. Also, the traditional government operational systems and infrastructure, which are largely based on the planned economy of the past, tend to hold back the development of e-government due to the problems of overlap of departmental functions, lack or no standard procedures, and finally the complexity involved in the administrative processes, systems and leaderships.

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Appendix A: Service items provided on Beijing, Shanghai, and Shenzhen Government Website

City/Service	e-governance	e-service	e-knowledge
Beijing.gov.cn	1) Mayor mailbox 2) Complaint and prosecution 3) Administrative affair hotline 4) Online interview video 5) Survey and idea collection 6) Email addresses list 7) Message board	1) Residence registration 2) Visa application 3) Marriage and adoption 4) Driver license 5) Small & medium business affairs 6) Hotline service and online enquiry 7) Application form downloading	1) News press release 2) Legal regulation 3) Organization responsibility 4) Financial management 5) Human resources, crime supervise 6) Education plan, food quality control 7) Old story 8) Special topic reports 9) Pictures and e-magazine 10) Site map navigation 11) Q&A and online enquiry 13) Quick links and search engine
Shanghai.gov.cn	1) Mayor window 2) News channel 3) Government Politics 4) Economics information 5) Investment information 6) Public opinion survey 7) Public scrutiny information 8) Public affairs 9) Q&A (for policy interpretation) 10) Connected links	1) Declare damage 2) Complaint only 3) Meters check 4) Online approve on coal business 5) Agriculture products 6) Second-hand cars business 7) Military products 8) Auction business 9) Animals slaughter business 10) Online legal aid 11) Traveling and tourism 12) National exam registration 13) Bill payments	1) Demographic information, history 2) Tourist information 3) Include view-points 4) Transportation information 5) Culture 6) Sports 7) Public accommodation information 8) Shopping 9) Food 10) House 11) Transportation 12) Entertainment 'live in shanghai' information
Shenzhen.gov.cn	1) Mayor Information 2) Leader mail box 3) Consultation and complaint 4) Online survey 5) Public opinion collection 6) Online interview video and message board 7) Government branch mail box addresses 8) Online survey and public opinion collection	1) Residence registration 2) Marriage registration 3) Education and employment 4) Medical care 5) Housing 7) Social insurance 8) National service 9) Finance and tax 10) Business registration & Certificate 12) Intellectual property issues 13) Finance and tax 14) Human resource	1) Government policy announcements 2) Government news and gazette 3) Statute and archives 4) Human resources 5) Finance publicity 6) Special topic reports 7) User guide 8) Approach Shenzhen 9) Investment direction

Appendix B: Beijin.gov.cn Screen shot

The screenshot displays the official website of the Beijing Municipal People's Government. Key features include:

- Top Navigation Bar:** Includes links for '市容 市人大 市政府 市政协' (Urban Environment, NPC Standing Committee, State Council, CPPCC), weather information ('天气: 晴 20°C / 阴 18°C'), and a search bar.
- Central Government Portal Banner:** Features a banner for the 'Beijing Olympic Organizing Committee' with a countdown to the 2008 Olympics (121 days).
- Content Area:**
 - Home Page:** Shows a banner for 'Self-built Residential Buildings Can Apply for Rent-to-Rent Services'.
 - Today's Beijing:** News items about the 16th International Olympic Conference and the opening of a public service conference.
 - Government Affairs Services:** A large section listing various services such as birth registration, household registration, marriage registration, education, culture, health, labor, social security, taxation, etc.
 - Special Topics:** Includes a banner for 'Spring Festival Cultural Activities'.
 - Services by Region:** Lists government departments from central to district levels.
 - Services by Function:** Categories like 'Business Services', 'Social Services', 'Public Services', and 'Special Services'.
 - Information Services:** Includes a 'City Comprehensive Information Service' section.
 - Feedback and Consultation:** Options for 'Feedback', 'Consultation', and 'Feedback'.
 - Events and Announcements:** A column for 'Upcoming Events' and 'Announcements'.
 - Bottom Footer:** Includes links for 'Central Government and State Council Websites', 'Provincial and Municipal Government Websites', 'Higher Education Institutions', 'News Media Websites', and a 'Help' section.

Appendix C: Shanghai.gov.cn Screen shot

The screenshot shows the official website of the Shanghai Municipal Government (www.shanghai.gov.cn). The top navigation bar includes links for the central government portal, Chinese version, English version, WAP wireless portal, and personalized customization. A search bar is also present.

The main content area features a banner for "Effortless Construction - International Shipping Center". Below the banner, there are several sections:

- Government Information Disclosure:** Includes links to the Shanghai government's mission statement, government documents, and a detailed list of recent policy notices.
- Online Services:** Offers various services such as road toll payment, tax declaration, and online application forms.
- Query Services:** Provides access to social security, housing fund, medical insurance, and other public service information.
- Public Participation:** Features a forum for citizens to comment on government policies.
- Consultation:** A section for citizens to ask questions and receive answers from government officials.
- Information Disclosure:** A comprehensive section listing all government documents, regulations, and policies.
- Emergency Management:** Information on emergency preparedness and response.
- Interactive Community:** A platform for citizens to communicate with government leaders.
- Shanghai Investment:** Information on foreign investment, industrial development, and investment projects.
- City Life Services:** Various services for daily life, including traffic, education, health, and tourism.
- Government Department Websites:** Links to specific departments like the Development and Reform Commission, Economic Commission, Education Commission, and Science and Technology Commission.
- Feedback System:** A form for users to provide feedback or suggestions.

At the bottom, there is a footer with copyright information, a link to the Shanghai People's Government website, and links to the Shanghai government's Weibo account, Sina Weibo, and official website.

Appendix D: Shenzhen.gov.cn screen shot

The screenshot displays the homepage of the Shenzhen Government Online website. At the top, there are language options: 简体中文版 (Simplified Chinese), 繁體中文版 (Traditional Chinese), English, and 个性化定制 (Customized). The header features the "深圳政府在线" logo and a search bar with a "高级检索" (Advanced Search) button.

The main content area is organized into several sections:

- 信息公开**: Includes links to 市政府信息公开规定, 市政府信息公开目录, 市政府各部门信息公开目录, 各区政府信息公开目录, 依申请公开, 领导成员, 政策法规, 政府公报, 城市规划, 政府采购, 新闻发布会, and 新闻发布稿 | 采访通知.
- 政务动态**: Shows a photo of a conference hall and lists news items such as "市政协四届四次会议今天开幕" (Session of the Fourth Standing Committee of the 4th CPPCC opened today).
- 专题报道**: Features a banner for the "深圳市四届人大五次会议" (5th Session of the 4th People's Congress of Shenzhen) and lists news items like "2007年度政府各部门目标..." (Annual targets of various government departments in 2007).
- 工作动态**: Lists news items such as "深圳市地税局推行举报案..." (Shenzhen Tax Bureau promotes reporting cases...).
- 政府公报**: Shows a photo of a press conference and lists news items like "深圳生态文明建设行动纲领" (Action outline for Shenzhen's ecological civilization construction).
- 通知公告**: Lists notices and announcements.
- 专项服务**: Includes links to 我要买房, 我要办理户口, 我要办理出入境, and 我要办理结婚生育.
- 在线办事**: A central search bar allows users to enter service codes. It includes sections for 个人办事 (Personal Affairs), 企业办事 (Business Affairs), and 旅游者 (Tourists), each listing various service categories.
- 一周热点事项**: Lists hot topics such as "老人投靠子女随迁入户" (Older adults moving in with their children) and "深圳市居民结婚登记" (Marriage registration in Shenzhen).
- 本周热点查询**: Lists topics like "二手房源公示" (Second-hand property listings).
- 信息查询服务**: Provides a search function for various service codes.
- 便民提醒**: Lists useful information such as "昨起禁随身带打火机火柴..." (Ban on bringing lighters and matches) and "4月7日:未来三天天气趋..." (Weather forecast for April 7th).
- 在线调查**: Allows users to participate in surveys.
- 意见征集**: Allows users to provide feedback.
- 咨询投诉**: Allows users to ask questions and file complaints.
- 政企通**: Provides services for enterprises, mentioning the unit: 国土资源和房产管理局 (Land Resources and Real Estate Management Bureau).
- 市政服务**: Includes 12345公开电话 (12345 Public Telephone), 咨询投诉电话 (Consultation and Complaint Telephone), 深圳电子监察 (Shenzhen Electronic Supervision), 深圳市行政服务大厅 (Shenzhen Administrative Service Hall), 电子政务服务 (Electronic Government Service), and other service links.
- 底部信息**: Includes the logo "深圳政府在线 SHENZHEN CHINA", contact information (主办: 深圳市人民政府, 承办: 深圳市信息网络中心, 网络报障: 0755-82104771 / 82001112, 备案序号: 粤ICP备17767号), and various logos for government departments.

How Social Media contribute to human and social capital

by

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ABSTRACT

Social Media provide an easy gateway for everyone to access and publish information. The simple to use technology therefore offers potentials to strengthen human and social capital of societies. The article claims that social participation, economic benefits for enterprises, better innovation processes and educational advantages contribute to human and social capital. Regarding the relatively high user rates of social media in emerging countries, the promotion of competences and interest for a purposive use of social media can contribute to preserve the competitive position of emerging societies.

KEYWORDS

social media, human capital, social capital, competences, innovation, communication, networks

1. CHANGING WAYS OF COMMUNICATION - SOCIAL MEDIA AS HUMAN CAPITAL

Social Media introduced new ways of communication. In the early Internet called Web1.0 there were few persons publishing information and a more or less undefined mass audience reading this information. This way is pictured in the early sender-object-receiver-models of communication science. With the emergence of Web2.0 it is technically easier for users to publish information on their selves, to collect, rewrite or share it. Instead of classical models of mass media this communication process is described by interactive models of communication.

Classical models of mass media communication described a linear, static and unidirectional way of communication like it is described in the model by Maletzke (1963). In this model

there is one sender creating a message that is distributed whether directly to one receiver or via mass media to a not further defined group of people. Mass media thereby act as a gatekeeper for information. There is the possibility to give feedback, but it is not essential to the communication process.

Internet and furthermore social media have been changing this model to an interactive, dynamic and multidirectional way of communication like it is described by the model of Oenicke (1996). There is a multitude of senders and receivers that are constantly changing roles and communicating to different types of receivers such as mass audience, groups or individuals. Different intermediates and multiplicators can modify or repeat messages, whereby communication partners are highly interconnected (Kramer, 2010). Communication in social media equates more and more to its original definition describing the relation between people (Beck, 2006). Those relations can be supervised in social media what contributes to the emergence of a new public (Kramer, 2010).

Social Media enable people to act as producers as well as consumers (so called prosumers) of information. The contents are of different types of interest and can be just funny private videos as well as public cries for help or political opinions. It does not matter what kind of information they are publishing, if it is interesting and affecting people it will be spread and shared in an uncontrolled way through the web reaching a big audience of highly interconnected people. The actions during the Arabian rebellions in spring 2011 are an example to what extend communication in social media can contribute to public and political affairs and social change.

The chance for people to participate in social processes is a chance for the development of societies. Habermas deals with this aspect in his concept of communicative competence (Habermas, 1981). Following his ideas social media provide an ideal communication situation wherein every partner has the same chance and right to speak. In his concept Habermas connects theories of communication and theories of society focusing on the adequate use of language in the respective society. Having communicative competence therefore requires to know the belonging culture and to communicate in the appropriate way to this culture. It is important to know how communication in social media works, e.g. to know the netiquette, as well as it is important to be able to create relations between people with that communication. If these two parts are accomplished, communication can be seen as social acting as proposed by Habermas.

That it is why social media effects depend on the people using them, on their knowledge, skills and competences. Regarding the contribution of social media to human capital these individual abilities of people are the human capital of societies.

Below we want to describe some essential knowledge, skills and competences to use social media. Therefore we use the concept of the tipping point by Malcolm Gladwell (2002) that we complement by two more concepts of competences, namely the concept of communicative competence by Habermas (1981) and the concept of media literacy.

Gladwell (2002) identifies three rules of epidemics describing how information can be spread to a big audience in a short span of time. Firstly a small group of communicators (“law of the few”) have to have the ability to inspire other people. This might be through their personality (“connectors”), their knowledge (“mavens”) or their rhetoric abilities (“salesmen”). These are the people having communicative competence. Secondly the content of the information has to be memorable and engage people to act (“stickiness factor”). The creation of media content is part of the concept of media literacy. Thirdly the information has to be published at the right time and at the right place (“power of context”). Therefore people need strategic knowledge. This part becomes more evident regarding the competences needed for employees that communicate for their enterprises. We described the competences for professional social media use at another place (Riedel & Sonntag, 2012).

The following table names some of the identified parts of knowledge, skills and competences to create human capital in a society using social media as a chance for participation and innovation. The contribution of social media to innovation will be treated in the next chapter. We will not list basic educational facts here that are also measured in the concept of human capital in general such as alphabetization or schooling rates. We will refer on that regarding the risks of social media in chapter 3.

Table 1: Important parts of social media competences as human capital

Communicative Competence	Media Literacies
Knowledge <ul style="list-style-type: none"> • Social Media Netiquette 	<ul style="list-style-type: none"> • Technical Knowledge (Use the Computer/ Internet, Create Social Media Profile) • Knowledge of Social Media Platforms

Skills	<ul style="list-style-type: none"> • Ability to create social relations • Critical Abilities (Identify relevant/ usefull/ right content) • Ability to create interesting content (Storytelling) • Ability to produce own (multi-)media products (Text, Picture, Audio, Video)
Attitudes	<ul style="list-style-type: none"> • Empathy • Goodwill to share information and to participate

2. CONNECTING PEOPLE – SOCIAL MEDIA AS SOCIAL CAPITAL

As shown in the chapter before, web2.0 is changing the way of communication and makes information more transparent. People are presenting and interconnecting themselves with the help of social media profiles. There are growing communities that treat different topics or special interests. That is the way not only people but knowledge to gets interconnected through social media and that is the big contribution to social capital.

A condition to the interaction of people and therefore for the aggregation of social capital is trust. It is an often used method to analyze social capital by showing social trust rates of people. To build trust people need to know and respect each other. Social Media offer a lot of possibilities to present oneself and its knowledge, i.e. to create a personal reputation. People publish and share more and more knowledge to augment their reputation. This has not only the effect that there is more knowledge (human capital) available. Knowing what people have done and what people know as well helps to trust those people and will afford interconnection of people with similar specific (thematical) interests.

These people can meet each other at different social media platforms as well as special interest networks or general social networks. They can share information, put it together and develop new ideas. The flow of information is thereby changing. Information is spread in networks instead of in a direct line from one to many. In place of the mass media as gatekeepers, now there are interconnected people that act as filters, modify and share information. Social Media are therefore a relevant place for innovations that are driven by the factor of networks (e.g. Fliaster, 2007; Johnson, 2010).

Social capital is therefore an important condition to competitive advantages and company growth (Fliaster, 2007) and a relevant factor for the development of countries. Enterprises already recognized the benefit social media use can contribute to the value adding process. The estimated benefit from using social media in partner or internal use is appreciated mostly

because of the increasing speed to access knowledge and to acces internal or external partners (see fig. 1).

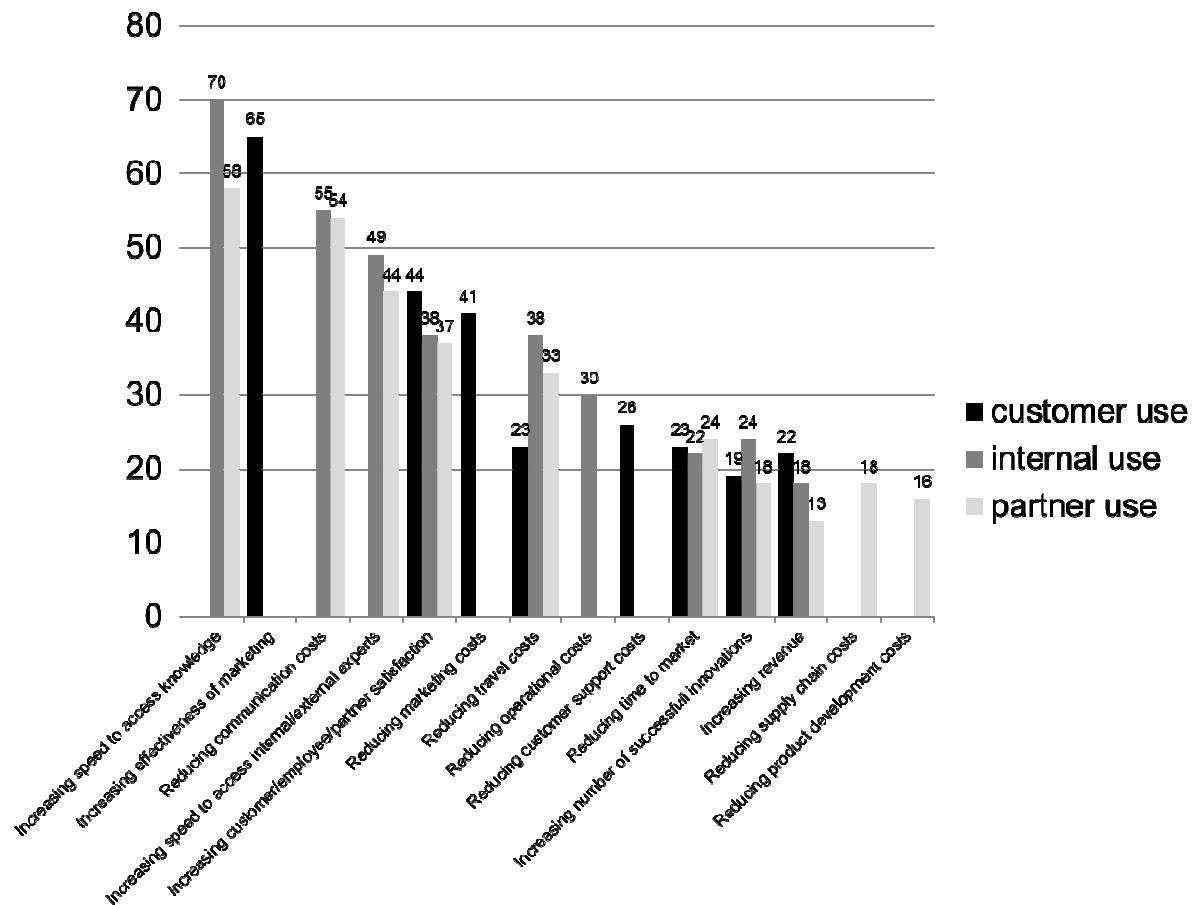


Figure 1: Expected benefits from social media use in different target groups, source: McKinseyQuarterly, 2011, own illustration

Social media though grant access to different sources of knowledge, i.e. to a wide human capital. This can be internal knowledge of the own employees, knowledge of external partners or experts as well as knowledge of lead users or even the public. The potential of the integration of externals is treated in the concept of an interactive value adding (Reichwald & Piller, 2009). Figure 2 shows that social media can support enterprises in different phases of the value adding process.

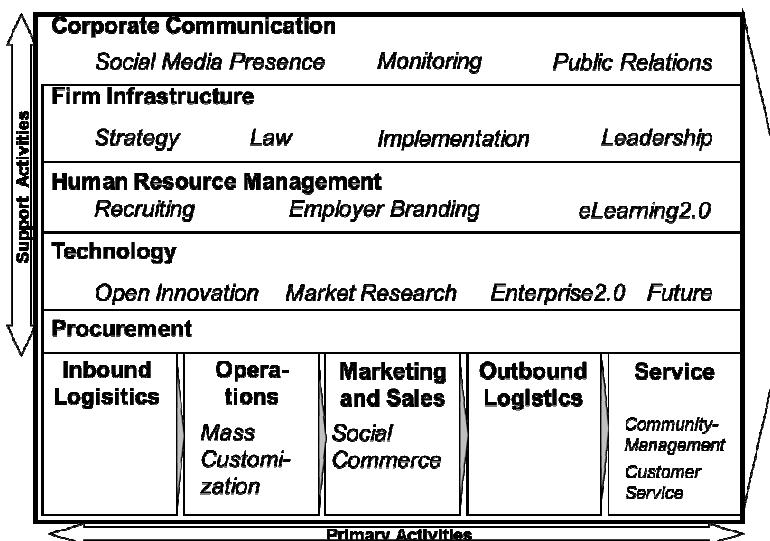


Figure 1: Possibilities in the use of Social Media in the enterprises value chain, Source: Own Illustration using the value chain by Porter (1996)

Despite the big potential of social media for internal use like Enterprise2.0 or leading innovation processes, enterprises still prefer the use of social media for customer relations and marketing purposes. Fig. 3 shows the actual global adoption rates in the different departments.

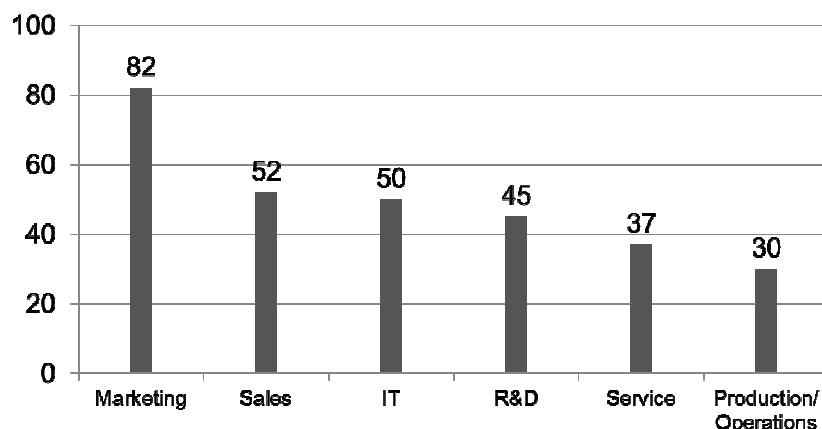


Figure 2: Adoption Rates in different departments, source: McKinseyQuarterly, 2011, own illustration

It might be the problem of change management that the potential of social media as social capital is not used that much. Besides the new technology there is a new way to work together that has to be implemented in enterprises (Denyer, Parry & Flowers, 2011). Working together, making knowledge explicit and transparent, sharing information, flatter hierarchies are inconvenient to most employees. And in the first step documentation needs more time so that the benefit cannot be seen short hand. Successful use of social media to strengthen social

capital is therefore dependend on the human capital of the people using it. This complementarity of social and human capital will be topic of the next chapter.

3. COMPLEMENTARITY OF SOCIAL AND HUMAN CAPITAL – BENEFIT FOR EMERGING MARKETS

The complementarity of the two concepts shall be shown in two areas: innovation and education.

As we have shown before, the development of innovations is highly dependent on cooperation. There are people with different and specific knowledge, skills and attitudes that exchange information (human capital). This exchange has to be placed and organized in networks (social capital). Only if the people are able to use those networks they can participate in the innovation process and only if there are organized networks people can share their experiences. This includes the fact that people that already have an established network and that have the ability to cooperate can innovate better than less connected people because they can revert to greater resources (Fliaster, 2007). Social Media give the chance to discover the right people and to get them organized in the right networks and to augment innovations.

Social Media are not only a driver to innovation but also a catalyzer to build human capital. Of course human capital as result of education can be developed on its own, because it is built by individual people. But social capital can help to accumulate even more human capital because it makes it possible to access more resources (Birchmeier, 2002). Social Media in this context provide new potentials for educational settings. They can be used in formal and informal learning processes and enable people to learn more self-directed and in social environments. Learning becomes more efficient and is independent from time and place. Social Media Technologies can be well applied in professional education and to support lifelong learning. Because of the possibilities to exchange, compare and connect different experiences they are characterized as a technology to learn competences (Erpenbeck & Sauter, 2007). In addition the use of social media technologies in the learning context improves media literacies and builds new human capital as well as it assists social and networking abilities that as a meta-competence can make learning processes more effective.

These examples explain why social capital is dependent on human capital and why vice versa the accumulation of human capital is dependent on social capital. This complementarity of

the two concepts leads to the following chances and risks of social media in the context of their contribution to human and social capital.

As a precondition to use the chances of social media in the development of societies there must be human capital in form of the competences and possibilities to use social media (see chapter 1). As a result there is a big crowd of people that can easily contribute, share and publish as well as access and collect information and opinions. This drives to more transparency in the information processes. People get the chance to create their own opinions, to participate in public and social affairs and that way to contribute to the development of societies (see the concept of communicative competence in chapter 1). Of course there still exist mechanisms that prevent free opinions, participation and transparency in a repressive way, but they become more difficult to be accomplished.

Social Media as social capital give the chance to connect with other people and to share experiences. This opens a potential for innovations that can support the economies and by doing this the development of societies (see chapter 2).

Using social media technology in formal or informal learning processes helps to build new human capital that as a conclusion can support the development of societies.

Table 2: Chances and Risks of social media for the development of societies

Chances	Risks
<ul style="list-style-type: none"> • easy access to information/ knowledge • transparency • chance for participation • chance for innovation • economic effects • catalyzer of education 	<ul style="list-style-type: none"> • exclusion of groups of people • division of society • highly dependent on education and technical infrastructure

On the other hand there is always the danger of exclusion. The often mentioned digital divide excludes people that do not possess the necessary skills to use Social Media (beginning with the ability to write and read and ending with the capacity to produce and publish videos) or not even possess technical access to the internet. This is a big problem excluding not only different groups of people such as elderly or less educated in one society but also less developed countries from the rest of the world. There is the danger of emerging gaps between groups or societies that can only be weakened with efforts and investments in technical

infrastructure and especially in education. If it is possible to achieve that, there are good chances for the development of societies that we will focus on in the next chapter.

4. SOCIAL MEDIA CONTRIBUTION FOR THE DEVELOPMENT OF SOCIETIES

Fortunately people in many countries and mainly in emerging countries already use social media and obviously have basic competences to use the chances of social media contribution. Emerging countries even show higher user rates and a bigger growth of engagement in social media than industrial countries as can be shown in figure 4.

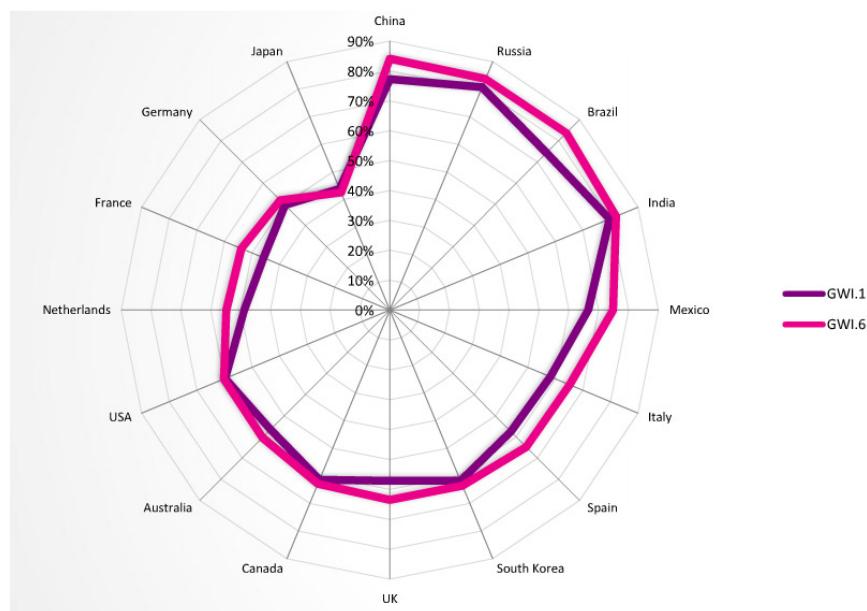


Figure 4: Global Social Media Use: Percentage of internet users per market having done following activities in the past month: Social Networking, Blogging, Video Uploading, Photo Sharing, Micro-Blogging, Forum Visitation, Rates from July 2009 (GWI.1) and November 2011 (GWI.6); source: GlobalWebIndex, 2012

There are good conditions for emerging countries to use the chances named in the chapter above. Mainly in using the contribution of social media to social capital they can use the potential to drive economic development.

There are two ways for enterprises to benefit from social media use. Existing enterprises can use social media in the different parts of the value chain (see fig. 2) to maximize their economic success. One way is to use social media in marketing affairs as it is done by the majority of global enterprises yet. By that way enterprises can possibly attract new customers as well as augment the customer loyalty to achieve higher rates of business volume. There are no standardized metrics to measure the return on invest of social media engagement yet, but surveys with executives (McKinseyQuarterly, 2011; PulsePoint Group; Economist

Intelligence Unit (EIU), 2012) as well as case studies (Petersen, 2010) show the benefits that can be drawn out of social media engagement.

Another possibility that is not yet used to a great extend is the use of social media to drive innovation processes as shown in chapter 2. It does not matter if the use of social media is constricted to internal experts or to a big public audience. Cooperation will increase the potential of innovations for new products or services. The potential for innovations as well compasses new business ideas that lead to the founding of new enterprises that can contribute to the economic potential of societies.

On the other hand societies can use social media technology to augment their human capital. Besides the investment in educational programs that support the development of knowledge, skills and attitudes the use of social media as described in chapter 1, societies can establish educational programs in nearly every special field. Educated people improve their work performance more effectively, work more productively and can support economic development.

As there seems to be no difference in the competences to use social media between industrial and emerging countries there is a big chance for the former to use social media to support their economic and social development. Social Media in this way can contribute to the conservation of the competitive position of emerging societies.

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Problems in Enterprise System Implementation Across the System Lifecycle: Transition versus Developed Economies

by

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ABSTRACT

The results of investigation into similarities and differences between problems of enterprise system (ES) implementation in transition and developed economies are presented. In doing so, the research builds on the opinions of ES practitioners from Poland, a transition economy from Central and Eastern Europe. The main findings suggest that problems in developed economies seemed to be clearly assigned to a specific ES implementation phase whereas in Polish companies difficulties seem to span through all the lifecycle phases. In addition, it is noticeable that in transition economies practitioners have to deal mostly with system-related issues, while in developed economies the shift from system-related to business-related problems throughout the system lifecycle is clearly visible.

Keywords:

Enterprise system, ERP, implementation, adoption, lifecycle, problem, transition economy, Poland.

Article Type: Research paper

INTRODUCTION

Transition economies are defined as countries that are in transition from a communist style central planning system to a free market system (Roztocki and Weistroffer, 2008b). Most transition economies can be recognized as emerging economies that are a subgroup of developing economies and include countries having low absolute, but fast growing, per capita income. Also, emerging economies usually have governments that are dedicated to economic liberalization (Roztocki and Weistroffer, 2008a).

The process of information technology (IT) adoption in developing countries is connected with different considerations as compared to practice observed in developed economies (Bingi, Leff, Shipchandler and Rao, 2000; Roztocki and Weistroffer, 2008a). In particular, IT adoption projects conducted in developing and transition economies struggle with lack of IT experience, inadequate IT infrastructure and maturity, and lack of long term strategic thinking (Huang and Palvia, 2001; Roztocki and Weistroffer, 2008b).

Different considerations experienced by transition and developed economies also apply to enterprise system (ES) adoption projects, which are one of the most advanced IT-related large-scale investments. ES, having their roots in MRP, MRP II, and ERP systems, are now very complex systems that support the management and integration of the whole company and offer inter-organizational integration with company's clients and suppliers (Volkoff, Strong and Elmes, 2005). ES adoptions span the whole organization, involve multiple stakeholders both from within the company and external organizations, extend over time, and, in consequence, are very costly (Brown and Vessey, 2003; Jones, 2008).

During the usually long process of ES adoption the company may experience many problems and impediments to project success (e.g. Kim, Lee and Gosain, 2005). The multi-staged character of ES adoption calls for the incorporation of the system lifecycle into the investigation of ES adoption issues (Themistocleous, Soja and Cunha, 2011). This observation and different ES considerations experienced by projects conducted in transition and developed economies were the main drivers for this research.

The goal of this paper is to investigate differences in impediments to ES adoption success between transition and developed economies. In doing so, the current research incorporates the multi-staged nature of ES adoptions and seeks to explore how the problems change across the system lifecycle. The particular research question involved can be formulated as follows:

- How do the difficulties experienced by ES adoptions change across the system lifecycle and how do they differ between transition and developed economies?

In order to compare the problems experienced by ES adoptions between transition and developed economies, the authors drew from the opinions of practitioners from Poland, a transition economy from Central and Eastern Europe. The discovered issues were then compared with the findings of Markus, Axline, Petrie, and Tanis (2000), who built on the experience of developed economies. Their research is shortly described in the research background section, which follows the introduction. Next, the research methodology is

depicted which is followed by the presentation of results. Then, the paper discusses the main findings and closes with concluding remarks.

RESEARCH BACKGROUND

Prior literature dealing with ES adoptions mostly builds on the experience of developed countries from Western Europe and North America, where most ES developers are located and implementations have occurred (Davison, 2002). This rule also applies to studies dealing with difficulties experienced by ES adoption projects. In particular, Markus et al. (2000) conducted research among a few dozen respondents from North America and Europe, both adopters and experts representing system suppliers. Another study, conducted by Kim et al. (2005), is based on a survey of the largest American organizations listed in Fortune 500. Kremers and van Dissel (2000), in turn, focused on the issues connected with migrations of ERP systems and conducted research among Baan customers mainly from highly developed countries from Europe and from the USA and Australia. Next, Wright and Wright (2002) conducted interviews with experts from the largest American consultancy firms. Finally, Themistocleous, Irani, O'Keefe and Paul (2001) performed an Internet survey and gathered responses from ES adopters mainly from Europe, North America, and Australia.

The prior studies conducted in developed countries recognized mainly organizational problems connected with time over-runs and lack of alignment of organizational structure with the adopted ES. The practitioners from industrialized countries also acknowledged difficulties connected with the enterprise system deficiencies. The group of the most important impediments to ES adoption success is complemented by difficulties connected with lack of user involvement. ES projects in developed economies also suffered from inter-departmental conflicts, inadequate training, and problems with system customization. However, these problems affected ES adoption to a lesser extent.

Prior research suggests that ES adoptions in transition economies differ from ES projects conducted in developed countries. This might be connected with various factors such as fast changing laws and regulations, strong governmental control, low and rising salaries, high demand for highly qualified workers, and continuous and fast economic growth (Roztocki and Weistroffer, 2011b). ES adoptions in transition economies, as compared to developed countries, seem to be affected to a greater extent by financial and people-related problems (Soja, 2008; 2011). Also, ES adopters in transition economies appeared to place greater emphasis on phased ES deployments and expected higher levels of external support

(Bernroider, Sudzina and Pucihar, 2011). In addition, ES adoption projects may go through a different system lifecycle and might require different roles of the project participants, as compared to developed countries (Themistocleous, Soja and Cunha, 2011).

The main shortcoming of prior research is connected with the fact that, in transition economies, research works on IT investments in general and ES adoption in particular are scarce (Roztocki and Weistroffer, 2011a). In particular, they include two studies conducted in Poland, a European transition economy. The first study was based on the opinions of experts representing ES suppliers (Soja, 2008). The second research paper analyzed source problems in ES adoptions and drew from the experience of various practitioners representing ES adopters (Soja and Paliwoda-Pękosz, 2009). The results of prior studies suggest that the most significant difficulties experienced by the organizations in transition economies include:

- problems connected with the knowledge, education, and attitudes of various stakeholders,
- high costs of ES implementation,
- organizational problems connected with ES adoption planning, such as goal setting and the assessment of a company's condition.

Another shortcoming of prior research is connected with the multi-staged character of ES adoptions and resulting changing considerations across phases of the project. In particular, among the abovementioned prior research works dealing with difficulties in ES adoption, only the study by Markus et al. (2000) incorporated the system lifecycle into the research approach. Their categorization includes the following four ES implementation stages (Markus and Tanis, 2000):

- Project chartering – making a key business decisions concerning the scope of the project, budgeting, choosing system vendor, etc.
- The project – the main implementation phase with the purpose of getting system and users “up and running”,
- Shakedown – stabilizing and incorporating ES in everyday operations,
- Onward and upward – deriving benefits from ES implementation.

Prior literature includes various definitions of the ES lifecycle. The most interesting examples include the proposition of Parr and Shanks (2000) who divided the whole ES adoption process into three general phases: Planning, Project, and Enhancement. Within the Project

phase, they defined five sub-phases: Set up, Reengineering, Design, Configuration and testing, and Installation. Another example includes the definition of Ross and Vitale (2000) who proposed five ES adoption stages: design, implementation, stabilization, continuous improvement, and transformation. Nonetheless, the most comprehensive definition of the ES lifecycle was proposed by Somers and Nelson (2004) who distinguished six implementation phases grounding their approach in the six-stage model of IT diffusion (Cooper and Zmud 1990). The suggested stages of ES implementation are as follows:

- Initiation – a company recognizes and justifies the need for ES implementation (which may have organizational or technological background), chooses the ES and its provider,
- Adoption – the final decision to invest resources is reached, the project is defined and participants of the project are selected,
- Adaptation – the enterprise system is installed, the needed organizational changes are made, users are trained in two directions: how to use the new ES application and how to operate in new business processes and procedures,
- Acceptance – organizational members are induced to commit to ES application usage and in consequence the ES is employed in organizational work,
- Routinization – the company uses the ES on a daily basis, the organizational procedures are appropriately adjusted,
- Infusion – increase in organizational effectiveness takes place, the company should experience the maximum benefits from ES implementation.

The purpose of this study is to address the abovementioned shortcomings of prior research connected with lack of research conducted in transition economies and lack of incorporation of the lifecycle in the ES adoption-related research. To this end, this study employs the lifecycle model defined by Somers and Nelson (2004), builds on the research conducted among Polish practitioners, and maps the achieved results onto the results of Markus et al. (2000) who uniquely incorporated the system lifecycle into their research approach dealing with ES adoption difficulties.

METHODOLOGY

The current research is an extension of the authors' previous work investigating the problems during enterprise system implementation (Authors, 2009 - blinded at this stage due to the

double blind reviewing process). The authors, as the background method of research, applied qualitative approach based on the grounded theory developed by Glaser and Strauss (1967). The data-gathering process was conducted via interviews with practitioners, who were asked to elicit problems that they encountered during ES implementation. The interviewees assigned these problems to a certain project phase according to the Cooper and Zmud (1990) classification of the project phases.

82 ES practitioners expressed their opinions and mentioned 433 problems in total. These problems were interpreted and classified by the authors using open and axial coding (Corbin and Strauss, 1990) and investigator triangulation (Myers, 2009, p.11) as the basic methods of data analysis. As a result, the problems were classified into a two level taxonomy and, in the next phase, the analysis of the problem occurrence across the system lifecycle was conducted. In order to compare the achieved findings with the results from developed economies, the study by Markus et al. (2000) was chosen.

This study was based on a different classification of ES lifecycle stages, therefore, the mapping of the two employed lifecycle models was needed. On the basis of descriptions of stages from these two models, the authors proposed the phase mapping presented in Table 1. In the next stage of the analysis, the difficulties declared by this study's respondents were mapped onto the problems listed by Markus et al. (2000). The results of the conducted analysis are presented in Table 2.

Lifecycle stages proposed by Cooper and Zmud (1990)	ES lifecycle stages proposed by Markus et al. (2000)
Initiation	Project chartering
Adoption	
Adaptation	The project
Acceptance	
Routinization	Shakedown
Infusion	Onward and upward

Table 1. Mapping of ES Lifecycle Phases

RESULTS

Table 2 presents the results of mapping of problems reported by this study's respondents onto the taxonomy of difficulties elaborated by Markus et al. (2000). The level of problem occurrence across different stages of the lifecycle was marked by appropriate bullets. The occurrences of problems among Polish respondents were indicated in columns named TE

(transition economy), while the occurrences of difficulties on the basis of Markus et al.'s (2000) research were listed in columns DE (developed economies).

Phase	Chartering		Project		Shakedown		Onward	
	TE	DE	TE	DE	TE	DE	TE	DE
lack of results orientation in the business	○	●						
culture resistant to change	●	●	●		○		○	
lack of top management support	○	●						
system integration	○		●	●	○		○	
implementation consultants	○		○	●	○		○	
cutting end-user training	○		●	●	○		○	
inadequate testing				●				
BPR (not first improving business processes where this needs doing)	○		○	●	○			
data quality	○		○	●	○			
reports			○	●			○	
software modification				●				
personnel turnover				●				
emphasis on functional perspective				●				
inappropriately project scope cutting				●				
system performance	○		●		○	●	○	
decreased performance of business processes						●		
disappointing business results								●
fragile human capital	●		●	○	○		○	●
migration problems				○				●
unknown business results								●
IT infrastructure	○		●		○		○	
system-misfit	○		●		○		○	
enterprise financial and organizational condition	○		○		○		○	
legacy systems replacement	○		○					
problems with implementation process (duration time, participants, project definition)	○		○		○			
trainings scope and schedule	○		○		○		○	
legal regulation and situation in industry	○		○					

Note: Bullets represent the level of problem occurrence reported by the respondents: ● – high, ○ - medium ○–low

Table 2. Mapping Problems Reported by Polish ES Practitioners onto Difficulties in Developed Economies

DISCUSSION

Similarities and Differences between Transition and Developed Economies

Companies from both types of economies perceived at the similar level difficulties connected with lack of results orientation in the business and lack of top management support. These impediments were encountered during the first organizational stage of the implementation project. Also, both groups of practitioners declared with the similar emphasis difficulties connected with reporting in the project phase, however, Polish respondents also pointed to this problem during the last phase of the project.

There were several difficulties that were not clearly perceived by the Polish respondents but proved significant for practitioners from industrialized countries. The majority of them occurred during the project phase and referred to difficulties connected with cutting scope of the project, lack of BPR, inadequate testing, and problems resulting from software modifications. These project phase-specific problems were complemented by difficulties visible during the last phase of the implementation, which were connected with decrease in company's processes performance and disappointing business results. The problems in developed economies tended to evolve from system-related to those connected with business as the implementation proceeded from the project phase to the onward and upward phase.

Practitioners from transition economies, on the other hand, tended to focus on the system-related issues. In doing so, they uniquely perceived problems connected with IT infrastructure and lack of fit between the company processes and the adopted enterprise system. In addition, instead of recognizing problems with business performance, Polish practitioners pointed to problems connected with an unsatisfactory enterprise system performance. They also perceived to a greater extent problems connected with system integration. It is interesting to note that, among Polish companies, the system-related problems occurred first and foremost during the project phase, which is similar to the situation in developed economies. However, among Polish practitioners these problems also appeared to some extent during the whole implementation project.

Practitioners from Polish companies seemed to suffer more from people-related problems which were captured by difficulties connected with a company culture resistant to change and related to fragile human capital. In both developed and transition economies practitioners

experienced people's resistance mainly during the first phase of the implementation. However, among transition economies this problem was also significant in the remaining phases. The similar rule applied to difficulties connected with human capital, which occurred over the whole implementation in transition economies, while their main occurrence among developed economies falls within the last phase and, to a lesser extent, the project phase.

Difficulties connected with implementation consultants occurred primarily during the project phase in the case of developed economies. Among transition economies, on the other hand, difficulties with the provider representatives occurred to a much lesser extent and seemed to span over the whole implementation.

Various impediments related to trainings seemed to affect ES implementations conducted among transition economies to a greater extent than projects taking place in developed countries. The latter suffered first and foremost from cutting end user training during the project phase, which was also true in the case of ES implementations in transition economies. However, practitioners from Polish companies were also affected by problems with quality and organization of trainings over the remaining phases of an implementation project.

Polish ES practitioners uniquely perceived problems connected with financial and organizational conditions of an ES adopting company. Problems of this kind occurred to some extent over the whole ES implementation process with the tendency to concentrate in the project phase. The similar rule applies to problems connected with the implementation project definition and organization, which were also uniquely reported by Polish practitioners. However, in this case, we may notice a greater emphasis on the first, chartering phase of the implementation project. The group of difficulties uniquely reported by the Polish respondents is complemented by problems having their roots in the company's environment and connected with changing legal regulations and situation in industry.

The group of problems that deserve our special attention is connected with system migration. Polish practitioners perceived difficulties of this kind with respect to migration from legacy systems to the new enterprise system. However, on the other hand, practitioners from developed economies report the migration from the previous version of an enterprise system to the newer version or to another brand of the system. In both cases, the project phase was the focal point of difficulties connected with system migration.

Upon comparing phases of the ES implementation, we may observe that ES implementations in both economies experienced the greatest difficulties during the project phase of an

implementation. In addition, Polish practitioners seemed to experience significantly greater difficulties during the first phase of the implementation. The same, although to a lesser extent, applies to the remaining phases, i.e. shakedown phase and onward and upward phase. It turns out that during these phases Polish practitioners experienced many different problems, however, their intensity was limited.

Summing up, companies from developed economies paid closer attention to business-related issues as opposed to companies from a transition economy that were distracted mostly by system-related problems. Problems in a transition economy tended to spread over time and affect companies to a greater extent than in developed economies. Specifically, constant care is required as regards cooperation with the system vendor, which confirms the findings of Themistocleous et al. (2011) suggesting that in transition economies different rules of collaboration between ES adopters and providers may exist.

Both studies reported problems with system migration mainly during the project phase, however, they were of different nature: Polish companies migrated from previous legacy systems whereas companies in developed economies upgraded their current ES systems to a newer version or changed the brand of ES system. This confirms the previous research findings suggesting that companies in transition economies were in the first wave of ES adoption (e.g. Lukman, Hackney, Popovic, Jaklic and Irani, 2011) whereas companies from developed economies experienced second or even third wave of ES adoption (Shanks, Seddon and Willcocks, 2003; Stein and Hawking, 2003).

Limitations and Future Research

The main limitation of this study's findings is connected with the scope of research results. This is due to the research respondents who represent ES practitioners from Poland. In consequence, we should generalize the results for other countries with caution. Supposedly, the scope of this study's findings should cover countries from Central and Eastern Europe which belonged to the Communist Bloc after the World War II but recently joined the European Union and are now undergoing economic transition. Also, other countries from the same geographical region may benefit from this study's result, however, to a smaller extent. This refers to two countries neighboring Poland: Ukraine and Belarus, which now reveal a lower level of development than Poland.

The findings suggest some avenues for further research which may focus on investigating the causal structure and mutual relationships among the discovered impediments. To this end,

future studies may involve a multi-method research combining qualitative and quantitative approaches and should incorporate a substantial research sample. Another strand of future research may be connected with an in-depth stakeholder analysis of the experienced difficulties with the purpose of discovering the mechanisms useful in better stakeholder management during the ES adoption projects. Finally, future studies may focus on examination of the influence of the experienced difficulties on ES adoption success.

CONCLUSION

This paper presents the results of comparing problems accruing during ES implementations across the system lifecycle in transition and developed economies. First, the problems reported by Polish practitioners, operating in a transition economy, were elicited and classified. Next, the results were compared with the results of research conducted by Markus, Axline, Petrie and Tanis (2000) concerning companies that operate in developed economies. In doing so, the authors proposed the mapping between different ES lifecycle stages that were adopted by both studies. The results reveal some similarities in problem perception between both studies, mainly during the first organizational stage of ES implementation, concerning lack of result orientation in the business and lack of top management support. Nonetheless, the achieved results suggest that differences are more significant. Firstly, in companies that operate in developed economies, a shift from system-related problems to business-related problems was noticeable over time, whereas companies in a transition economy tended to struggle mainly with system-related issues throughout the whole system lifecycle. Secondly, people-related problems were visible mostly during the chartering phase in both studies, however, they were also recognized during other phases of ES implementation by Polish practitioners. Similarly, training problems recognized mostly in the project phase were also noticeable in other phases in a transition economy. Finally, there appeared problems specific for Polish companies, e.g. difficulties connected with financial and organizational condition, mostly visible during the project phase, and problems with the implementation project management emphasized greatly in the chartering phase.

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A stage-based model for RFID assimilation processes by supply chain participants in China

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ABSTRACT

RFID technology is an emerging technology that attracts attention of supply chain participants. However, most Chinese supply chain participants just adopt this new innovation without making further steps to fully utilize its benefits. Extant IS research on this technology also only focuses on factors that will impact its organizational adoption. Assimilation theories suggest that most information technologies exhibit an “assimilation gap” which means the widespread usage tends to lag behind their adoption. But a technology can only achieve its greatest benefits through full-scale deeper diffusion into the organization’s daily operations besides physical adoption. Drawing upon TOE framework, we use a stage-based model to investigate factors that influence the assimilation of RFID into an organization. Moreover, we investigate these factors’ changing effect across different assimilation stages in the Chinese context which is addressed little in the previous literature.

Keywords (Required):

Innovation diffusion, assimilation, RFID technology, TOE framework, stage-based model

1 INTRODUCTION

In recent years, RFID has emerged as a new technology to increase operations efficiency in warehouse management and inventory monitoring. Compared with traditional bar code, RFID can identify tagged products without line of sight and track the status of products when they are received or shipped away from the warehouse in real-time. Therefore, product inventory status can be captured with less labor force and increase inventory management efficiency.

The benefits resulting from this technology innovation may be curtailed if it cannot be widely adopted (Zhu, Kraemer, Gurbaxani, & Xu, 2006). Adoption is just one part of an innovation assimilation process, which cannot ensure wide-scale assimilation. Only through wide-scale assimilation of RFID can its benefits be realized. As indicated by Chatterjee et al. (2002b), many firms have failed to achieve deep usage beyond initial adoption. Most recent IS research on RFID focus on a single stage such as one-shot adoption decisions. According to the literature review of Fichman (1999) and Zhu et al. (2006), the post adoption stages of assimilation are especially worthy of a focused study.

This research will fill the research gaps and investigate various factors' changing effects on each stage of assimilation processes. As indicated by Fichman (1999), it is necessary since the same factors may have "differential effects," depending on the stages of assimilation. Similar to the definition of e-business assimilation by Zhu et al. (2006), RFID assimilation is defined as a series of stages from a firm's initial evaluation of this technology at the pre-adoption stage (initiation), to its formal adoption, and finally to its full-scale deployment at the post-adoption stage in which RFID becomes an integral part of the value chain activities (routinization).

Further, it is also important to identify antecedents that influence RFID assimilation. According to Roger's innovation diffusion theory, some of technology characteristics which will influence innovation diffusion are relative advantage, complexity, and compatibility. Beyond technology perspective, Chatterjee et al. (2002b) identified organizational enablers including management support and cross-department coordination. Moreover, influences from the environment could also affect RFID assimilation (Teo, K.K.Wei, & Benbasat, 2003). However, there is a lack of literature which integrates these different factors into a single research framework. Thus, we develop an integrated model to investigate different contextual factors' effect.

Motivated by the above theoretical gaps, we propose an integrative model to address the following questions: (1) which factors (including technological, organizational, and environmental factors) would impact RFID assimilation? (2) How do these different factors impact each assimilation stage? An integrative theoretical model combining the innovation diffusion theory, institutional theory, and stage-based model will be built to investigate these problems. Our research model will be tested through data collected from supply chain participants in China which have already adopted RFID technology in different stages.

Structural equation modeling will be used to test each factor's importance across three assimilation stages.

2 THEORY OF INNOVATION ASSIMILATION AND STAGE-BASED MODEL

2.1 THE STAGES OF INNOVATION ASSIMILATION

Innovation assimilation is a dynamic and complex process, which means a multi-stage analysis is necessary to better understand the assimilation processes. In this section, extant stage-based models and their corresponding tasks are introduced.

In order to describe the phenomenon of a system implementing organizational innovation, Lewin (1952) propose a three-stage change model including unfreezing, moving, and refreezing. Meyer and Goes (1988) categorized assimilation into three primary stages: knowledge-awareness stage, evaluation-choice stage, and adoption-implementation stage with each of these primary stages having three sub-stages. Cooper and Zmud (1990) identify that assimilation can be viewed as a six-stage process from initial adoption to a complete infusion. Premkumar et al. (1994) investigate the diffusion of EDI in three stages: adaptation, internal diffusion, and external diffusion.

Wu and Chuang (2010) investigate diffusion of electronic supply chain management from a multi-stage perspective: adoption, implementation and assimilation. They classify the diffusion stage into three categories: (1) adoption classified for initiation, comprehension, earliness of adoption and adoption; (2) implementation classified for adaptation, acceptance and implementation; (3) assimilation is classified for routinization, infusion and assimilation. Antecedents which can influence each assimilation stages are investigated as well as financial and non-financial firm performance.

Zhu et al. (2006) conduct a study on the assimilation process of e-business and investigate the assimilation from three stages perspective: initiation, adoption, and routinization based on the TOE framework. Comparison studies between developed countries and developing countries suggest that technology readiness strongly influence assimilation process in developed countries while technology integration has a significant effect on developing countries' assimilation.

At initiation stage, organizations are aware of the new technology and evaluate whether the technology can solve the organization's problems. As indicated by Zhu et al. (2006), firms at this stage evaluate how the potential benefits of the innovation can improve a firm's value chain activities. Organizational problems are also identified.

Following initiation is adoption which involves allocating necessary resources to obtain the technology and prepare for redesigning business processes. The degree of fit between innovation and organization's tasks and problems determines the adoption of this technology.

However, adoption does not always result in widespread usage. Fichman and Kemer (1999) suggest that there is an assimilation gap between adoption and widespread routinization. Adaptation/acceptance stage is the stage at which organization begins to learn and adapt to the innovation by trying it out and then their feedbacks are collected. At this stage, innovations are transferred for regular use and the organization's governance systems are adjusted to account for the IT application.

At the routinization and infusion stage, innovation has already been widely used as an integral part in a firm's value chain activities in a more comprehensive and integrated manner. This stage is usually regarded as a significant dimension of IS success. After introducing various stage-based models, we will analyze their strengths and weaknesses in the following part based on which we propose our own research models.

In Table 2.1, we summarize various stage-based models from existing literature. In Table 2.2, we illustrate assimilation stages and tasks involved in each stage.

Table 2.1 Summary of the stage-based models

Model	Name of stage	Literature
Two-stage model	Adoption (activities of knowledge acquisition, persuasion and learning, and adoption decision) Implementation (preparations of organizational changes, processes, and technologies necessary for innovation deployment)	Rogers (2012) Rogers(L.Fries, M.Turri, C.Bello, & f.Smith, 2010)
Three-stage model	unfreezing, moving and refreezing knowledge-awareness stage, evaluation-choice stage, and adoption-implementation stage adaptation, internal diffusion, and external diffusion adoption, implementation, assimilation initiation, adoption, routinization adoption, implementation, assimilation	Lewin (1952) Meyer & Goes (1988) Premkumar et al. (1994) Ranganathan et al. (2004) Zhu et al.(2006) Wu and Chuang (2010)
Six-stage model	Initiation, adoption, adaptation, acceptance, routinization, infusion	Kwon and Zmud (1990)

Table 2.2 Different assimilation stages and tasks involved in each stage

Stage	Definitions	Tasks involved in each stage
Initiation	Decision makers are aware of this innovation and make formal evaluation and trial through vendor organizations.	Evaluate how the potential technology can bring benefits to an organization.
Adoption	Decision makers make the adoption or non-adoption decision according to their potential cost benefits analysis of RFID.	Allocating necessary resources to adopt RFID and prepare for redesigning business processes.
Routinization	Innovation has already been widely used as an integral part of a firm's value chain activities.	Integrate RFID with other enterprise systems such as ERP, MRP, CRM, etc.

2.2 Antecedents of innovation assimilation

In the previous section, we find that the most innovation-related research employs the TOE framework to investigate influencing factors that can impact innovation diffusion and assimilation. Related literatures include Furneaux and Wade's (2011) investigation of discontinuance intention of information systems. Wang et al. (2010) investigate determinants of RFID adoption in the manufacturing industry in Taiwan drawing upon the TOE framework. Kuan and Chau (2001) employ the TOE framework to investigate EDI adoption in small businesses. Hong and Zhu (2001) investigate six variables drawing upon the TOE framework to successfully differentiate non-adopters from adopters of e-commerce. Zhu et al. ((2006a), (2006b)) explore how factors within the TOE framework influence the e-business assimilation at the organizational level.

As indicated by Wang (2010), TOE framework has many consistent empirical supports, so it can help analyze and consider suitable factors for understanding the innovation-adoption decision. We think TOE framework is a powerful tool to explain the assimilation processes, and thus we use it to explain RFID assimilation processes in our research.

With reference to the technological context, classic *DOI (diffusion of innovation)* theory proposed by Rogers (1995) identifies five innovation characteristics including: (1) relative advantage, which means "the degree to which an innovation is perceived as being better than the idea it supersedes". (2) compatibility, which is defined as "the degree to which an innovation is consistent with existing business processes, practices and value systems"; (3) complexity, the degree to which an innovation is difficult to use; (4) observability, the degree to which the results of an innovation are visible to others; (5) trialability, the degree to which

an innovation can be experimented with. Among these factors, the first three are the most frequently used to explain and predict innovation diffusions and therefore we include them as technological factors in our research framework and investigate their changing effects across different assimilation stages.

Organizational context refers to top management support, an organization's IT infrastructure, managerial capability which is important components for an organization. These factors could help explain why some organizations are more innovative while others are less prone to innovate. As indicated by Mishar et al. (2007), the diversified performance differences of innovation diffusion is due to the significant differences in the resources the firm possess, which include managerial knowledge, technology infrastructure, and prior experiences with IT. Some other literatures also suggest that the value firms obtain from IT is dependent on their skills to leverage it ((Mata, W.Fuerst, & J.Barney, 1995) (Bhardwaj, 2000). Firms which possess strong managerial capability and prior IT experiences can utilize IT more efficiently than their competitors. Therefore, we include managerial capability, IT infrastructure and absorptive capacity which is regarded as organizational resources as antecedents.

As indicated by Tornatzky and Fleischer (1990), *environmental context* is the area in which a firm conducts its business-the industry, competitors, and dealing with government. DiMaggio and Powell's institutional theory proposes that institutional environment provides rule-like social expectations and norms for appropriate organizational structures, operations, behaviors and practices. The firm's perceptions of these pressures affect its interpretation of the environment in general and innovation intentions in particular. Thus we investigate factors within the institutional pressure that will impact RFID assimilation processes. Institutional pressures are classified into three categories: coercive pressure, normative pressure and mimetic pressure.

Coercive pressure is defined as the pressure originating from political influences exerted by the powerful firms on which the focal firm depends (Paul & Powell, 1983). This pressure is mainly from dominant suppliers and customers because these dominant partners hold resources organizations need such as new business contracts or funding. Normative pressure refers to the perceived extent to which members of the dyadic relational channels have adopted the innovation and the extent to which the government and industry agencies promote the use of information technology. In our model, we use regulatory support as the normative pressure that will influence RFID's assimilation processes. Mimetic pressures are

those which make an organization imitate others when the organizational technologies are poorly understood, goals are ambiguous, or the environment is uncertain. Since RFID standard is still uncertain and investment is irreversible which means the market of RFID is still uncertain. Companies will follow others which have successfully implemented this technology. Meanwhile, fierce competition will make companies imitate others which have already successfully adopted this technology into their enterprises. In our research, we include market uncertainty and competition intensity as the source of mimetic pressure.

3 RESEARCH MODEL AND HYPOTHESES

Predictions related to technological factors

Relative advantage

Drawing upon previous literature, relative advantage is a best predictor to predict the benefits of technology innovation. This is true because at initiation stages, the function of RFID technology will be evaluated to check whether it has relative advantage over traditional bar code systems. Compared with traditional bar code systems, RFID can help retailers track and control stock in real-time. If integrated with other backend systems, RFID can reduce the lead time and then improve replenishment efficiency, and thus reduce product misplacement, stock-level, out-of-stock and labor costs. (Tsai, et al., 2010b).

However, the influence of relative advantage is not so significant on assimilation stages since at this stage, the major task is to adjust current operations process to adapt RFID technology into their daily operations and make employees accept this technology. Thus, the influence of relative advantage might not be so significant on this stage. Accordingly, we propose hypothesis as follows:

H1: Relative advantage plays a more significant influence on initiation than on assimilation stages of RFID technology.

Complexity

Complexity is defined as “the degree to which an innovation is perceived as relatively difficult to understand and use” (Rogers and Shoemaker, 1971, p.154). In the context of RFID, Wang et al. (Wang, et al., 2010) define complexity as immaturity of RFID technology, lack of common standards. The difficulty of integrating RFID with the existing enterprises’ information systems and business processes is also included as one component of complexity.

Thus, complexity of innovation should also be analyzed to make sure that organization has enough financial and human capital to overcome the difficulties during implementation.

The influence of complexity is even more significant on later assimilation stages since at this stage organizations need to reengineer existing working procedures and integrate it with other enterprise systems including warehouse management systems, ERP, MRP, etc. Thus, complexity plays more significant negative influence on later than on early assimilation stages. We predict the hypothesis as follows:

H2: Complexity plays more significant negative influence on assimilation than on initiation stages of RFID technology.

Predictions Related to Organizational Factors

Besides technological context, factors in organizational context can also influence RFID assimilation processes. We include IT infrastructure, managerial capability as well as absorptive capacity into the organizational context and investigate their changing effects across different stages.

IT infrastructure

With reference to IT infrastructure, Grant (1991) classifies IT-based resources into three categories: (1) the tangible resource comprising the physical IT infrastructure components; (2) the human IT resources comprising the technical and managerial IT skills; (3) the intangible IT-enabled resources such as knowledge assets, customer orientation, and synergy.

According to resource-based theory, tangible resources enable firms to assimilate innovations more quickly and improve products (S.Bharadwaj, 2000). IT infrastructure provides a platform on which innovative IT applications can be launched faster. Therefore, tangible resources are relevant factors that might influence RFID assimilation processes.

Human resources include both technical IT skills and managerial skills. Since RFID assimilation process entails significant changes of the business processes and IT infrastructure, managerial capability plays an important role in coordinating activities related with process redesign. Technical IT skills become important in the analysis, design, and implementation of changed business processes. The flexibility of human IT resources to adapt to change might be a significant antecedent for successful RFDI implementation.

Previous literature suggests that customer orientation has a significant role on innovation assimilation, e.g. Internet assimilation in China (Chau, Lai, & Li, 2008). It might also be an

important driver for RFID assimilation since it shortens lead time between the manufacturers to customers, increases the traceability of products which makes the products more visible. If a company is more customers-oriented, it will consider improving customers' satisfaction through introducing new technology.

Knowledge assets refer to the ability of firms to integrate, transfer, and apply knowledge (Matusik & Hill, 1998). It is also critical for RFID assimilation processes since if a firm has a strong capability to integrate and transfer new knowledge that will be easier for them to assimilate new innovations.

Synergy is defined as sharing of resources and capabilities across organizational divisions. A firm is more flexible and can react faster to market needs if it shares knowledge and information across its functional units. Since RFID technology enables information sharing across warehouse division, purchasing division and production division across a company, it provides a good way to share resources and information. Thus, we think synergy of intangible resources is also related with RFID assimilation and include it into our research model.

Based on above analysis, we can see that physical IT infrastructure, human IT resources, and synergy all have significant relationship with RFID assimilation. Therefore, we include IT infrastructure as an antecedent of RFID assimilation process.

According to Bharadwaj (2000), IT as a resource can generate competitive value only when it leverages or enables pre-existing resources and skills. The situation is the same for RFID technology implementation. RFID can achieve its greatest benefits only through integrating with other backend systems such as enterprise resource planning (ERP), customer relationship management (CRM), and decision support systems (DSS) and sharing data and information with them. Again, this does occur until later assimilation stages. Importantly, the adoption rate of these enterprises systems remain very low in China (XU, Zhang, & D.C., 2005) which means information and data flow may stand alone and cannot be integrated with business processes. Thus, this is a particularly important innovation barrier in China.

Moreover, when adopting and routinizing RFID technology, companies might have many technical problems and have to overcome these knowledge barriers. Relying on consultants is not enough because few consultants understand the clients' business processes sufficiently and thus must work closely with their clients (S.Bharadwaj, 2000). Technical skills of inter-house staff are important for speeding up preparation and enhancing chances of success in

implementation. However, current Chinese enterprises lack such kinds of internal staff who are experts in RFID deployment, which can further inhibit RFID's adoption and routinization.

These negative influences might not be significant in the early assimilation stages since at these stages, initiation and adoption do not require RFID's integration with other backend systems including ERP, CRM and DSS. However, the impact of IT infrastructure challenges is likely to be substantial on later assimilation stages because organizations need to integrate RFID systems with other enterprise systems and data generated from RFID systems need to be used by other systems. The negative influence of unique Chinese IT infrastructure challenges might be even more significant on later assimilation stages than on early assimilation stages. Consequently, we predict the hypothesis as follows:

H3: Current Chinese enterprises' IT infrastructure has more significant negative influence on assimilation stages than on initiation stage of RFID technology.

Managerial capability

Asif et al. (2005) suggest that the deployment of tags and readers by themselves cannot push companies ahead of their competitors. What is more important is how an organization uses the fine-grained and real-time data derived from RFID to change and improve its business processes that will determine the extent of strategic benefit the companies can obtain from RFID technology. RFID is a radical innovation that can significantly change the operational process of an organization, but doing so requires substantial managerial capability. Fichman (2004) likewise suggests that technologies which enable more radical improvement require substantial complementary changes to organizational structures, routines and policies. Accordingly, RFID involves some unique changes with reference to organizational and process adaptations (Chatterjee, et al., 2002a). Robert et al. (2003) note that not all firms can effectively manage adaptation since they lack managerial skills and know-how for change management. Thus, the effect of managerial capability which refers to managerial skills for managing organizational adaptation to accommodate RFID assimilation is worth investigating.

Organizational adaptations in RFID assimilation include making organization changes on structures and coordination mechanism (Chatterjee, et al., 2002a) and acquiring new expertise necessary to use the innovation (G.Fichman, 1999). Most literatures owe IT failure to management issues such as lack of synergy between business and IT skills, how to integrate the technology with the business strategy, skilled technical people and experienced, trained

users. These literatures suggest that managerial obstacles can impede RFID initiation, adoption and routinization when organizations cannot make organizational changes, redesign business processes, and acquire new expertise. The influence of managerial capability is especially significant on later stages since at this stage, organizations need to make organizational changes to adapt the new innovation and infuse it into the company's daily operations.

As indicated by Bai and Hamilton, since Chinese economy has evolved from centrally-planned to market-oriented, there is a great shortage of management personnel who understand and master Western management skills in marketing, financial management, inventory control, human resources, and international business rules. Moreover, they lack know-how for change management, which makes it very difficult to make radical organizational changes and improvements. Most Chinese enterprises have not been engaging in world markets for nearly as long as Western counterparts. It has only been until recently that Chinese managers have had access to advanced managerial education involving basic courses in market economics, change management, and business process improvement. This might inhibit the RFID assimilation process, especially in later stages. Therefore, we predict the hypothesis as follows:

H4: Current Chinese enterprise's managerial capability plays more significant negative influences on assimilation stages than on initiation stages of RFID technology.

Absorptive capacity

As defined by Cohen and Levinthal (2006), an organization's *absorptive capacity* is represented by its ability to recognize the value of new, external information, absorb it, and apply it for commercial ends. They also point out that effective absorptive capacity can be determined by prior relevant knowledge and intensity of effort. Especially in an uncertain environment, absorptive capacity can affect expectations formation and enable a firm to predict more accurately the nature and commercial potential of technological advances. Because RFID is a radical innovation that is full of uncertainty, it requires absorptive capacity to recognize the value of it, absorb it and apply it to their operations.

Existing literature regard absorptive capacity as a knowledge base, especially the extent of prior knowledge the firm possess. (Lane, Salk, & Lyles, 2001). This is similar to *path dependency*, which is a firm's ability and incentive to adopt an innovation, which can be largely determined by its level of related experience with prior relevant technologies (Hassan

& Chatterjee, 2006). Also indicated by Cohen and Levinthal (2006), such skills and knowledge are critical for successful adoption of new technology standards. Thus, firms which have prior experiences ***and knowledge*** with related technology such as EDI or barcode systems may have developed technical and managerial skills for deploying RFID technology compared with those firms without EDI or barcode experiences.

However, most Chinese enterprises lack absorptive capacity to absorb RFID technology and apply it for their application since most of these companies do not have ***related*** prior ***knowledge and*** experiences to use EDI or barcode before. Lack of previous ***relevant knowledge and*** experiences related with EDI or barcode technology will inhibit them to implement RFID technology. Therefore, we predict the following hypothesis:

H5: Current Chinese enterprises' absorptive capacity has negative influence on both initiation and assimilation stages of RFID technology.

Predictions Related to Environmental Factors

Competition intensity

Competition intensity is “the degree that the company is affected by competitors in the market” (Zhu, et al., 2004). Porter (1980) suggest in his five-force competitive model that competitive pressure is an important external driver to initiate the deployment of IOS among trading partners.

According to Tsen (2001), China’s economic reform towards a market economy promote more trade and encourage more foreign direct investment (FDI) to contribute economy growth since its economic reforms in 1979. As suggested by Fu (2008), China has become the second largest FDI recipient in the world which is after the United States and the largest host country among developing countries. These FDIs bring capital, knowledge and new managerial skills to China. However, they also attracted the most talent researchers and compete in the markets of innovation products that can threaten local firms, especially the SMEs. Their participation increases competition in the domestic markets which makes challenges to Chinese enterprises’ technology and managerial capabilities. Therefore, we posit that competition intensity will influence Chinese enterprise’ RFID assimilation process.

Its effect on RFID assimilation might also be different across different assimilation stages. At initiation and adoption stage, benefits derived from first movers’ RFID adoption might arouse decision makers’ awareness of this technology and make them consider adopting it. Compared with traditional bar code systems, RFID can track the status of products in real-

time and thus improve the inventory visibility as well as asset management. These improved efficiencies are critical for companies to maintain their competitive advantage. Therefore, competition intensity is likely to drive companies to initiate and adopt RFID technology.

Nevertheless, competition intensity could have a reverse effect on later assimilation stages. According to Mata et al. (1995), complex technologies can only be routinized through a gradual and learning-by-using processes. Nonetheless, more competitive pressure would drive firms to leap rapidly from one technology to another rather than develop skills to routinize existing technologies. As mentioned before, the current Chinese competitive environment drives firms to leap from one technology to another which means they are less likely to undergo a gradual, careful and sustained learning by doing process to routinize RFID into their organization. Hence, we postulate that competition intensity has positive influence on early assimilation stage but negative influence on later assimilation stages. Accordingly, we predict the following hypothesis:

H6: Competition intensity has positive influence on initiation stage, but it has negative influence on assimilation stage.

Regulatory support

Regulatory support is a critical factor influencing innovation diffusion (Zhu & Kraemer, 2005; Zhu, Kraemer, & Xu, 2006). Williamson (1983) suggest two ways which government could affect innovation diffusion. "One way is to take tax and other measures to increase or decrease payoff, the other way is to alter the climate in which they are received." (Williamson, 1983, p. 126). Zhu et al. (2006) investigate the assimilation of e-business and find that governments can encourage e-business legislation by supportive regulations and policies.

These issues are particularly important in China. Chau et al. (2008) investigate the assimilation process of Internet technologies in China and find that Chinese companies have the highest concern for the regulatory environment in which they and their business reside. In our research, since currently Chinese government is proposing the twelfth five-year plan and government plans to invest in R&D of the "Internet of Things" and cloud computing, and develop digital and virtual technologies. RFID technology is the key enabler of the Internet of Things. Regulatory support from the government can form an encouraging environment that will make decision makers aware of this technology and consider adopting it in their

enterprises. The influence of supportive regulatory support is also significant on later assimilation stages. Therefore, we have hypothesis as follows:

H7: Current Chinese government's regulatory support is positively related with initiation and assimilation stages of RFID.

Environmental Uncertainty

As indicated by previous literature, firms facing environmental uncertainty have greater incentives to adopt IOS (inter-organizational innovation) to improve information exchange and to reduce uncertainty between trading partners. Sharma (2000) also indicate that firms facing higher environmental uncertainty will sense more opportunities, are proactive and innovate more than other firms.

However, this situation might be different in China. As indicated by Chau et al.'s (2008) investigation of Internet assimilation status in China, market uncertainty has a negative influence on a firm's proactive and innovative strategies and behaviors. Since adopting RFID technology requires a lot of investment and whether benefits can be gained from these large investment costs is still a problem for most enterprises. Compared with bar code system, the cost of an RFID tag is still much higher which approximately ten times of that of bar code. The costs might still be a large hurdle for Chinese enterprises' RFID deployment. This problem is even more serious for the low-end product industry such as toys and clothes. Another cost incurred is the IT infrastructure. As Konsynski and Smith (2005) suggest, deployment and development is likely to add significant cost to the tight implementation of RFID technology. Moreover, the investment cost is irreversible due to the tight coupling between the technology and organization.

With reference to standards uncertainty, the Chinese government has decided not to use either EPC or UID, but instead to develop their own RFID standard. Additionally, two bureaucratic challenges further complicate the current standards problems (Lai & Hutchinson, 2005). The first one is that radio frequency assignment for RFID is not finalized. The second challenge is that it is not clear who is responsible for drafting the RFID standards. Currently, there are two organizations which have overlapping functions for developing RFID standards: one is the working group of electronic labeling set up by SAC (Standardization administration of China), the other is the ANCC (Article Numbering Center of China) which is the authority for product coding.

At early assimilation stage, uncertainty of standards might inhibit decision makers make purchase and adoption decision since they are not sure which RFID system they should purchase. At later assimilation stage, lack of harmonization between standards might increase the complexity of application or operation. Thus, standards uncertainty might negatively influence both early and later stages of RFID assimilation. Taking these factors into consideration, we have following hypothesis:

H8: Environmental uncertainty will negatively influence both early and later stages of RFID assimilation.

We depict our research framework in figure 1.

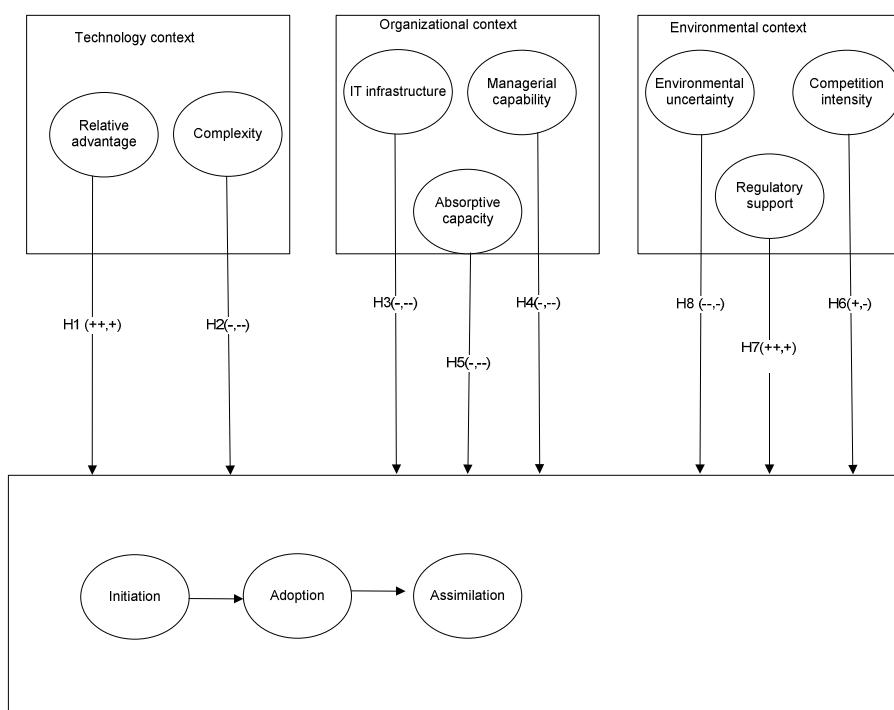


Fig.1 Research model

4 METHODOLOGY AND DATA ANALYSIS

4.1 Sample Frame

We will use questionnaire surveys to collect data from various supply chain participants including manufacturers, retailers and logistics providers. We collect data through two non-profit organizations: Gs 1 Hong Kong and LSCM centre (Hong Kong R&D Centre for logistics and supply chain management enabling technologies). They help us distribute the

questionnaires to their member companies. IT managers or project managers who are familiar with the deployment process of RFID technology will be respondents for investigation and this can avoid response bias from a single informant.

Before surveying, we conduct three pilot interview studies to check if there are any content validity problems with our questionnaires. To reduce the common-method bias, we collect data through several different ways: online questionnaire surveys, paper questionnaires as well as telephone surveys.

4.2 Measures

Measurement items are developed based on a comprehensive review of the literature as well as expert opinions. Seven-point Likert scales ranging from “(1) strongly disagree” to (7) strongly agree” will be used for all items.

4.3 Data analysis

4.3.1 Measurement model

Partial least-squares (PLS) approach will be used to test the structural model. It assesses the relationships between the research constructs as well as the relationships between the constructs and their measurement items (Ranganathan, Dhaliwal, & Teo, 2004). It involves no assumptions about the population or scale of measurement. Its sample size requirement is either 10 times the largest measurement number within the same construct or 10 times the largest measurement number affecting the same construct. It is better suited when the focus is on the theory development, whereas LISREL is preferred for confirmatory testing of the fit of a theoretical model to observed data, thus requiring stronger theory than PLS (Barclay, Thompson, & Higgins, 1995). We use smart-PLS to evaluate the research model.

A two-step data analysis will be conducted to first assess the measurement model and then test the hypotheses by fitting the structural model. In the measurement model assessment, construct reliability, convergent validity, discriminant validity will be evaluated. Reliability measures the degree to which items are free from random error, and therefore yield consistent results. It is evaluated by Cronbach's α . If a construct has a composite reliability in excess of 0.70, it implies this construct has an acceptable level of reliability (Fornell and Larcker, 1981). Construct validity includes convergent validity and discriminant validity. According to Fornell and Larcker (1981), convergent validity for a construct is evaluated by three criteria: (1) item loadings (λ) larger than 0.70; (2) composite construct reliability larger than 0.80; (3) average variance extracted (AVE) larger than 0.50. Discriminant validity is the extent to

which h different construct diverge from one another. It is assessed by the criterion that the square root of AVE for a construct should exceed its correlations with all of the other constructs, which indicates that items share more variance with their respective constructs than with other constructs.

4.3.2 Structural model

First, an exploratory analysis is conducted for empirically defining the diffusion stages. Based on the measurements of initiation, adoption and routinization, we classify the investigated firms into two categories: those who are in the early assimilation stage and later assimilation stage. A structural model will be built to examine the causal structure of the research framework. The evaluation of the structural model using PLS is conducted in the following two steps. First, the standardized path coefficient and statistical significance for the influence paths in the structural model is estimated. We will perform bootstrapping analysis with a large sample size to estimate path coefficients, statistical significance, and relevant parameters such as means, standard errors, item loadings and item weights, etc. Second, the coefficient of determination (R^2) for endogenous variables will be calculated to assess the predictive power of the structural model which is similar to that found in multiple regression analysis. We will perform three separate runs for each of the three stages based on the clusters of data to test which factors are important on each stages. After that the results of these three separate models will be integrated into one model for illustration.

5 CONCLUSION AND SUMMARY

Drawing upon innovation diffusion theory, TOE (task-organization-environment) framework and stage-based IT diffusion model, this research empirically investigates different factors' impact on different diffusion stages. This model extends the current state-of-the-art since most IOS research focus on one stage-adopts or not adopts which neglect the dynamic nature of RFID diffusions. However, our research capture this nature of RFID diffusion in an organization and it will provide some important findings for scholars and practitioners:

This study used a multi-stage diffusion approach and proposed a novel theoretical framework to explain RFID's diffusion processes within an organization. Previous research focused on technology implementation issues from a single decision view of adoption or acceptance which has often caused inconsistent findings. Subsequent research could be based on this foundation and investigate RFID's diffusion processes across various trading partners since

it's an inter-organizational technology and only through collaborating with trading partners can its benefits be greatly achieved.

Second, the relationships between different external antecedents and different diffusion stages will guide organizations to diffuse RFID technology more efficiently. From technological perspective, when firms are planning to initiate RFID deployment, relative advantage of this technology may draw special attention of decision makers while complexity and compatibility may not play a significant role since at this stage decision makers haven't decided to whether adopt it or not. However, at adoption stage, large investment costs push decision makers to conduct cost/benefit analysis, comparing relative advantage with its large investment costs and consider the complexity of adoption and implementation and compatibility with other applications of the organization as well as the working procedures of the organization. At routinization stage, relative advantage and complexity may not become the major concern but compatibility may still play an important role since RFID technology needs to be integrated with other applications as well as the organization's working procedures to finish the organization's operations. From organizational perspective, organization size is positively related with initiation and adoption since larger organizations usually have more slack resources to invest in the high cost technology such as RFID. However, during the routinization stage, due to the entrenched structure and complex business processes and hierarchical decision making process, it is more difficult to reengineer the business processes. And therefore, organization size is negatively related with routinization stage. Since RFID's implementation involve unique changes with regard to organizational adaptations, organizations which lack managerial skills and know-how for change management will have some difficulties in RFID's initiation, adoption and routinization. Managers need to consider both advantages and disadvantages of their organization characteristics (e.g., size, managerial obstacles), during their RFID diffusion process and propose some solutions to deal with these challenges of each stage. From environmental perspective, mimetic and normative pressure may play significant effect on initiation stage and adoption stage, but its positive effect is not significant on the routinization stage. Coercive pressure has significant effect on adoption and diffusion stage with less significant effect on initiation stage. These results will give some guidance to organizations in different RFID implementation stages to overcome inhibitors associated with that stage and diffuse RFID technology more deeply and efficiently. Thus this research will provide many valuable implications for practitioners.

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Assessing the Use of Computer Role-play Games in Classrooms

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ABSTRACT

With the advancement of Information and Communication Technology (ICT) in educational settings, simulation role-play games are increasingly being used to replace traditional role-play games. However, it is still unclear whether computer role-play games are effective tools to enhance students' learning process. The purpose of this study is to investigate the extent to which computer role-play games improve students' understanding of the learning material. Two groups of third year undergraduate students from a university in Bahrain participated in this study by playing a manual and computerized role-play game called Beer Game. The first group played the computer Beer Game first and then the manual Beer Game whereas the sequence was reversed for the second group. The findings show that to improve students understanding of the learning material, both role-play games should be implemented in classroom. This study provides useful guidelines and insights to educators interested in adopting these tools in classroom settings.

Keywords: e-learning, Beer Game, role-play game.

Introduction

Role-play games are educational techniques that aim to provide the student with a simplified reproduction of part of a real world or imaginary world (Van Ments, 1999). These games create a system where students play roles in a controlled setting with a particular set of rules (Feinstein, Mann and Corsum, 2002). The use of these techniques helps students relate theoretical concepts taught in class to complex real life situations. More specifically, the

purpose of role-play games is to help students learn the material by focusing on not only 'hearing' and 'seeing' but also 'doing' (Specht and Sandlin, 1991).

Given the benefits of role-play games in facilitating student-learning behavior, it has been used in many fields such as health care (Woodward et al., 1988), mathematics (Lee and Chen, 2009), medicine (Joyner and Young, 2006) and Information Systems (Reimer, 2008). In the past, instructors relied on traditional or manual role-play games to foster students' learning processes. This type of role-play games is where the instructor uses paper, pens, and objects and so on to replicate a system. However, implementing manual role-play games in classrooms becomes tedious because it takes time to organize and set-up the game and requires active involvement of the instructor (Reimer, 2008).

More recently, with the advancement of Information and Communication Technology (ICT), there have been a shift from manual role-play games to computer simulation for use in educational settings because the latter provides visualization and ease of use to foster the learning process among students (DeNeve and Heppner, 1994). However, the literature provides conflicting findings on the influence of computer role-play games on the students' learning process. Some studies contend that computer role-play games in classrooms plays an effective role in enhancing learning (Aubusson et al., 1997; DeNeve and Heppner, 1997; Rendas, et al., 1999), while other researchers have argued that implementation of these technologies in classrooms have limited effect (Kim et al., 2002). Currently, there are limited studies that provide a deeper understanding on how these games promote students' learning process.

The aim of this study is to investigate the use of computer role-play games in improving students' understanding of the classroom material. The main research question of this study is 'to what extent does computer role-play games improve students' understanding of the learning material?' To address this research question, an experimental research was conducted with two groups of students from a university in Bahrain by playing a role-play game called Beer Game. The Beer Game is chosen because it is one of the most widely used role-play game in Logistics, Supply Chain Management and Information Systems and the computer version is being adopted in more than 224 universities from 47 countries (Reimer, 2011).

The next section presents the Beer Game, followed by a brief overview of the variables used to measure students learning. Then, the research method is discussed, which is followed by the analysis of the experiments. Finally, the discussion and conclusion are presented.

Beer Game

The Beer Game is a role-play simulation of a supply chain, which includes four roles, namely the factory, distributor, wholesaler and retailer. The aim of the game is to manufacture and deliver units of beer. The consumer (usually the instructor) drives the game by providing consumer demand on a weekly basis to the retailer and based on the demand, the retailer orders units of beer through two stages (wholesaler and distributor) until it reaches the factory. The factory then manufacturers the products and delivers the units, through three other stages (distributor, wholesaler and retailer) until it reaches the final consumer.

A group of students (two to four) are assigned to each of the four roles in the supply chain. The game runs in weeks (rounds). It starts in week 1 and usually finishes in week 35. Every week, each role places an order and makes deliveries. For example, the distributor's places orders to the factory. The factory then places orders, which become a production order. The game has a two weeks delay, which is also called *lead-time*. When any party places an order in week 1, it will be delivered after two weeks, which is in week 4.

The students in the four roles are not allowed to communicate to each other. They have one objective, to minimize their cost. The cost is calculated by adding inventory carrying cost and back orders (orders that cannot be fulfilled). Inventory holding cost is \$ 0.5 per unit of Beer per week and the cost of not fulfilled orders is \$ 1 per unit of Beer per week. All back orders must be fulfilled in the following week(s). The only decision that the student in each role makes is the order quantity.

As the game does not allow the parties to communicate, the supply chain members experience a lot of issues such as being out of stock or have over-stock, which adds cost. These issues can be addressed by adopting IS because these technologies improve processes between companies and facilitate information sharing. Therefore, the Beer Game becomes a useful teaching exercise to show students how IS can be used by organizations to have more efficient and effective supply chains.

Manual Beer Game

In the manual Juice Game, students use paper, pens, envelopes and cans to play the game. The table setup for students in each role is shown in Figure 1. Each week, students in each role receive incoming orders and incoming deliveries and send outgoing order and outgoing deliveries. Every week the numbers have to be filled in a works sheet to calculate the total cost. The participants fill their orders in small paper sheets, put them in an envelope on the outgoing orders slot and the instructor or a teaching assistant moves each envelope to the next party. Similarly, when the students in each role receive incoming deliveries, these numbers are filled in their work sheets, outgoing deliveries are calculated and a paper slip of the quantity is put in a can and placed in the outgoing delivery slot. In addition, the students are made aware of a two weeks delay (lead-time) to receive the orders placed by them (see the two extra fields between the tables in Figures 1 and 2).

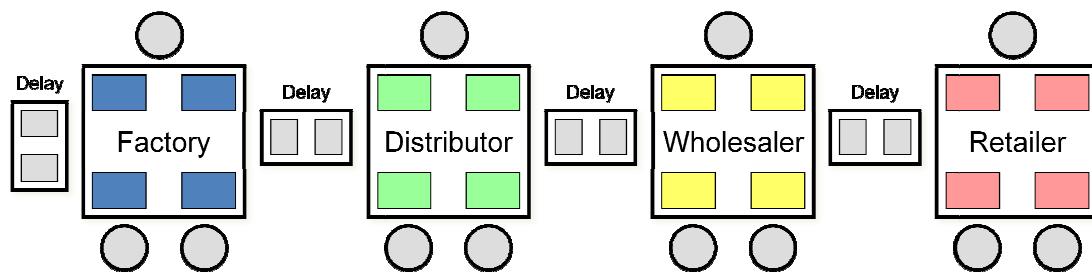


Figure 3: Manual role-play setup (Reimer, 2008)

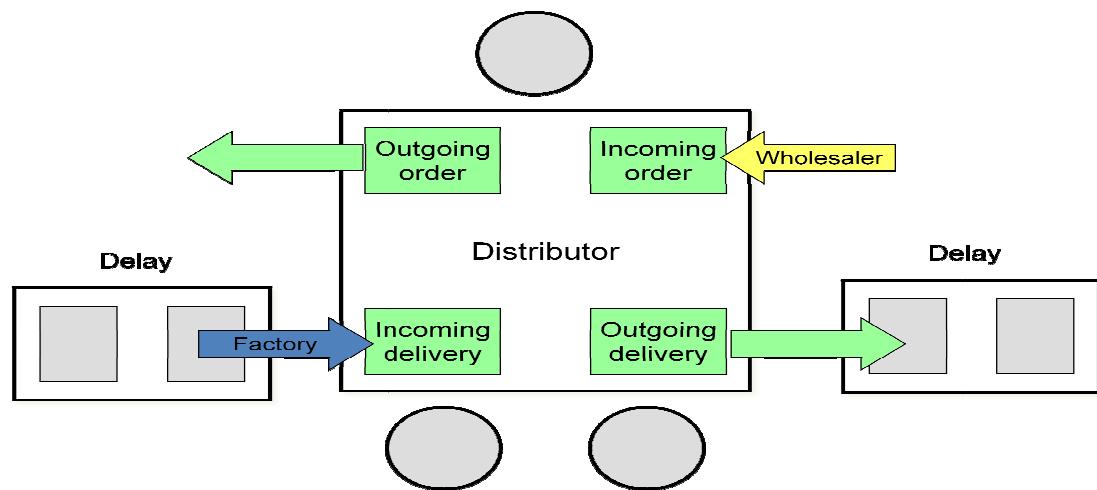


Figure 4: Manual role-play table setup (Reimer, 2008)

Computer Beer Game

The computer beer game has been developed by Kai Reimer and can be downloaded from www.beergame.org. The software is being adopted in more than 224 institutions from 47 countries (Reimer, 2011). The game is in a form of a client-server application. The students log on to the game using their email address and password via a web browser. Once all four roles have logged on, the instructor starts the game from the server. All the orders and deliveries are electronically received and sent. As shown in Figure 3, the students do not perform any calculations; all the student does is simply decide on the order quantity with the objective of reducing their total cost.

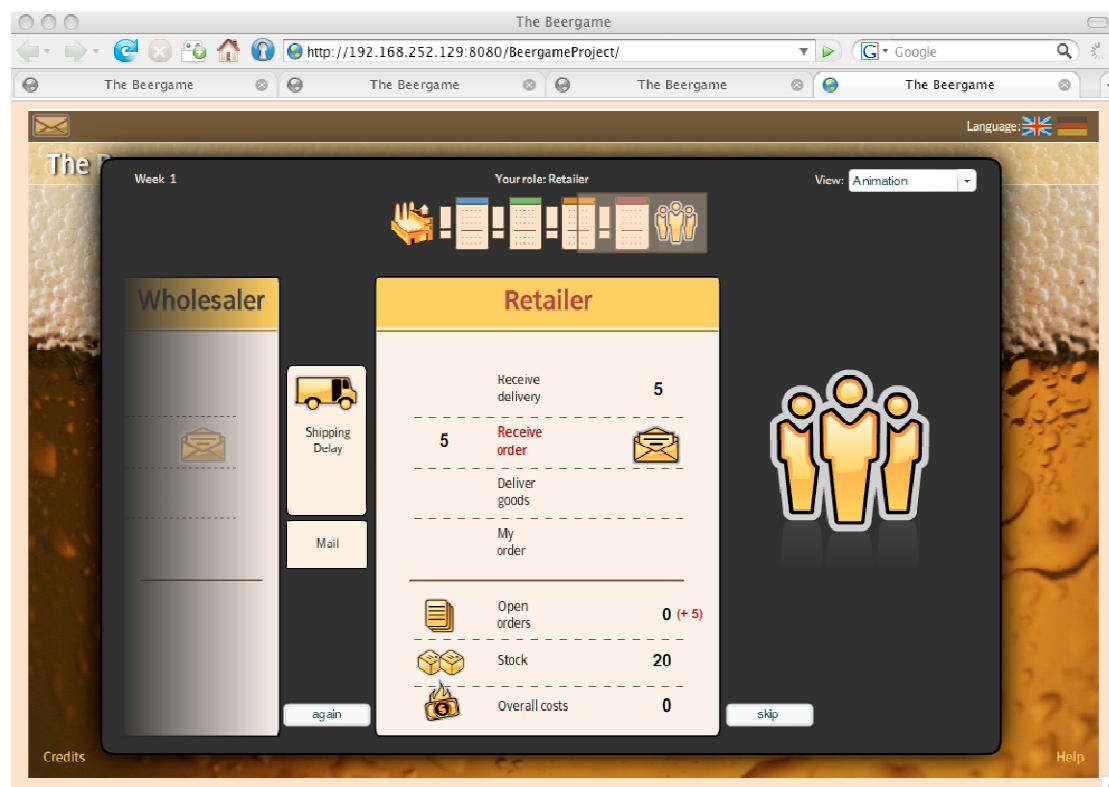


Figure 5: Computer Beer Game (Reimer, 2011)

Measures of students' Understanding of Supply Chain Concepts

This study adopts De Freitas and Oliver (2006) framework on how to evaluate the use of role-play games to determine how learning process takes places. The authors argue that evaluation of the learning process depends on the context of the study, the learner specification, pedagogic considerations and mode of representation (tools for use). In the context of this study, students' understanding is measured by the extent to which students become familiar with the concepts of lead-time, calculations of cost and understanding of supply chains. These three measures are explained below:

Lead-time: It is measured by the extent to which students are familiar with the concept of lead-time and its impact on the supply chain.

Calculations: It is measured by the extent to which the student is familiar with the calculations to obtain the final cost.

Overall understanding: it is measured by extent to which the students understand the concepts of the supply chains and the need to use IT to managing problems in supply chains.

Research method

This study adopts an experimental research approach because it helps the researcher to bring about a change in a situation, while not influencing the participants. The primary data collection technique used in this study was semi-structured interviews. The data was collected from students taking an E-Business course at the Information Systems Department at a University in Bahrain. These students played the Beer Game (the name was changed to Juice Game for cultural reasons as alcohol is a prohibited drink among Muslims) as part of their course project. Two classes were involved in this study, which formed two experimental groups. The two experiments were conducted in the first semester of 2011. The participants in both experiments were interviewed two times (once after playing each game). All interviews lasted for approximately 15 to 20 minutes. An interview protocol was used as a guide in all interviews. It included questions relating to topics such as students' experiences using the game, understanding of concepts of supply chain and the comparison between both role-play games. The data were transcribed after the interviews and were analyzed by finding common themes through pattern matching logic (Yin 2003) using Nvivo software.

Prior to conducting the experiments, participants were provided with a description of the study. Ten students participated in the Experiment 1 and 11 students participated in the Experiment 2. The students in both experiments were assigned into groups and each group was assigned a role (either a factory, distributor, wholesaler or retailer). The first experimental group started by playing the computer beer game and then they were interviewed after the game. Then in a week time, the same group played the manual beer game and then they were interviewed for a second time. The second experimental group played the manual beer game first and then the computer beer game. This group was also interviewed after playing each game.

The data was analysed by using three indicators (lead-time, calculations and overall understanding of the supply chains). For instance when a student indicated that he/she understood a concept a value 'yes' was given, whereas if a student indicated that he/she did

not understand the concept a value ‘no’ was given. In this way, all three concepts were precisely measured.

Rigour in the study was achieved by following the guidelines as suggested by Yin (2003). In particular, the focus was on construct validity, external validity and reliability. The construct validity was established by having participants reviewing the interview transcripts. External validity was achieved by applying replication logic. Multiple respondents were used to achieve literal replication.

The reliability of the study was achieved by: (a) clearly conceptualizing variables: The variables were clearly conceptualized as they were defined prior to conducting the empirical study; (b) using an interview protocol: An interview protocol was developed and used in all interviews; and (c) maintaining a database: All the interview data was managed within Nvivo.

Experiment 1

In this experiment, the students first played the computer role-play game. They were explained how the game works and the steps to log on to the system. These students were interviewed after the game. Then, in a week time, the same participants played the manual role-play game and then they were again interviewed after the game.

The participants were asked questions to assess their level of understanding of concepts such as lead-time, calculation of cost and supply chains problems and issues. These three were used as indicators to assess the computer and manual role-play games. The value ‘yes’ indicates an improvement in these concepts, while ‘no’ indicates that the student did not understand the variable (concept). A summary of the data analysis concerning each of the variables and improvement in the level of understanding of students relating to supply chain concepts is presented in Table 1.

The results indicated that in the computer role-play game only a few students (four out of 10) understood the concept of lead-time. The four participants stated that the lead-time was clear in the game and therefore the value is yes:

Yes, the lead-time was obvious in the computer game; I knew it when I played the game.

Participant A

Yes, the truck was on the screen, we could see it. Participant J

However, six participants indicated that they did not understand lead-time in the computer game and therefore have a value of ‘no’. Even though the lead-time was explained in an earlier class and shown as an animation on the screen, these participants did not understand the concept. For example the two quotes below explains students’ views:

I understood lead-time when I played the manual game, in the computer game it was not so clear. Participant C

In addition, most of the participants (eight out of 10) were not familiar with the formulas of the calculations required in the game and could not understand the cost. This is because the participants did not need to do the calculations in the computer role-play game as all they had to do is to enter the order quantity in the game and the costs were calculated automatically:

I like the manual game better because we know what happened, how we calculated the cost. In the computer, we only put the numbers. In the manual, we work more. Participant D

The two students that understood the calculations from the computer role-play game stated that they had practiced it before the session and had to know the calculations to minimize their cost.

I understood the idea from the computer game... The things were moving faster from the computer. Because you explained to us on the computer first when we put the numbers in the sheet we thought we had to enter them but there were already there on the computer but we understood them [the calculations]. Participant J

Table 1. Summary of Experiment 1

Participants	Computer role-play game		Manual role-play game		
	Lead time	Calculations	Lead time	Calculations	Change in understanding of concepts after the manual role-play game
A	Yes	No	Yes	Yes	Improved

B	Yes	No	Yes	Yes	Improved
C	No	No	Yes	Yes	Improved
D	No	No	Yes	Yes	Improved
E	No	No	Yes	Yes	Improved
F	No	No	Yes	Yes	Improved
G	No	No	Yes	Yes	Improved
H	No	No	Yes	Yes	Improved
I	Yes	Yes	Yes	Yes	No change
J	Yes	Yes	Yes	Yes	No change

The data indicates that students after playing the manual role-play game had a better understanding of the concepts of lead-time and got familiar with the calculations. These students explained that because there are delay cans between each group, they are able to understand the lead-time concepts. They could understand the calculations better because they were calculating the costs manually:

I think the manual game helped me understand better because when we write the numbers, it is easier rather than put it in the computer... we can see when they [other supply chain members] delivered and receive orders. Participant H

When the students were asked if they preferred the manual role-play game, most of them recommended both games in class. They stated that in the manual game, they could understand the concepts of lead-time and calculations and supply chain concepts and then they could easily play the computer role-play game once they got familiar with these concepts.

Summary of Experiment 1

The data from eight participants indicates that students got a better understanding of the concepts of the supply chains after playing the manual role-play game. This finding is inconsistent with findings of some studies in the literature (for example, DeNeve and Harpener, 1997). In addition, these eight students preferred to play both games. They also suggested that the manual role-play game should be played before the computer role-play game so that students get familiar with the important concepts and thus will be able to play

the computer role-play game. However, two students believed that the computer role-play game was still sufficient for understanding supply chain concepts.

Experiment 2

Similar to the previous experiment, the participants were explained the aims of the research and given a consent form. The primary purpose of this experiment was to assess (a) students' understanding of supply chains when the sequence of the games is reversed, that is having the manual role-play game first and then the computer role-play game and (b) whether changing the sequence of the games would provide any new findings.

Similar to the previous experiment, the participants were asked questions to assess their level of understanding of concepts such as lead-time, calculation of cost and supply chains problems and issues. These three were used as indicators to assess the computer and manual role-play games. The value 'yes' indicates an improvement in these concepts, while 'no' indicates that the student did not understand the variable (concept). A summary of the results from the 11 participants is shown in Table 2.

The data indicates that all the students that were interviewed after playing the manual role-play game understood the formulas and calculations completely:

Yeah, it [the calculations] was easy. No problems. It's pretty basic accounting
Participant L

In terms of lead-time, three out of 10 students did not realize that the manual game had a lead-time. However, the remaining seven students understood that they would receive their deliveries after two weeks of placing their orders.

I was imagining I was living the real situation. I was sending an order. For example, I was ordering products when I had low inventory, so I made the order but I didn't know what I'd get in two weeks and if I would need additional inventory. So I didn't know if I'd have orders or not after two weeks. I felt I was not in a game but working in a real life situation. Participant K

In addition, the data indicates that all students understood the concepts of supply chains from the manual role-play game:

I already understood all this [the concepts] in the manual. It [the computer Beer Game] was not different from the manual game. Participant P

Table 2. Summary of Experiment 2

Participants	Manual role-play game		Computer role-play game		
	Lead time	Calculations	Lead time	Calculations	Change in understanding of concepts after playing the computer role-play game
K	Yes	Yes	Yes	Yes	No change
L	Yes	Yes	Yes	Yes	No change
M	No	Yes	Yes	Yes	No change
N	Yes	Yes	Yes	Yes	No change
O	Yes	Yes	Yes	Yes	No change
P	Yes	Yes	Yes	Yes	No change
Q	No	Yes	Yes	Yes	No change
R	Yes	Yes	Yes	Yes	No change
S	No	Yes	Yes	Yes	No change
T	Yes	Yes	Yes	Yes	No change
U	Yes	Yes	Yes	Yes	No change

Moreover, all participants stated that they preferred to play both role-play games in the same sequence as the experiment. More specifically, the data indicates that participants thought that the manual role-play gives them a good understanding of the formulas, calculations and movement of orders and deliveries. Then, the computer game could be used for execution because it is faster and creates a better structure to the role-play process:

In the manual game we were focused on the formula, on the calculations, on understanding flow of products in supply chain, we didn't focus on the order. In the electronic game, we were predicting the demand, how much to order, how much to order the inventory, we didn't focus on the calculations, and we focused on the demand and order. Participant U

I think playing the manual first was helpful before playing the computer game. In the manual we will understand how to calculate, the cost better and then the computer will be faster for playing, the manual game was too slow. Participant T

Summary of Experiment 2

This experiment shows all students did not have a preference any particular role-play game but preferred to play both role-play games. Students showed a better understanding of the concepts because they played the manual game first and then the computer game. Therefore, this confirms that playing both games was more beneficial to the students. The manual role-play game should be played first and then the computer role-play. The findings indicate that students regarded the manual role-play useful for practicing the formulas and understanding the concepts and strategies of the game, while the computer-role play was more enjoyable and faster. They do not need to know calculate the cost for each of the 35 weeks in the computer role-play game. The participants thought that a few weeks were sufficient in the manual role-play and once they got the practice and they could use the computer-role play game to expedite the process.

Conclusion

This study examined the extent to which computer role-play games improved students' understanding of the learning material. The results were compared between the manual and the computer role-play games using two groups of students. The findings show that computer role-play games cannot entirely replace the manual role-play games. To enhance students' learning, it may be necessary to play both, with the manual role-play game played first, and then the computer role-play.

In addition, there are inconsistent findings in the literature on the influence of computer role-play games to improve students learning process (Kim et al., 2002). This study provides new explanations on the effectiveness of using both types of role-play games. The manual role-play game could be used at the start of the learning process as students can relate to concepts by seeing objects and doing. Then, the computer role-play game can be used for the faster execution of the game.

Moreover, to the best of the researcher's knowledge, this is the first study that compares between a manual role-play game and computer role-play game to assess students' understanding of the material. Previous studies have compared the use of computer role-play games with traditional lectures or text book learning (DeNeve & Heppner, 19997; Kern, 2000; Kim et al., 2002; Liu et al., 2011). This is problematic as these are two different types of analysis, which creates many confounding variables that may affect these studies findings.

In addition, previous studies have relied entirely on surveys to examine the difference between traditional lectures and computer role-play games (DeNeve & Heppner, 19997; Kern, 2000; Kim et al., 2002). Surveys do not provide rich explanations as to why in some situations the computer role-play game is effective for student learning and in other cases there are no change. In this study, 21 participants were interviewed using a rigorous method. This provides a richer understanding on the influence of role-play games in classroom settings.

The limitations of this study should be noted. The participants of this study were third year university students. It would be interesting to compare the results with lower level students or postgraduate level students. In addition, in this study the Beer Game was used as a tool to assess the influence of computer role-play game in improving classroom learning. While the findings may be applicable to other role-play games in other domains, the context and variables used to measure students' understanding should be taken into consideration.

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Socioeconomic and Sociopolitical Transformations Through Information and Communication Technologies: Evidence from Transition Economies

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ABSTRACT

The aim of this research is to identify the transformative role of information and communication technologies (ICT) in transition economies (TEs). We investigated how ICT spending influences the socioeconomic and sociopolitical changes in TEs belonging to two regional groups (Central and Eastern European and Latin American) from 2004 to 2010. Moreover, we compare the effects of ICT in TEs to those in developed OECD countries. Our results show that while ICT spending is positively associated with overall economic freedom and job creation, it does not significantly improve the TEs' democratic values or mitigate their existing wealth inequality levels. The results also show that the impact of ICT spending on transition processes varies across regional groups. In addition, we confirm the different roles of ICTs in TEs and developed countries. These findings provide insights to future researchers on the role of ICT and its impact on societal changes (economic and political) in transition economies.

Keywords:

Information and communication technologies, transition economy.

INTRODUCTION

The rapid pace of technological progress has been recognized as a significant driver of accelerating economic growth and dramatic structural changes in societies around the world. There is ample evidence in academic research studies and mass media reports suggesting that investment in and utilization of recent information and communication technologies (ICT) is a critical factor for stimulating economic and sociopolitical changes in developing and developed countries (Cumps et al., 2006; Dewan and Kraemer, 1998; World Bank, 2010). However, there have been few studies on the consequences of introducing ICTs in new economies known as transition economies (TEs) that are undergoing significant socioeconomic and sociopolitical liberalization or reforms. The International Monetary Fund (2000) defines transition economies as the “countries moving from centrally planned economies to market-driven economies.” In general, they have experienced transition processes that include one or more of the following transformations: economic and social liberalization, privatization of government-owned enterprises and resources, and creation of a financial sector.

Even though most TEs continuously increase ICT spending after their transitional years, the role of ICTs in facilitating such transition processes is not well understood. Figure 1 illustrates the annual ICT spending of two regional groups of TEs and the OECD countries from 2004 to 2010. While the OECD countries consistently spent around 6.2 % of GDP for ICTs over the seven years, the two regions undergoing economic transition doubled their amounts of ICT spending in the same period albeit with considerable variations between groups. Such increased ICT spending implies not only a growing demand for and use of ICT in transitional economies, but also increased access to ICT applications required by societies in the process of transformation. With a significant spend of national wealth being directed to ICT, we expect its impacts manifest itself in both political and economic markers for these economies.

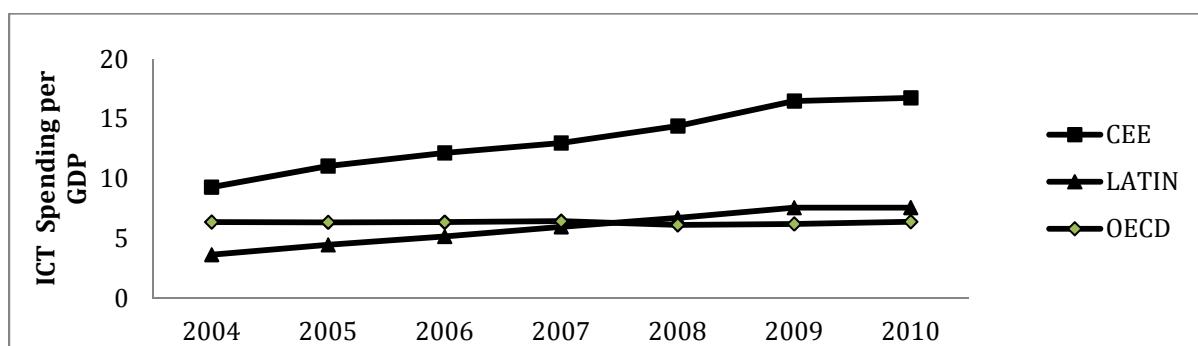


Figure 1. Annual ICT Spending per GDP

Recent politics, economics, and information systems (IS) studies have attempted to assess the changes in economic values (Piatkowski, 2004; Samoilenco and Osei-Brynon, 2010) and the level of democratization (Shiraz, 2008; Soper et al., 2011) resulting from ICT investments in transition economies. They have found that ICT has contributed a great deal to the overall economic growth and sociopolitical changes. However, the research in this area has been conducted without solid theoretical foundations or distinction of TEs from developing or developed countries. This has consequently led to ill-measured effects of ICT. Thus, a specific appreciation of key properties of transition economies is required. Furthermore, the role of ICT in transition economies may vary with different uses of ICT. While some TEs adopted ICT as a tool for accelerating economic growth, others utilized ICT to change sociopolitical structures. As such we broaden the definition of TEs.

Prior studies have also mostly concentrated on examining the role of ICT in the early stages of transition process where drastic economic and societal shifts occurred rather than in the later stages that were typically associated with significant ICT investments and widespread ICT use. This focus on early stages makes it hard to substantiate the exact transformative power of ICT in TEs. Our aim is to fill this research gap by examining how ICT has been able to contribute to restructuring socioeconomic and sociopolitical environments in more recent periods of transition process, where the role of ICT became more critical and essential to TEs.

Drawing on the key tenets of theories of skill-biased technological change and endogenous growth, this study attempts to determine whether ICT plays a transformative role in TEs and examine how the outcomes of transition processes differ according to the intentional uses of ICT.

In order to investigate the association between ICT investments and transition processes, we use data on two regions housing transition economies with very different histories (i.e., Central and Eastern Europe and Latin America) from 2004 to 2010 and measure the effects of ICT-related spending on changes in macro economic conditions, employment, wealth equality, and the level of democratization. Then, we examine whether such outcomes of ICT spending in TEs are different from those in the five developed OECD countries.

In this study we focus on the following research questions: 1) Does ICT play a transformative role in transition economies? 2) How do ICT investments influence socioeconomic and

sociopolitical changes in transition economies? 3) Do these associations vary across different groups over time? 4) What are the unique contributions of ICT to TEs as compared with the developed countries?

This study may contribute to the extant literature on IT payoff at the macro level. The studies of ICT dynamics and their impacts on the transition are important issues in various research areas. Thus, this study will provide opportunities to make new contributions to the existing body of knowledge on these subjects.

THEORY DEVELOPMENT

Although research on the impact of ICT on TEs is still scarce, related literature on economics, politics, and information systems (IS) provides a theoretical groundwork for addressing the research questions. The following sections review the literature that is relevant to the impacts of ICT on economic and sociopolitical changes, and derive a set of implications for our research hypotheses.

Literature Review

Our study draws on the extant literature on ICT dynamics and IT productivity at the country level. This stream of research has commonly found positive relationships between ICT investment and economic changes (i.e., GDP growth and labor productivity). For instance, Dewan and Kraemer (1998) and Kraemer and Dedrick (2001) noted that for the developed countries, IT investment is more positively associated with economic returns (i.e., GDP per capita) than for developing countries. Cumps et al. (2006) found a sustainable competitive advantage from ICT investment in the developing countries.

The research concerning the effects of ICT investments on TEs is still growing. A few recent economics and IS studies have attempted to measure the economic growth contribution from ICT investments (Smoilenko and Osei-Bryson, 2010) and IT-induced labor productivity in TEs (Piatkowski, 2004). However, those studies examined the immediate contributions of ICT on the transition process during the earlier stage of transition, in particular from the early 1990s to the early 2000s. Since, in the initial periods of transitional years, transition economies experienced drastic economic and societal shifts such as changes in fundamental economy structure from planned economies to market-driven economies and changes in liberalization of economies through privatization, the significant transformation might be more influential to the transition process than what was initially attributed to ICTs. Thus, the

transformative role of ICT in TEs may be observed inadequately or underestimated.

With respect to the impacts of ICT on employment, prior studies suggested that technological innovations have replaced the low-skill workers with new technologies (Bresnahan et al., 2002; Meng and Li 2002) and the progress of ICT implies that job could be lost through the causes of obsolesce, automation, and disintermediation (Ubraru, 2010). However, these unbalanced job opportunities do not imply job destruction. The ICTs also have capabilities of spurring new job opportunities by creating innovative ICT-related tasks and occupations such as system designers, telecommunication equipment providers, or installers.

In addition to economic changes, the transformative role of ICT in facilitating sociopolitical change has caught researchers' attention. A few studies have examined the association between ICTs and wealth inequality. Flores (2003) and Katagiri (2010) found that the utilization and progress of ICT have broadened income dispersion. In terms of transition economies, such income disparity became more severe during the first decade after the transition year mainly due to the progressive shift toward market-driven economy. Thus, the questions on how income inequality changed after market structural adjustment and whether ICT contributed to closing a widening gap of income inequality remain largely unanswered.

Several studies have found that ICT can stimulate rapid democratization in certain regions of the world: underdeveloped countries (Ferdinand, 2000; Meier, 2000) and developed countries (Gronlund, 2001) alike. Falch (2006) also argued that ICT had a positive impact on future conditions for democratic governance. However, these studies presented mere conjectures mainly based on theories alone (e.g., IT diffusion) or particular indicators without solid empirical data and rigorous analyses. Although several recent studies (Shirazi, 2008; Soper et al. 2011) have measured a country's democratization level with civil liberties and political rights, we do not observe significant variations of these democratic values over the last decade for most countries. These indicators of democratization may not reflect well the effect of ICT on democratic reforms. They are more likely to be influenced by macro-level structural changes such as alterations of ruling party or religion.

In summary, the research on ICT impact on economic and sociopolitical changes to date is fragmented and still not well established for investigating the transformative role of ICT in transition economies. While most studies conclude that ICT is positively associated with economic growth and democratization but negatively associated with job creation and income

disparity, these findings highly focused on specific country groups (i.e., developed and developing countries), early periods of the transition process, and limited research variables chosen. This study contributes to the existing literature by investigating the role of ICT in transition processes and addressing the concerns identified above.

Hypotheses Development

The research hypotheses draw on the existing literature discussed in the previous section. Table 1 presents a set of relevant studies and the implications for each of our research hypothesis.

Transition Process	Study	Implications for the Hypotheses
Socio-economic	Dewan and Kraemer (1998)	
	Kraemer and Dedrick (2001)	<i>Positive</i> impact of ICT investment on Economic growth and environment changes.
	Piatkowski (2003)	
	Piatkowski (2004)	
	Samoilenko and Osei-Bryson (2010)	
	Bresnahan et al. (2002)	<i>Positive</i> impact of ICT investment on overall job creation, but <i>negative</i> impact on job opportunities for unskilled workers,
Socio-political	Meng and Li (2002)	
	Brinjoffson and McAfee (2011)	
	Flores (2003)	<i>Negative</i> impact of ICT investment on wealth inequality
	Katagiri (2010)	
Democratization	Meier (2000)	
	Gronlund (2001)	
	Falch (2006)	<i>Positive</i> impact of ICT investment on democratic values
	Shirazi (2008)	
	Soper et al. (2011)	

Table 1. Prior Studies and Implications for the Research Hypotheses

ICT and Socioeconomic Changes

While prior literature concludes that investments in ICT contribute to positive economic growth and higher socio-technological development in TEs, these studies do not provide a solid theoretical framework or comprehensive measures for evaluating the transition process in TEs. Although there are differences between TEs and developed countries, researchers use common theoretical frameworks to investigate the impacts of ICT investments on macroeconomic outcomes in both settings. In terms of economic growth contribution from ICT investments, numerous studies still merely utilize production functions, regardless of unique properties of TEs. For instance, Piatkowski (2006) showed that ICT has a large potential to increase long-term economic growth in TEs by stimulating productivity growth at the industry level based on the growth accounting methodology developed by Solow (1957). In the Solow's growth model, technical progress is exogenous. That is, the model does not

explain the source of technological progress. However, most transition economies have adopted ICT with the intention to boost economic growth and accelerate democratic values. In line with this argument, Romer (1990) presented endogenous growth theory for technological change innovation that attributes technological progress to systematic efforts by profit-maximizing economic agents. Thus, the endogenous technological change model explains that economic changes from ICTs are effected by people or countries that have incentives to push for sustained economic growth. Most transition economies have used ICT as a tool to improve their economic conditions, not only for keeping pace with rapidly changing global economic conditions but also for transforming centrally planned economies into market-driven economies effectively. Thus, we predict that the investment in ICT, coupled with the purposeful utilization of gained economic benefits, has a positive impact on overall economic environment in TEs. This leads us to the following hypothesis:

Hypothesis 1a (Economic Freedom): ICT investments will be positively associated with overall economic changes in transition economies.

The creation of job opportunities from ICT investments can be regarded as an indicator of sound economic policy at the country level. Many countries have adopted ICT in order to mitigate rising unemployment rates (Bresnahan et al., 2002). However, some prior studies are concerned that the adoption of ICT has led to lost jobs for unskilled workers. Meng and Li (2001) examined the pressure of unemployment from ICT's displacement effect in developing and developed countries and found that the dynamics of IT replace human labor and increase the demand for skilled labor. Such a negative impact of ICT on job creation can be explained by the theory of skill-biased technical change. Violante (2008) defined skill-biased technical change as "a shift in the production technology that favors skilled (more educated and more experienced) over unskilled labor." Some studies in the economics literature provide a foundation for skilled-biased technical change. Galor and Moav (2000) argued that more educated and experienced labor deals better with technological change. Since it is easier to teach skilled workers a new technology, firms generally prefer skilled laborers to unskilled ones. IS studies have also found that innovations in IT led to skill-biased technical changes. They mostly argued that such an increase in skill demand arises from reduced IT prices and increased use of IT (Bresnahan et al., 2002; Brynjolfsson and McAfee, 2011).

Regarding transition economies, many new jobs have been created in ICT-related industries, and there is soaring demand for skilled workers. Over the years, CEE TE countries have increased average ICT spending per GDP from 8.8% to 16.8% and Latin America TE countries have increased from 3.1% to 7.6%. The increasing ICT spending over the past decade indicates TEs are eager to adopt new technologies. Such active technological adoptions have led to creation of more highly skilled jobs. In addition, while ICT has radically replaced conventional tasks and jobs through automation, new technologies also have created new tasks and jobs in TEs. According to the World Bank's recent report on ICT and its impact on job creation (2009), the demand for ICT goods and services created new jobs and each new job in ICT sectors creates between two and four new jobs in other fields across transition economies (e.g., IT and telecommunication outsourcing and offshore software development in China and India). In this regard, we tested how ICT investments influence job creation in transition economies.

Hypothesis 1b (Job Creation): The investments of ICT will be positively associated with job creation in transition economies.

ICT and Sociopolitical Changes

In addition to the socioeconomic transition process, the role of ICT in facilitating sociopolitical shifts should be identified. After the transition process was launched, most transition economies have faced severe income disparity. Generally, centrally planned economies distribute income more evenly than market-driven economies (including TEs). Since the beginning of the transition, increased income inequality is a common phenomenon for transition economies. In this regard, Kolodko (1999) suggested three reasons for rising income inequality in transition economies: 1) the reduction of state subsidies; 2) reduced employment from the state sector; and 3) the shift of labor from the state to the private sector.

From the perspective of the widespread use of ICT in transition economies, the theory of technological skill-bias can also account for such rising income inequality (Galor and Moav, 2000). Since technological advances favor skilled and educated workers, they also lead to greater wealth inequality in transition economies. This leads to the following hypothesis:

Hypothesis 2a (Wealth inequality): The investments of ICT will be negatively associated with wealth equality in transition economies.

ICT can be viewed as a medium by which relationships can be transformed and open interactions likely lead to more democratization. On the economic level, ICT plays a role in integrating TE into the global market and in spurring the rise of worldwide electronic business activities (Zembylas and Vrasidas, 2005). On the level of social organization, ICT is seen as a mediator for civil democratic processes of citizen participation and decision-making (Noveck, 2000). From this point of view, Shirazi (2008) investigated the impact of ICT expansion on social and political freedoms in ten countries of the Middle East. The results indicated that the use of ICT tools, such as the mobile cell phone and the Internet, enables citizens to share their opinions with others inside and outside their countries and therefore promotes democracy and freedom of expression in the region.

These findings lead to the expectation that the utilization of ICT positively influences social processes of freedom and democracy in TEs.

Hypothesis 2b (Democratization): The investments of ICT will be positively associated with improvement in democratic values in transition economies.

Consistent with the theory of endogenous growth for technological change innovation, economic and sociopolitical impacts from ICT can be influenced by policymakers or leaders in countries that encourage progressive economic and sociopolitical changes. Though transition economies seem to share the same goal of accelerating transition processes, they could weigh their importance differently according to their current transition status. While some TEs use ICT for establishing strong economic foundation and stabilizing overall economic conditions rather than resolving existing social or political problems others leverage it for improving civil rights and making gradual progress in educational coverage rather than drastic economic shifts. In other words, both economic and sociopolitical changes have been attempted by the ICTs. As a result, we expect that the investments in ICT, with different uses of reaping ICT benefits, lead to different outcomes. Consequently, we formulate the following hypothesis:

Hypothesis 3: The outcomes of using ICT for transition processes will differ across regional groups of transition economies.

Our hypotheses are empirically tested with data on three groups of TEs from the seven-year period of 2004 to 2010. Figure 2 presents the research framework of ICT impacts on transition economies.

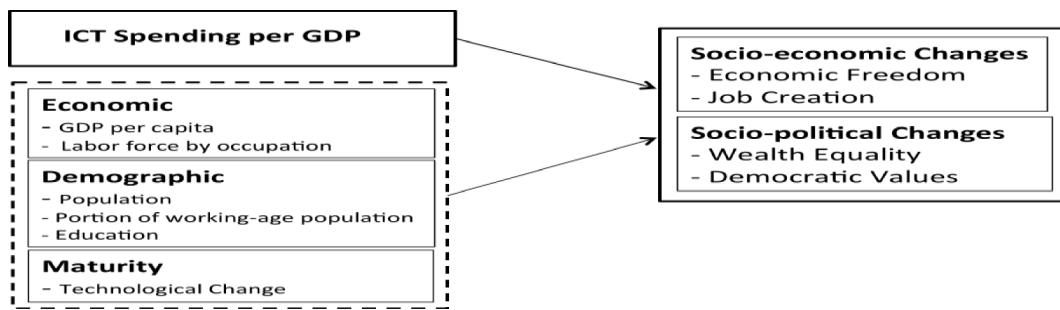


Figure 2. Research Framework

For Hypotheses 1 and 2, the outcomes from transition processes are determined by ICT spending and a set of control variables that could influence the transition processes at the aggregated level. To examine the variations of transition outcomes between groups (Hypothesis 3) and the different outcomes of ICT between TE groups and developed countries, we estimate these associations at each individual region level.

EMPRICAL APPROACH

Classification of Transition Economies

Sample data for our analysis was collected for the two transition economy groups, with a total of 10 countries according to IMF's classification for economies in transition (2000). The two regional groups of transition economies are presented in Table 2. Although IMF's classification does not include Latin countries, our study includes five countries in Latin America because in a broader sense, the definition of transition economies applies to a country or region with low absolute, but fast growing, and authorities committed to economic and political liberalizations (Amold and Quelch, 1998).

Group	Country (Transitional Year)	Transitional Event
CEE	Czech Republic (1990)	- The end of communism in Eastern Europe
	Hungary (1990)	- The disintegration of USSR
	Poland (1990)	
	Slovakia (1990)	
	Slovenia (1990)	
Latin	Argentina (2001)	- Delinking Peso from the US dollar
	Brazil (2002)	- The IMF rescue package
	Chile (1990)	- The end of military dictatorship of Gen. Pinochet
	Columbia (1991)	- The Columbian Constitution was drafted and ratified
	Peru (1990)	- Break away from Hyper-inflation

Table 2. Classification of Transition Economies

Even though each country is grouped based on its geographical location, the two groups have different uses of ICT. As we discussed, most studies on transition economies have aimed at examining ICT-driven economic and political changes in the initial stages of transition process, so they do not present rich insights on the transformative role of ICT in TEs. This study aims to identify salient ICT implications based on each region's transition status and intention of ICT uses during the past seven years when ICT has become more essential and universal for transition processes.

CEE: Countries in CEE included for this study were the part of Soviet sphere of influence. They have the same transitional year of 1990, the year for the collapse of the USSR and the subsequent dismantling of communism in Eastern Europe. The five-exemplar countries included in this study joined the European Union in 2004. While their overall economic and societal indicators had stabilized, their economic markers remained below the European and OECD average (The World Bank, 2011). Important economic indicators such as GDP per capita and employment ratio were much lower than other OECD countries. In this regard, these countries hoped to catch up with living standards in developed countries and use ICT to stimulate overall societal improvements. Higher ICT spending would reflect such efforts (around 13.2% of GDP, which is approximately twice as high as the average spending of other OECD countries). So we examine whether investments in ICT are effective for socio-economic transition processes for these advanced transition economies.

Latin America: The selected countries in Latin America have experienced significant economic and political restructurings after initial transitional years. Their transitional years were mainly triggered by political liberalization. They have relatively healthier economic indicators as compared to other countries in the region, but they are still undergoing liberalization of economies and societal changes. While GDP per capita across the countries has continuously increased over the past decade, the gap in income distribution is still higher than those of other transition economy groups. Moreover, ICT-related social issues such as limited public access to digital services and education, lack of legal framework that encourages ICT investment, and affordability of ICT services and goods are still unsettled. However, in the last decade, there has been an increasing interest in all these countries to promote the use of ICT with attempts to develop and support e-government, e-health and e-commerce (Santos, 2009).

Data Description and Measurement

Our analysis was conducted on the two transition economy groups using publicly available data sources from 2004 to 2010. Moreover, the high-income OECD countries were included for the comparison purpose with the TE groups. Variables extracted for our dataset and their descriptive statistics are presented in Table 3.

Variables	Description of Variables / Data Source	Mean (S.D.)			
		Overall (CEE+LATIN) (N=70)	CEE (N=35)	LATIN (N=35)	OECD (N=35)
<i>Econ_free</i>	Overall economic freedom (0 ~100) - Source: Heritage Foundation	63.62 (6.60)	64.25 (3.96)	62.99 (8.48)	72.49 (6.82)
<i>Unemployment</i>	Unemployment rate (%) -Source: The World Bank	9.41 (3.04)	9.89 (3.88)	8.92 (1.81)	6.85 (2.19)
<i>Gini</i>	Gini coefficient (0~100) - Source: The World Bank	40.98 (12.52)	29.11 (3.55)	52.85 (4.12)	34.74 (6.32)
<i>Press_oppression</i>	Press freedom (0 ~115) - Source: Reporters Without Borders	15.01 (12.95)	6.06 (4.44)	23.96 (13.45)	5.01 (2.44)
<i>ICT_spending</i>	ICT related spending per GDP (%) - Source: Digital Planet; ITU	9.52 (5.71)	13.17 (5.77)	5.87 (2.37)	6.33 (.70)
<i>GDP_growth</i>	GDP growth (%) - Source: The World Bank	4.44 (3.65)	3.40 (4.07)	5.48 (2.37)	1.13 (2.65)
<i>Second_edu</i>	Secondary school enrolment (%) - Source: The World Bank	93.05 (6.76)	95.66 (4.37)	90.45 (7.37)	99.08 (2.13)
<i>Pop_growth</i>	Population Growth (%) - Source: CIA the World Factbook	.62 (.53)	.16 (.30)	1.09 (.22)	.39 (.42)
<i>Working_age</i>	Portion of working-age population (%) - Source: CIA the World Factbook	68.09 (2.86)	70.60 (.84)	65.58 (1.72)	66.15 (.89)
<i>Industry</i>	Labor force by occupation-Industry (%) - Source: CIA the World Factbook	26.06 (8.58)	33.19 (4.81)	18.93 (4.67)	24.48 (5.05)
<i>Service</i>	Labor force by occupation-Service (%) - Source: CIA the World Factbook	63.71 (6.56)	58.79 (4.69)	68.64 (3.90)	72.47 (5.57)

Table 3. Summary Statistics of the Dataset

Two datasets were leveraged for testing the proposed hypotheses: the aggregated dataset combining two TE groups for testing Hypotheses 1 and 2; and the individual grouped data sets for testing Hypothesis 3. In order to control for regional differences in the research variables, we normalized the variables to comparable scales.

Definition of Measures

To examine the impacts of the investments in ICT on socioeconomic and sociopolitical changes, we utilized four dependent variables of transition processes, an explanatory variable of ICT investments, and six control variables.

Econ_free: This variable is a measurement of overall economic freedom. The Heritage Foundation measures the overall economic freedom major components² of economic freedom for macroeconomic stabilization on a scale of 0 (not free) to 100 (free).

Unemployment: A dependent variable indicating the proportion of the transition economy's working-age population that was unemployed. We examine how ICT spending influences job creation of a transition economy.

Gini: A dependent variable indicating the level of wealth inequality of a country. A lower Gini coefficient indicates a more even income distribution.

Press_oppression: A dependent variable indicating the level of press freedom. Reporters Without Borders annually assesses the overall press freedom based on surveys on direct attacks on journalists and the media as well as indirect sources of pressure against the free press. Note the score ranges from 0 (free) to 115 (not free).

ICT_spending: Domestic spending on computer hardware and software, communication services, and communication equipment as a percentage of GDP.

Time: The number of years elapsed from 2004. This variable controls for the unobserved technological change and endogenous time effects on a country's transition process outcomes.

GDP_Growth: It indicates the percent increase rate in real gross domestic product.

Second_edu: Net enrollment ratio is the ratio of children of official school age based on the International Standard Classification of Education who are enrolled in secondary school compared with the population of the corresponding official school age.

Pop_growth: Growth in population of individual countries. Due to large variations in population among countries, we used the change in number of individuals in the population per unit time.

Working_age: Proportion of the working-age population (ages 15-60). It indicates an estimate of the total number of potential workers within a country.

² Ten components of economic freedom: property rights, freedom from corruption, fiscal freedom, government spending, business freedom, labor freedom, monetary freedom, trade freedom, investment freedom, and financial freedom

Industry and **Service**: the percentage distribution of the *labor force by occupation (industry and service)*.

Empirical Model

Using the country-level data, we tested the proposed research hypotheses. The research framework presented in Figure 2 leads to the empirical model.

$$\begin{aligned} \text{Transition_Process}_{it} = & \beta_0 + \beta_1 (\text{ICT_Spending})_{it-1} + \beta_2 (\text{Time})_{it} + \beta_3 (\text{GDP_growth})_{it} \\ & + \beta_4 (\text{Second_edu})_{it} + \beta_5 (\text{Pop_growth})_{it} + \beta_6 (\text{Working_age})_{it} \\ & + \beta_7 (\text{Industry})_{it} + \beta_8 (\text{Service})_{it} + \varepsilon_{it} \end{aligned}$$

, where for country i in year t :

$$\text{Transition_Process}_{it} = \begin{bmatrix} \text{Econ_free}_{it} \\ \text{Unemployment}_{it} \\ \text{Gini}_{it} \\ \text{Press_oppression}_{it} \end{bmatrix},$$

In order to test the hypotheses, we analyzed the dataset with multiple regression models. Each model includes a socioeconomic or sociological value (i.e., *Econ_free*, *Unemployment*, *Gini*, or *Press_oppression* in a transition economy over seven years) as a dependent variable and an explanatory variable (*ICT_spending*), as well as other control variables for economic (*GDP_capita*, *Industry*, and *Service*), demographic (*Second_edu*, *Pop_growth*, *Working_age*), and maturity (*Time*) factors in each country.

It is also desirable to construct a time-lagged dataset through which the impact of ICT spending on subsequent transition processes could be longitudinally assessed. ICT spending values per GDP (i.e., *ICT_spending*) from 2003 through 2009 were used to predict transition processes from 2004 through 2010.

RESULTS AND DISCUSSION

We report two sets of results from regressions. The first set of results includes the estimates from a pooled sample across the two regional groups of TEs, and the second set of results presents the estimates from each regional dataset and those from OECD countries. While we have not reported the correlation matrix, we did not find strong correlations between the explanatory variables; the highest correlation ($\rho=-.61$) among the explanatory variables was between *Industry* and *Service*. Instead of using a country's age of transition, we used *Time* to control for unobservable technological change effects on a country's transition process

outcomes, but we did not find significant differences in results and these two variables were highly correlated ($\rho=-.83$). Further, we tested for the presence of multicollinearity using Variance Influence Factors (VIF) of each explanatory variable in each regression model. The largest VIF was below 8.0, which indicates that multicollinearity was not an issue in our models. We also compared the regression models of no lag effect with those of one-year lag effect. The models with a lag effect had higher explanatory power as compared with the models with no lag, and this demonstrates the need to consider the models with a lag effect of *ICT_spending*.

ICT Impact on Transition Processes for Transition Economics

From the pooled sample across the regional groups over seven years, we estimate the effects of ICT spending on transition processes in order to test Hypotheses 1 and 2. The results are presented in Table 4.

Variables	Economic Freedom	Unemployment Rate	Wealth Inequality	Press Oppression
<i>Intercept</i>	143.429(58.583)*	-44.469(26.383)	23.039(28.317)	-104.535(89.045)
<i>ICT_spending</i>	.480(.198)**	-.252(.089)**	.017(.009)	.407(.301)
<i>Time</i>	.337(.389)	-.125(.175)	-.359(.188)	-.497(.591)
<i>GDP_growth</i>	-.156(.232)	-.195(.105)	-.126(.112)	.128(.053)*
<i>Second_edu</i>	-.352(.126)**	-.226(.056)***	.126(.061)**	-.272(.192)
<i>Pop_Growth</i>	6.093(3.483)	-3.702(1.569)**	.710(1.684)	11.229(5.294)*
<i>Working_age</i>	-.551(.757)	1.249(.341)***	.692(.366)	1.685(1.151)
<i>Industry</i>	-.685(.167)***	-.215(.076)**	-.117(.081)	.119(.255)
<i>Service</i>	-.133(.233)	.042(.105)	-.345(.113)**	.363(.355)
<i>R</i> ² (adj. <i>R</i> ²)	.385(.293)	.412(.324)	.760(.754)	.641(.575)
Sample size	70 (=10 _{Countries} * 7 _{Years})			

* = $p < .05$ ** = $p < .01$ *** = $p < .001$

Table 4. Analysis Results across Regions

Overall, the findings from the analysis of dataset mostly support the formulated hypotheses on socioeconomic changes in transition economies. The estimates of *ICT_spending* are positively associated with overall economic freedom and job creation; however,

sociopolitical outcomes have negative yet insignificant relationships with *ICT spending*. We examine the detailed socioeconomic and sociopolitical changes derived from ICT spending across the regions as follows.

ICT and Socioeconomic Changes: Regarding the relationship between ICT and changes in economic freedom, the estimate of *ICT_spending* is positive and significant. This indicates that a 1% increase in ICT spending per GDP is projected to improve the overall economic freedom index by .48 percentage points across the groups of TEs. Furthermore, we found that ICT spending per GDP significantly decreases unemployment rates. This implies that ICT has created more job opportunities in transition economies by creating new ICT-related jobs and by changing existing jobs toward such new industries. In addition, the negative and significant estimate of *Second_edu* implies that there exist high demands for skilled workers in transition economies.

In sum, we found that the ICT has played a significant transformative role in TEs' socioeconomic changes. Consequently, the findings support Hypotheses 1a and 1b.

ICT and Sociopolitical Changes: In our analyses of the impact of ICT spending on changes in sociopolitical values, we did not find a significant association between ICT spending and sociopolitical indicators. The estimates of *ICT_spending* on *Gini* and *press_oppression* are both positive and insignificant. Therefore, Hypothesis 2a and 2b are not supported by the results.

These different findings in socioeconomic and sociological outcomes may be explained by the immaturity of ICT uses in transition economies. The liberalization and macroeconomic stabilization could be undertaken in a short period of time, as could the privatization of small-scale enterprises through ICT at the early stage of transaction process. In the meantime, the improvements in sociopolitical values would take a longer time since such changes are generally intensified by significant and large-scale legal and institutional reforms through better utilization of ICT. Therefore, the effects of ICT on transition processes may vary according to the different level of ICT uses and of transition progress (i.e., maturity of ICT utilization). It leads us to additional analyses accounting for each region's use of ICT and its impacts on transition processes. The following subsection presents the detailed results based the region groups.

ICT Impact on Transition Process within Groups

To investigate the regional differences in the transformative role of the ICT in transition economies (Hypothesis 3), we report the impacts of ICT spending on transition processes at the individual regional level. Tables 5 and 6 contain the results of region-level regressions. In order to compare the contributions of ICT in TEs with those in the developed countries, we included the top five high-income OECD countries (i.e., France, Germany, Japan, United Kingdom, and United States).

Variables	CEE	Latin	OECD
Economic Freedom			
<i>Intercept</i>	53.588(59.199)	258.170(110.067)*	-176.145(294.652)
<i>ICT_spending</i>	.318(.099)**	3.818(1.129)**	5.570(1.04)***
<i>Time</i>	-.217(.272)	-.339(.870)	.313(.282)
<i>GDP_growth</i>	.021(.131)	.157(.358)	.005(.220)
<i>Second_edu</i>	-.492(.118)***	-.834(.200)***	-.489(.967)
<i>Pop_Growth</i>	2.031(1.885)	10.880(6.573)*	-1.837(2.894)
<i>Working_age</i>	.629(.712)	-2.213(1.488)	.701(1.491)
<i>Industry</i>	-.009(.103)	-1.105(.346)**	2.041(1.458)
<i>Service</i>	.165(.113)	.177(.504)	2.28(1.402)
<i>R</i> ² (adj. <i>R</i> ²)	.768(.682)	.751(.675)	.865(.824)
<i>Sample Size</i>	35 (=5Countries * 7Years)	35 (=5Countries * 7Years)	35 (=5Countries * 7Years)
Unemployment Rate			
<i>Intercept</i>	-88.053(78.303)	37.352 (25.158)	-184.831(154.345)
<i>ICT_spending</i>	-.184(.031)***	-.222(.257)	1.652(0.546)**
<i>Time</i>	-.278(.360)	-.259(.199)	.327(.148)**
<i>GDP_growth</i>	-.350(.174)	-.248(.082)**	.001(.115)
<i>Secondary_edu</i>	.171(.155)	.012(.046)	.451(.507)
<i>Pop_Growth</i>	-3.047(2.493)	1.079(1.502)	4.124(1.516)**
<i>Working_age</i>	1.903(.941)	-.215(.340)	1.242(.781)
<i>Industry</i>	-.465(.136)**	.219(.079)**	1.108(.764)
<i>Service</i>	.006(.150)	-.252(.115)*	.627(.734)
<i>R</i> ² (adj. <i>R</i> ²)	.555(.418)	.713(.625)	.642(.532)
<i>Sample Size</i>	35 (=5Countries * 7Years)	35 (=5Countries * 7Years)	35 (=5Countries * 7Years)
<i>* = p < .05 ** = p < .01 *** = p < .001</i>			

Table 5. Analysis Results of Individual Group's Socioeconomic Changes

Socioeconomic Changes: Overall, ICT spending is positively associated with improvements in the economic environment across two transition economy groups. Since both regions have utilized ICT to improve economic conditions during the transition process, they have experienced positive economic outcomes in economic freedom and job creation. For CEE, the estimates for *ICT_spending* are significant for both socio-economic factors. Meanwhile, Latin America countries have experienced a significant and positive impact of ICT only on economic freedom. Since Latin America countries are more likely to utilize ICT as a tool for enhancing societal liberalizations, they might not benefit from ICT in terms of mitigating

unemployment rate. However, the negative and significant estimate of *Service* implies that the countries can create job opportunities by investing ICT into the service sectors. Regarding the OECD countries, although they have enhanced the overall economic conditions, they have failed to reduce the number of unemployed workers. This result is consistent with prior findings for developed countries (Bresnahan et al., 2002; Brynjolfsson and McAfee, 2011). This implies that not every country benefits from technological progress, at least not in the same way. For developed countries, many jobs have been replaced by ICT applications that increased the demand for skilled workers adaptable to such ICT dynamics but likely reduced the demand for low skilled workers. While Brynjolfsson and McAfee (2011) found a negative association between technological progress and job creation only in the U.S. industries, our results suggest that such a negative association may be prevalent across developed countries.

After all, the findings suggest that ICT has contributed to solving each region's economic problems in their transition status and this contribution is more effective for TEs.

Variables	CEE	Latin	OECD
Wealth Inequality			
<i>Intercept</i>	-.594(65.194)	70.574(18.708)***	-17.058 (361.183)
<i>ICT_spending</i>	-.144(.109)	.666(.192)***	7.097(1.277)***
<i>Time</i>	.280(.299)	-.662(.148)***	.346(.346)
<i>GDP_growth</i>	-.035(.145)	.071(.061)	-.012(.270)
<i>Second_edu</i>	.444(.129)***	.068(.034)	-.057(1.185)
<i>Pop_Growth</i>	-1.817(2.07)	7.287(1.117)***	10.734(3.547)**
<i>Working_age</i>	.073(.783)	-.055(.253)	-2.639(1.827)
<i>Industry</i>	-.171(.113)	.108(.059)*	2.206 (1.787)
<i>Service</i>	-.182(.124)	-.0474(.085)***	1.764(1.718)
<i>R</i> ² (adj. <i>R</i> ²)	.632(.519)	.767(.757)	.765(.692)
Sample Size	35 (=5Countries * 7Years)	35 (=5Countries * 7Years)	35 (=5Countries * 7Years)
Press Oppression			
<i>Intercept</i>	103.113(70.378)	-53.246(137.992)	57.3229 (257.853)
<i>ICT_spending</i>	.079(.118)	-2.404(1.215)	-.442(.911)
<i>Time</i>	1.023(3.23)**	-.693(1.091)	.102(.247)
<i>GDP_growth</i>	-.045(.156)	.939(.449)*	.196(.192)
<i>Second_edu</i>	.089(.139)	-.074(.251)	-.249(.846)
<i>Pop_Growth</i>	-1.252(2.241)	54.903(8.240)***	2.268(2.532)
<i>Working_age</i>	-1.868(.845)*	-1.052(1.865)	-.098(1.304)
<i>Industry</i>	-.041(.122)	.831(.434)	-.223(1.276)
<i>Service</i>	.443(.135)**	.873(.631)	-.198(1.227)
<i>R</i> ² (adj. <i>R</i> ²)	.726(.641)	.820(.764)	.292 (.193)
Sample Size	35 (=5Countries * 7Years)	35 (=5Countries * 7Years)	35 (=5Countries * 7Years)
* = $p < .05$ ** = $p < .01$ *** = $p < .001$			

Table 6. Analysis Results of Individual Region's Sociopolitical Changes

Sociopolitical Changes: Unlike the findings for economic changes, the findings for sociopolitical changes present a less consistent association with ICT spending between regions. Regarding wealth inequality, while Latin America has experienced a significant and positive impact of ICT spending, CEE had a negative but insignificant association with ICT. Moreover, in term of democratization (*Press_oppression*), ICT spending is not significantly associated with the vitalization of democracy in both regions.

For Latin America, ICT has been mostly used by small-scale enterprises rather than by large-scale enterprises or governments, and so they have improved overall economic freedom values, but failed to control existing high-income disparity and severe oppression of press freedom (see Table 3 where averaged value of press oppression is much higher than other groups) at the country level. Interestingly, for advanced transition economies in CEE, although they have created more jobs resulting from the increased ICT spending, they did not aggravate their income discrepancy between skilled and unskilled workers. Meanwhile, OECD countries, as we expected, faced worsening wage gaps between high-skill jobs and low-skill jobs because of growing demand for skilled workers.

Consequently, these diverse results suggest that the contributions of ICT to transition processes differ under each region's transition trajectory. A summary of the results is presented in Table 7.

	Overall	CEE	LATIN	OECD
Economic Freedom	** +***	** -***	** -***	*** +**
Unemployment	-	-	-	+
Wealth Inequality	+	-	+	*** +***
Press Oppression	+	+	-	-

*"≤"p"<.05"**"≤"p"<.01"***"="p"<.001

Table 7. Summary of Results

Consequently, our empirical evidence supports Hypothesis 3. With respect to socioeconomic outcomes, while CEE has seen improvements both in overall economic conditions and in better employment from ICTs, Latin America countries have achieved enhancement only in economic freedom. Regarding the effects of ICT on sociopolitical values, the increased ICT spending has aggravated wealth disparity in Latin America, but it did not lead to the same problem in CEE. Moreover, we confirm that the different roles of ICTs in TEs and developed countries.

CONCLUSION

This research has attempted to estimate the contribution of ICT investments to the transition processes of TEs between 2004 and 2010. The results substantiate that ICT has played an important transformative role in TEs. Overall, ICT spending has a positive association with economic freedom and job creation, but it is negatively or insignificantly associated with wealth equality and democratization of transition economies. Further, we found that these associations differ depending on the transition economy's different use of ICT. Our results also indicate that transition economies received more benefits from ICTs in terms of stimulating economic growth (for CEE) and enhancing sociopolitical status (for Latin America) than developed countries did.

From a practical perspective, our study helps guide policymakers in transition economies. The findings of the study will assist policymakers from transition economies in utilizing ICT to achieve economic success or increase their sociopolitical status.

This study also contributes to the extant literature on ICT dynamics, not only by providing new insights into the transformative role of ICT in transition economies over the past decade but also by identifying a diverse set of issues for future research. The growing demand for theories about the role of ICT in new economies will require researchers to conduct in-depth studies on specific aspects of the findings presented in this paper. For example, while this study concentrated on ICT spending and its impacts on the transition process, it might be interesting to examine the different characteristics and utilizations of ICT in a centrally planned system (e.g., ICT for reporting to central planners) and a market-driven system (e.g., ICT for facilitating communication between citizens and government), and to identify the specific ICT properties that further transition processes. Moreover, it would be worthwhile to examine how the actual usage and affordability of ICT applications can stimulate the TEs' transition processes.

This paper's findings await further refinement from future studies. These findings are based on only two groups of transition economies. Thus, the results might vary with other groups of transition economies or with different model settings. Researchers will need to more completely investigate the full relationship between ICT investments and the transition process of transition economies by including other country groups.

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Technologies, and the Prospect of a ‘Global Village’: Promises of Inclusion or Electronic Colonization? *Journal of Curriculum Studies*, 37(1), 65-83.

The role of human capital in creating competitive advantage based on technology³

by

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ABSTRACT

The article presents the main findings from research, which included companies that have the ability to create a competitive advantage based on technology. Successful implementation of innovations is based on a combination of two elements. One is the vision, derived from the R&D department, which is a change that builds new value. The second is the involvement of employees, who are implementing the developed solutions. This approach increases the chances of success of implemented innovations and allows to combine two factors - the efficiency and creativity.

Keywords:

competitive advantage, innovation, employee involvement

INTRODUCTION

In science and practice of strategic management, competitive advantage plays an important role because of the need to identify its sources and define the possibilities of its maintenance. Crucial to the success of enterprises is not only the end result, but also the entire process of creating a competitive advantage. That is why it is so important to look for a reciprocal link between growth and development, innovation, technology, success of businesses and having a competitive advantage. Innovations are considered as one of the primary sources. Their skillful implementation provides better-than-average profits for the company and guarantees a multi-dimensional success. However, for the advantage achieved through innovation to be sustainable, it is necessary to ensure effective implementation of the developed innovative strategies, taking into account participation of the employees in the work at various stages of

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the process. This allows to create and implement the strategy in accordance with the objectives and with the use of available resources, while ensuring a commitment from its direct contractors.

The purpose of this paper is to present results of a study on the achievement by the target company a competitive advantage based on technology and innovation, and to analyze the tasks and the role played by the employees in the implementation of such strategies.

COMPETITIVE ADVANTAGE

In the science and practice of strategic management, competitive advantage plays an important role because of the need to identify sources of competitive advantage and opportunities to sustain it. What is important for the success of enterprises is not only the end result, but also the entire process of creating a competitive advantage. For that reason it is important to search for a reciprocal link between growth and development, innovation, technology, successful businesses and having a competitive advantage.

For many years, management practitioners and theorists have wondered about the reasons for gaining and maintaining competitive advantage. In the literature, there are presented different approaches:

1. The approach which is a classic competition analysis emphasizes the importance of the company's market position and the specificity of the sector. This approach exposes the importance of external conditions (Porter 1980);
2. Resource approach, in which the greatest importance is attributed to the unique internal company resources, both tangible and intangible assets, core competencies of the organization, and quickly changing opportunities in the rapidly changing market (Prahalad and Hamel 1990);
3. The theory of creative destruction, which involves determining the importance of innovation and time against "being static" (Schumpeter 1934, 1950);
4. Learning organization theory emphasizes the importance of knowledge, assuming support for the permanent development of knowledge and skills (Senge 1991).

M. Porter pointed out three approaches to obtaining a sustainable competitive advantage: cost leadership, differentiation, niche market.⁴ Subsequent studies focused on the search for internal conditions which favour the obtaining and maintaining long-term competitive

⁴ M.E. Porter, "Przewaga konkurencyjna. Osiąganie i utrzymywanie lepszych wyników", Wyd. HELLIION, Gliwice, 2006, pp. 38.

advantage.⁵ The most recent works are devoted to analyzing the links between internal conditions in the company and opportunities posed by the market and the determinants of competitive advantage.

All approaches emphasize the need to link competencies, skills and strategies with environmental requirements, in particular with the key factors for success. Companies that understand the needs of the market, but do not have the necessary internal resources (e.g. a distinctive technology) can have a good diagnosis of the market, but cannot satisfy market needs. Even companies with strong internal resources, but without a market orientation may have a basis for creating a competitive advantage, which, however, will not match the market's needs.⁶

Competitive advantage refers to the situation when the company dominates the competition, being able to offer its customers additional value, quality or level of service.⁷ Having a competitive edge means standing out from competitors by having something or doing something.⁸ Competitive advantage, also referred to as strategic, can be defined as the achievement of⁹:

- higher value than competitors;
- better results than competitors.

Competitive advantage is a group of factors that distinguish the organization against its competitors by building in the eyes of customers a unique image of the company in terms of offered value and customer service.¹⁰

For the advantage to qualify as competitive, it must be: reasonable, supportable, and linked to a recognizable benefit for customers.¹¹ Some other features are also attributed to competitive advantage; a strategic advantage should be: permanent, visible and difficult to duplicate.¹²

⁵ J. Barney, "Firm resources and sustained competitive advantage", *Journal of Management*, 1991, Vol. 17, No 1.

⁶ M. Ghingold, B. Johnson, " Intrafirm technical knowledge and competitive advantage: a framework for superior market driven performance", *Journal of Business&Industrial Marketing*, 1998, Vol. 13, No. 1.

⁷ J. Sutherland, D. Canwell, „Klucz do zarządzania strategicznego”, Wyd. Naukowe PWN, Warszawa 2007, pp. 177 (in) M.E. Porter, "Competitive advantage: creating and sustaining superior performance", London, Simon&Schuster, 1988.

⁸ J. Rokita, „Zarządzanie strategiczne. Tworzenie i utrzymywanie przewagi konkurencyjnej”, PWE, Warszawa 2005, pp. 57.

⁹ J. Rokita, „Zarządzanie strategiczne. Tworzenie i utrzymywanie przewagi konkurencyjnej”, PWE, Warszawa 2005, pp. 58.

¹⁰ Hao Ma, "Creation and preemption form competitive advantage", *Management Decision* 1999, 37/3.

¹¹ J. Rokita, „Zarządzanie strategiczne. Tworzenie i utrzymywanie przewagi konkurencyjnej”, PWE, Warszawa 2005, pp. 61.

¹² M. Romanowska, „Planowanie strategiczne w przedsiębiorstwie”, PWE, Warszawa 2004, pp. 262.

The biggest question may raise durability of the advantage, which is rather an optimal condition which the company should pursue.

Sources of competitive advantage may arise in the implementation of the strategy and through luck, or both simultaneously. Potential sources of competitive advantage can be many:¹³

- unique resources,
- innovation,
- the impact of the market,
- efficiency.

Among the factors that define the short-and long-term competitive advantage are the following ones: product quality, price, promotion, distribution, performance, rate of technological progress, technical service, financial services.¹⁴ Tangible and intangible resources have a decisive impact on competitive advantage. Not all resources may turn out to be important. For this to happen, they must meet four conditions, i.e. to be rare, valuable, impossible to copy, and difficult to replace with substitutes.¹⁵ These resources can be used to build part of a strategy of competitive advantage.¹⁶

The next classification points to three sources of competitive advantage based on¹⁷:

- ownership (possession) of property or factors, such as a strong market position, unique resources, reputation, knowledge, access;
- acquaintances, that is opportunities and rights to gain special access to the means of production and markets, such as special relationships with suppliers or customers;
- access to special knowledge, skills, opportunities used to manage the company.

The new approach to the sources of competitive advantage emphasizes the need to acquire skills of regeneration of the resources, development of key skills and competencies, the ability to learn in the organization (individual learning), and the organization itself

¹³L.S. Foon, "Capabilities differentials as sources of sustainable competitive advantage", International Journal of Business & Society, 2009, Dec, Vol. 10, Iss.2.

¹⁴Ch. Beard, Ch. Easingwood, "Sources of Competitive Advantage in the Marketing of Technology-intensive products and processes", European Journal of Marketing, 1992, Vol. 26, No 12.; M.W. Lawless, R.J. Fisher, "Sources of durable competitive advantage in new products", Journal of Product Innovation Management, 1990, Vol. 7.

¹⁵J. Barney, "Firm resources and sustained competitive advantage", Journal of Management, 1991, Vol. 17, No 1.

¹⁶A. Toppinen , R. Toivonen, A. Mutanen, V. Goltsev., N. Tatti, "Sources of competitive advantage in woodworking firms of Northwest Russia", International Journal of Emerging Markets, 2007, Vol. 2, No 4.

¹⁷Hao Ma, "Creation and preemption for competitive advantage", Management Decision, 1999, 37/3.

(organizational learning)¹⁸. Currently, it is also important to note the reaction rate as a source of competitive advantage.¹⁹ To remain competitive, it is necessary to invest in the area of R&D and innovation, which in turn cause an increase in productivity.²⁰

In the literature, there are many classifications of competitive advantages. Advantage can be divided into²¹:

- offensive advantage, which includes cost advantage, the advantage of provided benefits;
- defensive advantage associated with the privileged position in the market.

Another classification proposes a division into a lasting and temporary competitive advantage.²² M. Porter, on the other hand, introduced the distinction between competitive advantage of low cost and high quality.

Global crisis has caused organizations to invest their capital more wisely, first of all spending it on human capital and R&D. Such a defence against the crisis will affect the competitive advantage in the future.²³

Technology as a source of competitive advantage

In the 21st century, referred to as the age of technology, winning in the competitive struggle involves the use of innovation and technology as key factors for success²⁴. Success today depends on the competitiveness which companies are able to expand by selecting the appropriate competitive strategies, using existing resources, using adaptability by following the market opportunities. In particular, companies operating in the international market should build a competitive advantage based on the R&D and innovative products and

¹⁸ S.V. Lopez, "Competitive advantage and strategy formulation. The key role of dynamic capabilities", Management Decision, 2005, Vol. 43, No 5.

¹⁹ ed. by M. Moszkowicz, „Zarządzanie strategiczne. Systemowa koncepcja biznesu”, PWE, 2005, pp. 108.

²⁰ S. Roper, S. Arvanitis, "From knowledge to added value: A comparative, panel-data analysis of the innovation value chain in Irish and Swiss manufacturing firms", Research Policy, 2012, Vol. 41, Iss. 6.

²¹ ed. by M. Moszkowicz, „Zarządzanie strategiczne. Systemowa koncepcja biznesu”, PWE, 2005, pp. 118.

²² T. O'Shannassy, "Sustainable competitive advantage or temporary competitive advantage: Improving understanding of an important strategy construct", Journal of Strategy and Management, 2008, Vol. 1, Iss.2.

²³ M. Sheehan, "Investing in management development in turbulent Times and perceived organisational performance: a study of UK MNCs and their subsidiaries", International Journal of Human Resource Management, 2012 Jun, Vol. 23, Iss. 12.

²⁴ M.E. Porter, "Technology and competitive advantage", Journal of Business Strategy 1985, Vol. 5, Iss. 3; A. Ahad , M. Osman-Gani, "International technology transfer for competitive advantage: a conceptual analysis of the role of HRD", Competitiveness Review: An International Business Journal Incorporating Journal of Global Competitiveness 1999, Vol. 9, Iss. 1.

production, assuming that the use of technology is the most important factor for global expansion.²⁵

Technological changes are a major factor affecting the competitive position of companies and the rules of competition²⁶:

- technology functions as an "equalizer", because the use or ignorance of it alter the competitive position of enterprises;
- technology initiates the development of new industries and determines the structural changes in existing industries.

Technology is of strategic importance because it is used to: reduce costs, correct quality, quick introduction of new products, and using new processes and technologies, and ultimately to establish successful competition. The common point of these considerations is the assumption that knowledge is the basis of technology and innovation.²⁷ Knowledge, in particular related to technology, is important for competitive advantage when the advantage is building, with a simultaneous change in the industry structure. Technology is correlated with a competitive advantage, since the possibility of gaining a competitive advantage is dependent on the ability to offer customers a distinctive proposal.

Not every change in technology may result in gaining sustainable competitive advantage. For this to happen, a change in technology should²⁸:

- result in lower costs and influence the variation;
- result in better distribution of costs and enhance the degree of differentiation;
- enable the position of a pioneer (leader) of the new technology.

There is a strong connection between technology and competitive advantage based on effective management of technology. The key issue is to create a comprehensive innovation strategy that will contribute not only to achieve, but above all to maintain long-term competitive advantage.

CREATING AND IMPLEMENTING THE INNOVATION STRATEGY

²⁵C. Tung-Lung, "Cultivating global experience curve advantage on technology and marketing", *Journal of Marketing Practice: Applied Marketing Science*, 1997, Vol. 3, No. 4.

²⁶M.E. Porter, "Przewaga konkurencyjna. Osiąganie i utrzymywanie lepszych wyników", Wyd. HELLIION, Gliwice, 2006, pp. 211.

²⁷J. Rokita, „Zarządzanie strategiczne. Tworzenie i utrzymywanie przewagi konkurencyjnej”, PWE, Warszawa 2005, pp. 216.

²⁸M.E. Porter, „Przewaga konkurencyjna. Osiąganie i utrzymywanie lepszych wyników”, Wyd. HELLIION, Gliwice, 2006, pp. 219.

Literature offers many definitions and ways to approach the term innovation. Some of them focus on aspects related to technology, others emphasize the innovative nature and unknown properties of the product or service. The authors of this paper find the following definition most appropriate: "innovation is a permanent change that builds new value, e.g. it allows to serve customers more efficiently and reduce costs. It is often identified with the area of research and development, but an innovator may as well as be the person who makes changes in the processes of sales, marketing and logistics. Sometimes, innovation means creating something new, and sometimes merely eliminating an unnecessary element."²⁹

Successful implementation of innovations is contingent upon a combination of two elements - a vision which comes mainly from the department of research and development, and the opinions and experiences of employees, which implement the developed solutions. Thanks to this, there are made ongoing changes as well as grassroots initiatives, and this approach increases the chances of success. Organizational culture focused on innovation, and the creation of a value system within it, accepted by the employee, is of considerable importance in that case. It seems that the notions of efficiency and creativity complement each other, and the objective system which builds confidence also encourages innovation. It is favoured by a flat and flexible culture, promoting the ideas generated at the lower levels of the organization³⁰. It is worth mentioning that "knowledge and inspiration coming from the market is just one of the factors determining the success of even the most innovative ideas. Effective implementation of innovations are the result of continuous research and joint efforts of all employees."³¹

It seems that it is appropriate, therefore, to recommend to organizations the introduction of a global and uniform approach to the process of creating ideas, their evaluation and use. Creation of such a careful program, which takes into account the participation of employees, turns out to be more effective than the automatic duplication of individual practices on innovation applied in other companies. It stems from the fact that challenges related to the implementation of innovations vary depending on a specific organization, and therefore there is no one universal solution, the application of which would

²⁹ T. Klekowski, in: „Skuteczne innowacje: doświadczenia polskich liderów”, Harvard Business Review Polska, July-August 2011, pp.64.

³⁰ „Skuteczne innowacje: doświadczenia polskich liderów”, Harvard Business Review Polska, July-August 2011, pp. 68.

³¹ A. Jacaszek, in: „Skuteczne innowacje: doświadczenia polskich liderów”, Harvard Business Review Polska, lipiec-sierpień 2011, pp. 66.

ensure maximum profits for the company. It is therefore necessary to diagnose the organization, focusing on the possibility of creating ideas within the company, as well as a potential supplement of existing resources by external influences. The next step should focus on conversion, that is appropriate selection and skilful transformation into concrete programs, decisions and projects, including the direct participation of the executives. Equally important is the final step, which is their distribution and, therefore, communication and promotion of the adopted solutions in order to decrease the potential resistance to change, and gain support for the revised, financed and developed projects.³²

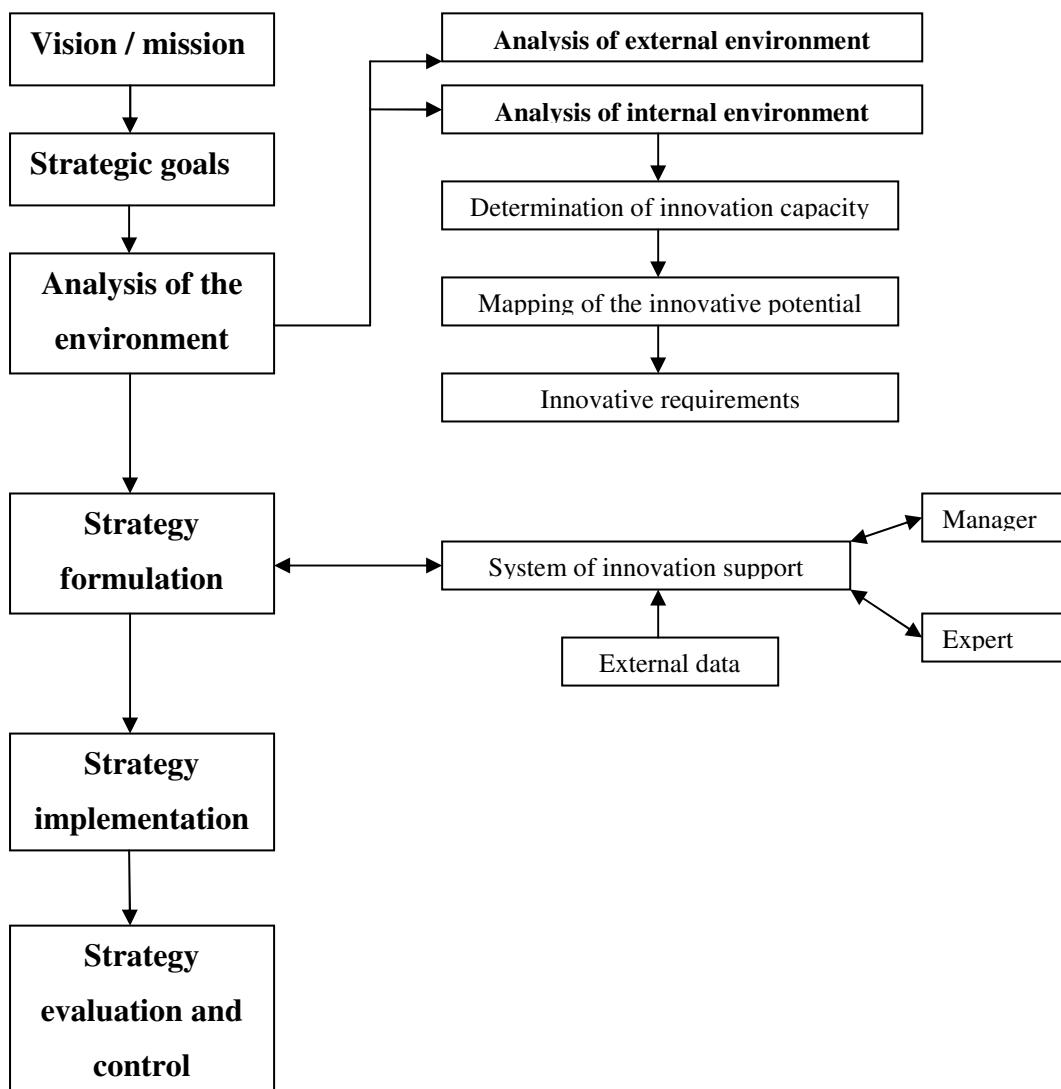
In the literature, one can find many definitions of innovation strategies, which slightly differ in some aspects. And so, according to some authors, innovation strategy allows one to specify areas of such use of resources as to achieve the objectives related to the implementation of innovation, thus achieving a previously competitive advantage.³³ According to others, this strategy is defined as the sum of the strategic choices related to innovation activities, where the aspect associated with setting strategic objectives is overlooked, and the ways and means necessary for its implementation are stressed. It should be emphasized that it is sometimes regarded as a kind of meta-strategy which covers all functions of the company.³⁴

To fully analyze the innovation strategy, it is worth quoting the model of its development and implementation, which is based on the classic strategic management process, adding, however, aspects related directly to the areas of innovation. It is illustrated by the following chart.

³² M. Hansen, J. Birkinshaw, „Łańcuch wartości innowacji”, Harvard Business Review Polska, październik 2011, pp. 116-122.

³³ M. Dogdson, D. Gann, A. Salter, "The management of technological innovation: strategy and practice", Oxford University Press, New York, 2008.

³⁴ N. Strecker, "Innovation Strategy and Firm Performance: An Empirical Study of Publicly Listed Firms", Gabler Verlag, Wiesbaden, 2009.

Figure 1. Model of creation and implementation of innovation strategy.

Source: based on V. Lendel, M. Varmus, "Creation and implementation of the innovation strategy in the enterprise", Economics and Management, No. 16/2011, pp. 822.

It is worth noting that the proposed model largely emphasizes the innovative aspects at the stage of strategic analysis and strategy formulation. These two pieces of the development and implementation of strategies seem to simultaneously and to the greatest degree emphasize the need to engage employees. They are, after all, a source of information regarding the potential of the organization as well as the possibilities and the extent of innovations, and they provide the necessary knowledge related to the diagnosis of the organization's environment. In addition, they offer support during the process of formulating the content of the strategy, clarification of its individual areas, as well as consultation - acting as experts in the various functional areas within the company.

Lack of involvement of employees in the development and implementation of innovation strategy is the most common omission on the part of managers, which in turn may lead to low efficiency of the strategy. Lack of information and communication deficiencies translate into lack of organizational climate which would foster innovation and creativity, and thus the situation contributes to the low support from the staff. This applies to any transposed strategy; however, effective implementation of innovations, due to its specific nature, seems to be uniquely associated with the support of the direct contractors.³⁵

An interesting, yet comprehensive concept regarding the effective development and commercialization of innovative ideas is the concept of innovative management based on the so-called innovation diamond, which includes:

- a) *a strategy* which defines corporate goals for innovation and for those areas around which it wants to build a competitive advantage,
- b) *organizational culture* which allows for free exchange of ideas and promoting innovators, while stimulating creativity at all organizational levels,
- c) *resources*, or, more accurately, rational resource management policies, dedicated to the implementation of innovative projects, which are often subject to significant risks and thus excite temperate enthusiasm,
- d) *implementation*, that is systematizing the process of development of new products and services through its division into several stages, and then monitoring the progress of the assumed stages of implementation and making decisions about further directions of implementation.³⁶

The interaction of all three components and to ensuring their correct functioning is a prerequisite for successful implementation of new products or services. Additionally, it is important to skillfully construct incentive systems, an environment conducive to "intellectual ferment", that is creativity, but also the ability of the employee to assess the merits of the ideas they propose and their impact on future growth of the company. Research proves that the most effective implementation of innovations is characterized by the companies that support any grassroots initiative of their employees, while establishing framework for

³⁵ P. V. Lendel, M. Varmus, "Creation and implementation of the innovation strategy in the enterprise", Economics and Management, No. 16/2011, pp. 824-825.

³⁶ „Wyzwalanie innowacyjności. Jak budować zdolność firmy do tworzenia i wdrażania nowych idei”, Harvard Business Review Polska, Luty 2012, pp. 134.

innovation strategy, understood as the objectives of the innovation process and the principles and rules for their implementation (including those related to the motivation system).³⁷

As already mentioned, the literature does not lack studies on the relationship between adaptation strategies oriented towards innovation, and integrated approach to human resource management, which would focus on the liberation of high performance and commitment. They include elements such as appropriate training and skills development, enabling employees to work on strategy and delegation of authority, a high level of autonomy, and remuneration system linked to performance and recognition.³⁸ Such an approach will achieve greater commitment and trigger the desire to become involved in strategic projects, which in turn will translate into greater creativity, and thereby increase the efficiency and productivity throughout the organization.³⁹

Many international studies show a relationship between the results achieved by firms classified as innovative (although innovations include not only products but also services and markets), and its practice of human resource management and participation in various elements of the development and implementation strategies. Roles that they play cover many aspects, ranging from advisory and consultative bodies, by providing ideas and inspiration, to delegation of decision-making powers and freedom in achieving the innovation policy goals.⁴⁰ There is therefore no doubt that the employees are then associated with a key asset of organizations and their participation seems a natural part of the activities conducted by the organization.

The results presented in this article also indicate that the existing link between creating a competitive advantage based on innovation and technology, and the inclusion of employees in the work during various stages of the strategic management process, as well as communication of the issues related to the implementation of developed strategies.

³⁷ B. Stokalski w: „Wyzwalanie innowacyjności. Jak budować zdolność firmy do tworzenia i wdrażania nowych idei”, Harvard Business Review Polska, Luty 2012, pp. 134 – 135.

³⁸ J. Guthrie, C. Spell, R. Nyamori, „Correlates and consequences of high involvement work practices: The role of competitive strategy.”, International Journal of Human Resources Management, No 13/2002, pp. 184.

³⁹ F. Cooke, „The important role of maintenance workforce in technological change – a much neglected aspect”., Human Relations, No 55/2002, pp. 965.

⁴⁰ F. Cooke, D. Saini, „(How) does the HR strategy support an innovation oriented business strategy? An investigation of institutional context and organizational practices in Indian firms”, Human Resource Management, No. 3/2010, pp. 380.

RESEARCH RESULTS

The following results and interpretations are part of a broader research on strategic management practices during the development of businesses, and they were carried out in 2011-2012 on a sample of 150 randomly selected companies (50 small, 50 medium and 50 large ones), which are joint stock companies or which are listed in the Warsaw Stock Exchange.

Out of the 150 studied subjects, there were selected for further study those companies which base their competitive advantage on innovation. This means that they replied in the affirmative ("rather yes" or "definitely yes") to the two issues presented to them, which read:

1) We are setting new standards in the industry (technological, product-related, organizational, etc.).

2) The main competitive advantage of our company is based on innovation and technology.

This way, 77 subjects were selected, which then became objects of further research. What followed was an analysis of the replies to the blocs of questions that focused on:

- 1) Level of the expansiveness
- 2) The competitive advantage
- 3) The interaction
- 4) The financing of development
- 5) Knowledge of strategies
- 6) Responsibility for implementation of the strategy.

The selection of these questions helped to formulate the basic conclusions concerning the role played by employees in the process of implementing a strategy based on technological superiority, and also to clarify the elements of the strategy itself. A synthetic summary of the research results is presented in the table.

Table 1. Results of the study.

Amount	Q22	Q32	Q38	Q40	Q73	Q74	Q75	Q76	Q77	Q81	Q82	Q83	Q84
I don't know	0	2	1	1	0	4	2	11	1	0	0	1	1
Definitely not	1	0	2	7	2	3	3	3	5	23	10	5	11
Probably not	2	2	3	13	7	15	10	4	14	21	18	9	19
Yes and no	8	10	12	10	13	7	8	12	10	15	12	6	22
Probably yes	29	26	27	18	23	23	21	22	20	14	24	29	15
Definitely yes	37	37	32	28	32	25	33	25	27	4	13	27	9
Total	77	77	77	77	77	77	77	77	77	77	77	77	77
% of the amount													
I don't know	0%	3%	1%	1%	0%	5%	3%	14%	1%	0%	0%	1%	1%

Definitely not	1%	0%	3%	9%	3%	4%	4%	4%	6%	30%	13%	6%	14%
Probably not	3%	3%	4%	17%	9%	19%	13%	5%	18%	27%	23%	12%	25%
Yes and no	10%	13%	16%	13%	17%	9%	10%	16%	13%	19%	16%	8%	29%
Probably yes	38%	34%	35%	23%	30%	30%	27%	29%	26%	18%	31%	38%	19%
Definitely yes	48%	48%	42%	36%	42%	32%	43%	32%	35%	5%	17%	35%	12%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Descriptive statistics													
Average	4,3	4,2	4,1	3,6	4,0	3,5	3,8	3,4	3,6	2,4	3,2	3,8	2,9
Median	4	4	4	4	4	4	4	4	4	2	3	4	3
Dominant	5	5	5	5	5	5	5	5	5	1	4	4	3
Standard deviation	0,9	1,1	1,1	1,4	1,1	1,5	1,3	1,7	1,4	1,2	1,3	1,3	1,3

Source: own research.

The goal of the questions was to investigate the importance of: growth as a strategic priority, flexibility and speed as a source of competitive advantage, seeking new fields of action in collaboration with partners, finances as barriers of development, knowledge of strategies and objectives of the staff, and knowledge of actions to achieve the strategic objectives.

The companies were asked to indicate whether:

- rapid growth is a strategic priority;
- flexibility and responsiveness are key competitive advantages;
- they cooperate with partners from other industries to find new fields of action;
- access to sources of funding is not a barrier for development;
- great importance is given to the knowledge of the strategy by the employees;
- all employees know the company's strategic goals;
- all employees know what they must do to reach the company's strategic objectives;

Question 22. Dynamic growth is our strategic priority.

Among the surveyed companies, 86% said the recognition of dynamic growth as a strategic priority (48% responded ‘definitely yes’, 38% ‘rather yes’). The opposite response (‘definitely not’) was given by 1% of companies, ‘probably not’ was chosen by 3%, and 10% were uncertain (‘yes and no’).

Most of the surveyed companies set themselves a bold goal of dynamic growth. Implementation of this objective is meant to strengthen the company’s position in market, it allows to make positive changes in the company, and it responds to the increasingly stronger competition. The increase, although it is not identical with the development, is correlated with it - the company has to develop as it grows, which largely determines the possibility of survival and competition. The fact that most companies show interest in planning their future

should be viewed positively. However, the most important issue is the possibility of achieving this goal.

Question 32. Flexibility and the reaction rate are the most important competitive advantages for our company.

In the next question, the companies were expected to indicate whether their flexibility and responsiveness are key competitive advantages. Most of the surveyed companies, 82%, utilize flexibility and responsiveness as their distinguishing factor. Only 6% of the companies do not consider operational flexibility and responsiveness as a source of competitive advantage (3% of companies replied 'I don't know', another 3% responded 'probably not').

Most participants involved in the study build a competitive advantage based on factors that enable them to leverage market opportunities and compete effectively. Selection of competitive advantage focused on speed and flexibility can translate into having an upper hand in the competition, while adapting to the market requirements. Time and individualized offers are now among the most important factors in distinguishing a company in the eyes of customers. It is important to note, however, the subjectivity of assessment of the sources of competitive advantage against competitors.

Question 38. We cooperate with partners from other industries to find new fields of action.

The next question served to gain knowledge about the cooperation with partners from other industries to find new fields of action. 42% of companies declares cooperation with partners from other industries in search of new fields of action, 35% is likely to cooperate in this manner. Only 7% of companies (3% responded 'definitely not' and 4%, 'rather do not') is not involved in this type of cooperation. 1% of the surveyed companies do not have discernment, and 16% are not able to specify the activity or level of cooperation. For the surveyed companies, this specific cooperation strategy is important, because only 8% of the companies lacks this kind of initiative.

The strategy of cooperation with partners from other industries, focused on finding new possibilities for action, includes long-term initiatives with partners with whom the company does not directly compete. Acting individually, companies will always be more at risk from competition. Therefore, cooperation allows for diversification of risk, achieving synergies, gaining new experiences and knowledge, in particular with regard to new projects. This kind

of cooperation can help achieve leadership in important areas, hence the sense of creating strategic alliances. In this way, companies are increasing their chances of survival, growth and success in the competitive struggle. Such initiatives should be deemed as something positive, since they prove that the company is actively shaping its future. Those companies that pursue a strategy of cooperation, going beyond the domain of their activities, are aware that cooperation can bring benefits in terms of utilization of development opportunities in the future. The results indicate no tendency to isolate themselves, and willingness to cooperate with other entities in relation to the dominant number of companies participating in the study.

Question 40. Access to sources of funding is not a barrier for our development.

With regard to the surveyed companies, there was an exceptional situation of 59% of the companies, whose growth is not hampered by a lack of access to sources of funding. 26% of businesses indicated the restrictions on the choice of development strategy through a capital or access to external capital (17% responded 'probably not' and 9% 'definitely not'). Only 1% have no knowledge on this subject.

With great emphasis, majority of companies indicated that access to sources of funding is not a barrier to their development. This is an unusual financial situation assessment, as Polish entrepreneurs signal enormous difficulties in raising capital due to its high price and difficulty in meeting the requirements, or their own lack of knowledge. Participants in the survey are in a privileged position because of the possibility of obtaining financial grants, or because of their own stable situation. In the long run, lack of support with the outside capital may significantly reduce the chances of companies to develop dynamically. In turn, building a competitive advantage requires large financial investments and innovations. However, in the opinion of the surveyed companies, lack of capital will not adversely limit their strategic choices.

Referring to the previous questions, it can be assumed that the implementation of bold assumptions for building competitive advantage based on speed and flexibility, and cooperation in entering new markets, will be possible due to access to sources of funding.

Question 73. It is important for us to ensure that all employees know the strategy of our company.

Another question was used in assessing the significance of knowledge strategy by the employees. Majority of the participants of the survey (72% responded 'yes' and 'probably yes') attach importance to the dissemination of the strategy among the employees. 17% of the

companies declares no clear view on the matter, and for 12% this issue does not matter, or probably doesn't matter.

The involvement of companies in the dissemination strategy of the workforce can be positively assessed. Knowledge of strategies among employees should help integrate them with the company and facilitate the implementation of the strategy. In addition, routine work performed by employees for the company has been given a deeper meaning. Implementation of a participatory approach is consistent with a modern style of management, where decisions are discussed with the company's employees. However, in this case we do not know whether the employees were actively involved in creating the strategy, therefore it is difficult to clearly determine whether the manner of informing them about the strategy is sufficient.

Question 74. All staff know the company's strategic goals.

The next question analyzed the knowledge of the strategic objectives of the company among employees. In most companies (62%) employees know the company's strategic objectives. Only 23% of businesses did not spread information about the objectives among their employees. A relatively large group of companies (5%) did not know whether strategic objectives are known to employees.

Even if employees did not participate in the development of the strategy, effective communication should facilitate the dissemination of goals. The competitive advantage of companies will largely depend on the objectives and the skills of their implementation. Due to the lack of knowledge about the goals, employees do not know the long-term objectives which they should fulfil in their daily duties. Such management may lead to sole focus on operational activities, and it does not build long-term relationships with the company, thus separating the top management from the employees.

Question 75. All employees know what to do so that the company achieves its strategic goals.

Up to 70% of the companies said that the employees know about their own activities pertaining to achieving the strategic objectives. Lack of such knowledge applies to employees of 17% of companies. 3% of companies do not have knowledge in this area, and 10% are unable to clearly assess the situation.

Companies that do not ensure that the employees know their contribution to achieving the strategic objectives do not utilize knowledge of modern management. Nowadays, more and more often it is noted that success depends not only on developing a good strategy, but on its

rapid and effective implementation. To achieve this, the company should at least familiarize the employees with their contribution to the implementation of the strategic objectives.

Question 76. All employees accept the strategy.

In a large part (61%) of surveyed companies most employees accept the strategy. Of course, it should be verified by in-depth study involving employees from different organizational levels, but such a large number of responses suggests that in these companies much importance is attributed to the system of communication strategies. The number of responses may suggest that communication activities are conducted with some regularity, and that adequate funding and necessary amount of time is devoted to them. It should be noted that the tried and tested traditional methods of communicating decisions between tiers of the organizational hierarchy and information campaigns are not an effective way to ensure business efficiency and effectiveness. The most serious omission of the managers, leading to long-term negative consequences for the further development of the company, include, amongst others, lack of consultation with specialists from other departments as well as single-handed strategic decision-making, not taking into account when creating strategic plans the analyses of the market, competition and customers created by employees of different cells, or the lack of verification of policies and lack of conducting periodic reports summarizing the results of the implementation. Recommended preventive measures which aim to eliminate these errors, relate to, among others, conducting regular meetings involving people from different departments, training of all employees (including managers) in creative thinking, managing change and effective implementation of innovation. It seems, therefore, that the subjects in question were able to successfully combine the above-mentioned solutions, and thus they made the knowledge of the strategy by the employees one of the essential elements of the implementation of innovation strategy.

Question 77. We inform all employees about the current progress in implementing the strategy.

The same number of positive answers was given to the next question diagnosing transmission to all employees current information on progress in implementing the strategy. Again, this indicates a high strategic awareness of the surveyed companies, which, after analyzing the resources, capabilities, or characteristics of an organization, developed the most efficient variant of the action, contributing to an effective process for communicating the progress of implementation. This is especially important in the context of the introduced innovations,

when the time plays a key role in their implementation process, just like the employees' awareness of the achieved results. An important role is played by informal leaders as channels of communicating strategic findings and demonstrating their beneficial effects on the activities of the organization. Thanks to this, it is possible to react quickly to the observed deviations, and thus to show more flexibility which, as a result, helps to achieve a competitive advantage based on innovation.

Question 81. The responsibility for implementing the strategy belongs solely to the board.

Other questions concerned the responsibility for implementation, and the obtained responses lead to interesting conclusions. The first question in the thematic block included the issue of sole responsibility for implementation, resting on the board/owner. More than half of the surveyed companies (57%) explicitly denied such a statement. Only 5% responded "definitely yes", which clearly demonstrates the conscious sharing of responsibilities between different levels of management.

Question 82. All employees are responsible for implementing the strategy.

Next, respondents were asked whether all employees are responsible for implementing the strategy - here the number of affirmative responses was slightly lower at 48%. This means, therefore, that the implementation of the strategy does not involve the whole group of employees, but only some part of it. This may prove a strategic awareness of the surveyed entities in which managers are convinced that this is a laborious undertaking, impossible to cope with the participation of a narrow group of performers. There are therefore assigned responsible persons who assume leadership roles in implementation projects, and who ensure the proper implementation of the strategy. In the case of innovative projects, which are often realized by maintaining a separate budget and a range of resources, there are established autonomous teams responsible for monitoring progress in achieving the objectives and their associated metrics.

Question 83. To facilitate the implementation of the strategy we assign the leaders at various organizational levels

The next question verifies the above-mentioned issues, 73% of companies assign leaders at various organizational levels. Their task is to control the implementation of the strategy, and thus their role includes cascading the strategy from the level of abstraction to the level of specific tasks and measures of their performance. They also inform a wide range of co-

workers about the connection of their operational tasks with the ultimate strategic effect. It is meant to create awareness of participation in implementation programs, as well as excite enthusiasm and active involvement in it, broadening the role of the employees not only as performers, but also as leaders. This is crucial in implementing the innovation strategy, which is often associated with the occurrence of resistance to change. Showing the connection between the current tasks and operational decisions, and implementation of a farsighted strategy, is definitely required for its success.

Question 84. The employees have the opportunity to decide how to implement the strategy.

The final question in this area concerned the area of freedom of employees to decide how to implement the strategy. Here, relatively few, because only 31% of companies admitted that their employees possess decision-making powers in this respect. This means that in these companies, the employees may themselves establish gauges linked to strategic objectives, or propose strategic initiatives, understood as any programs and projects beyond the operational activities of the organization, and undertaken with a view to facilitating the achievement of performance targets. Admittedly, this is a relatively small percentage of the surveyed population of enterprises; however, as seen in the graph, another 29% indirectly responded "yes and no," which may prove the existence of both, some powers of the employees in this field, as well as top-down management control. Employees may thus serve as a consultative function, while providing information on current progress of a project, as well as on expected deviations or lack thereof. Of course, these diagnoses may be subject to error arising from insufficient strategic awareness or knowledge; however, it seems that even then they can be an excellent base material, which subsequently will be subject to review by management. In that case, employees possess an auxiliary function, which may also play a considerable role in the implementation of the strategy.

CONCLUSION

The company's advantage may raise due to various reasons, therefore there are numerous factors that contribute to the existence or extension of the differences between companies and their market position. The research results pertained to the companies declaring the building of a competitive position based on innovation and technology. They are leading companies in the market, mainly due to setting new standards in the industry in which they compete. They may be considered as a specific model in the ways and tools for building and implementing

innovative strategies. Model business strategy stands against its competitors by focusing on dynamic growth, flexibility and responsiveness to changes observed in the environment. Another finding of the study can be confirmation of the results of previous studies which proved that company size is not a barrier to innovation. Moreover, vast majority of companies actively works with partners from other sectors to explore new fields of action, which proves their creativity, flexibility, planning, development, and innovative nature.⁴¹ It should be emphasized that a large percentage of enterprises attaches great importance to the participation of employees in the work involving the development and implementation of strategies. The key is not only knowledge of the employees about of the strategic plan, but also acceptance and ability to influence the stages of its implementation. Thus, it appears that the results of the studies confirm the link between effective implementation of strategies based on innovation, and engagement of the team of employees in each of its areas.

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Law, order and information technology: Crime report system at the Peruvian National Police Corps

by

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ABSTRACT

In this research-in-progress, we provide the theoretical underpinnings of a sociotechnical perspective for the analysis of a crime report system to be deployed across a number of police stations in Peru. The conceptual elements of actor-network theory inform our research. The tenets of grounded theory will guide our methodological procedures.

Keywords:

Sociotechnical systems, actor-network theory, human agency, crime report system

INTRODUCTION

Technology cannot be detached from society as much as society cannot be detached from technology. They both need to be analysed in a systemic, holistic fashion to render a plausible explanation of the world. The implementation and use of technology by individuals and social groups set in motion a complex set of transformations that redefine routine activities and create new possibilities, sometimes in a rather unpredictable way.

The intricate nature of the relationship between the technical and the social has been implicitly, yet vigorously, articulated by Heidegger [1]: “the essence of technology is by no means anything technological” [1]. This statement reflects the underlying non-technologically deterministic assumption that guides this study. This study presents a theoretical discussion that will inform the subsequent empirical work on a recently deployed information system in a number of police stations in Peru.

The goal of this research project is to analyse the role of human agency in the presence of information technology in a rather vertical organisation. Instead of following a hypothetic-deductivistic approach, we adopt an inductive thinking one in order to understand and reveal hidden patterns of a complex process of interaction between humans and information technology. The research questions we want to answer are worded in the following terms:

- *How human agency is manifested through computer-mediated work practices in a hierarchical organisation?*
- *How and to what extent can existing structures subsume human agency in the work place?*

This paper is organised as follows. In the next section, we discuss the notion of sociotechnical systems and the role of human agency from the perspective of actor-network theory, which provides the theoretical foundations for this research. In the third section, we describe the unit of analysis for this research. An overview of the Peruvian National Police Corps, including its Telematics Directorate, is presented, based on publicly available information. In the fourth section, we outline the methodological procedures we plan to apply for collecting and analysing data in this study. Finally, we describe the expected contributions and next steps in completing this research-in-progress.

THEORETICAL UNDERPINNINGS

In this section we present the two building blocks that will inform our subsequent analysis. First, we disclose and explain our sociotechnical approach in the study of the interplay between technology and society. Second, we discuss the agency attributes of human actors when using information technology in the workplace.

A sociotechnical system

“We are sociotechnical animals”, declares Latour [2]. This vigorous statement explicitly acknowledges and emphasises that every instance of human interaction is neither purely social nor purely technical. Social practices entail interactions between humans and technology [3]. Symmetry between humans and nonhumans is the fundamental assumption of actor-network theory, a school of thought initiated by Callon [4] and Latour [5]. Adopting a symmetrical approach when studying humans and nonhumans requires observing them as a unit and at the same time scrutinising the complex system of interactions that make them a unit [6].

Actor-network theory’s emphasis on the sociotechnical middle ground makes possible the examination of the dynamic set of interactions between human and nonhuman actors [7, 8]. It allows the opening up of the sociotechnical “black box”, making visible its constitutive parts [2]. Furthermore, actor-network theory solves the incommensurability of agency and structure [9] and generates opportunities to observe the minute details of the human-nonhuman interplay [10]. But this sociotechnical arrangement is neither stable nor predictable [11].

The heuristic nature of actor-network theory allows the researcher to gain insights on the process of constructing or not the network [6] as has been evidenced in a number of studies on the sociology of technology [cf. 3, 12, 13]. Similarly, since the early call by Walsham [14], actor-network theory has been widely used in the field of information systems. On the one hand, actor-network theory studies have revealed how, in some instances, the network of both humans and information technology can be stabilised [15-19]. On the other hand, they also illustrated cases where the network could not have been stabilised [20-22].

The focus of actor-network theory is on the negotiation process that takes place between humans and nonhumans when technical artefacts are introduced. Unlike theory of innovation diffusion [23], which does not question how well the technical artefact to be implemented fits into the sociotechnical system, actor-network theory makes explicit the contingency whether or not the innovation would be able to generate interest among the intended users by understanding both the human and nonhuman actors [24, 25]. This characteristic makes actor-network theory a good theoretical lens for the analysis of the arrangement of humans and nonhumans around the proposed innovation.

The salience of human agency in the use of information technology

The ability of individuals to make decisions and take actions embodies the agency properties of human beings. However, individuals do not act in a vacuum. Although their decisions and actions modify the state of affairs of the existing structures, the later impose constraints on the agency attributes of the individual. This mutually shaping interaction describes the nature of the relationship between agency and structures, as explained by structuration theory [26].

Using information technology entails the interplay of humans and computers in a representational environment, where face-to-face encounters are no longer a requisite for an interaction to take place. This interplay takes place in slices of time and space where humans and technology meet each other resulting in a reconfiguration of their interaction [27]. The interaction relies now on a system of symbolic representations – e.g., letters, numbers, images, etc. – that makes possible the communication by conveying information.

The value of information depends on its novelty, which by definition is ephemeral. It is about bringing some new knowledge to what is already known; otherwise it is of no value [28]. Thus, information is situated in a specific temporal and spatial context and recognises that information needs an actor that can interpret it and act upon it [29, 30]. The subsequent actions will simultaneously shape and be shaped by the interaction between social and technical resources [31], where both form an entangled unit [32].

It is at this juncture that the power of information technology makes apparent information. In the past, information could only be uttered in bulk in a rather undistinguishable fashion. Information technology makes possible now to literally ‘see information’ on a computer screen and ‘count information’ by bits and bytes [10]. The flexible characteristics of information systems make them unique in terms of both the negotiation processes and transformations they generate. Indeed, information systems users are continuously accommodating social practices in relation to the logic inscribed in the former and simultaneously adjusting the technology to their particular needs [33]. We assume that human actions make the sociotechnical entanglement unpredictable, which is subject to verification in a subsequent stage of this research project.

This negotiation process between human and nonhuman actors highlights the agency properties of the individual. Rather than coordinating and synchronising activities in a Tayloristic way, where rigid structures predetermine the course of action in a rather deterministic fashion, even in a hierarchical organisation, we recognise the temporal nature of human experience, where past experiences together with an assessment of possible future outcomes define the actions taken by the agents in the present [34]. It is at this juncture that we want to explore how the tensions between agency and structure are negotiated.

The previous discussion makes unavoidable a discussion on the differences between agency properties and intentionality. While actor-network theory recognises agency attributes on technical artefacts, these are not granted with intentionality; the former are subordinated to human intentionality. It is human intentionality what delineates organisational norms, power structures and individual choices. And these shape work practices that are supported, modified and created by technology to the same extent that technology is supported, modified and created by work practices [35].

PERUVIAN NATIONAL POLICE CORPS

In this section, we present a brief historical account of the Peruvian National Police Corps and describe its mission. In addition, we describe the crime report system, which is the unit of analysis of this study.

Historical background

The history of a professional police force in independent post-colonial Peru stems from when the keeping of public safety starts to be differentiated from the roles of the military. In 1845, President Ramón Castilla reorganised the National Guard to perform some of these functions and the later administration of General José Rufino Echenique began in 1851 to establish the Gendarmerie, a division of the military to have a policing role.

As Peru began to experience significant economic development as a result of the exploitation of guano, police activity began to focus on civil order through combating crime and, at first, forming fire departments. The government of President Manuel Pardo y Lavalle, starting from 1872 began the reorganisation of the police, creating the Civil Guard, a civilian organisation that sought to distinguish itself clearly from the Gendarmerie, an organisation more tied to military order and rules.

In 1879, when Peru was involved in the Pacific War against the neighbouring Chile, police forces were incorporated in military campaigns. In response to the void left by this situation, local patrol bodies – formed by groups of neighbours, firefighters and foreign expatriates – were created with the responsibility of ensuring public safety. In 1880, police stations and policing forces were established across the Peruvian territory.

The government of President Augusto B. Leguía began a process of institutional reform of the Peruvian police, creating in 1919 a structure that enabled the formation of a Police Academy and an organisational structure that contained specialised units: a Crime Investigation unit, a Civil Guard, a unit of Security and the Republican Guard. In 1921 a cooperation agreement was signed with the Spanish Guardia Civil who helped to establish the police academy.

With this structure, the Peruvian police incorporated a sense of professional and scientific methods in their actions. The institutions that made up the national police became more specialised with the Investigative Police of Peru focused on technical aspects of and offences and solving crime, the Republican Guard designed to ensure safety and security for prisons and the border, and the Civil Guard – a result of the unification of the former Civil Guard and the Security Corps responsible for ensuring public safety. This divisional structure, which initially allowed the professionalism and technical expertise of police work to develop, also

created an element of competition between these bodies, causing some problems in the operation of a national force.

In 1986 as a result of these problems, the government decided to unify the police forces into one organisation called the National Police Corps. Although some of the then existing problems were solved, the competition among the different divisions continued for a long time. Even today, there is still some remaining rivalry until the last group of today's high rank officers retires. The division and rivalry somehow interfered during the last part of the 1980s and early 1990s in fighting terrorism. The unification of police forces also brought some problems to merge information technologies and created some problems for the new National Police Corps. This problem, along with the uncertainty and poor economy slowed down the development of the new organisation.

The development of the structure and scope of the Peruvian National Police Corps was accompanied by the events that were affecting the country, especially the social unrest that generated violent protests in the 1980s and early 1990s. Economic growth tended to be concentrated in major cities and, from the 1960s, immigration from rural areas to the major cities began – a phenomenon that continues until today. In the 1980s the Peruvian state was faced with the rise of terror movements emerging from the social crisis as a result of the rapid urbanisation and economic stagnation in the cities of the Peruvian Andes, centred in Ayacucho. Terrorist movements – Tupac Amaru and Shining Path, the latter being particularly violent – posed a major threat to public order and tested the professionalism of the National Police Corps.

Nowadays, the mission of the National Police Corps is to secure, maintain and restore internal order, provide protection and assistance to individuals and the community, ensuring compliance with laws and safety of public and private property, prevent, investigate and combat crime, monitor and control the borders in order to protect society and individuals, to enable their full development as part of a culture of peace and respect for human rights. Its vision aims at portraying a police force that is modern, efficient and of cohesive service to the society and the State, committed to a culture of peace, dedicated to service and renowned for its full respect for the individual, human rights, the Constitution and laws, for its integration with community, for its honesty, discipline and leadership of its members. The unit responsible for providing information technology support to the National Police Corps is the Telematics Directorate. Its assigned mission is to provide scientific and technological support to the police force through computer and telecommunication systems (including databases, software and website). In order to attain this goal, the unit is responsible for the design,

development and maintenance of systems and networks across the different departments of the National Police Corps.

The Informatics Division is a sub-unit of the Telematics Directorate. The Informatics Division is responsible for coordinating all matters relating to the operation of computerisation of national police operations and to facilitate them to perform their duties, including the implementation and maintenance of software systems. Among the different applications under the responsibility of this division is the crime report system, which is the unit of analysis of this research.

The crime report system: an initiative at improving efficiency and quality service

The crime report system allows police officers to receive and eventually admit a crime report at the police stations. In addition, this system allows any individual to file a crime report online. In this case, due to legal requirements by national laws, the online report is considered as a draft report only until the person filing the report gets to the police station to validate and sign the report. If the individual reporting a crime online does not come in person to the police station, the crime report is considered anonymous and follows a special procedure. In addition to the capabilities related to filing reports, given that all crime reports are stored in a central database, the system allows centralised access to them.

The crime report system has been recently implemented. So far, it has been installed in the police stations in the Lima metropolitan area, an urban conglomerate of approximately 10 million people, including the neighbouring port of Callao. The system has also been implemented as a pilot project in two police stations in Cajamarca, a city in the northern highlands of Peru, with a population of 280,000 inhabitants. The plan is to interconnect and have the system deployed in every police station across the country.

The crime report system is expected to be one of the main tools for police stations to handle citizens' complaints or accusations. These reports will invariably derive into police actions such as investigations, operations and/or arrests. This system becomes even more important as it serves the citizens in providing copies of the reports for them to continue with legal paper work.

RESEARCH DESIGN AND METHODOLOGICAL PROCEDURES

At the time of writing this document, negotiation to the research site has been successfully negotiated. An introductory conversation has been held with the head of the Informatics Division.

We will begin the study by doing an environment assessment through the identification of the actors involved in the sociotechnical system under investigation: the crime report system

described in “The crime report system” section. This environment assessment includes both the technical actors and social actors. In-depth face-to-face interviews and non-participant observations are the primary sources of data for this research. The former will be conducted with front line police officers, IT specialists and commanding officers. Observations of the work practices will take place in the police stations. IT policy documents, crime report system manuals and standard operation procedures will constitute the secondary sources of data. We expect to initiate the data collection in August 2012 and estimate a six-month fieldwork.

Although a sociotechnical perspective informs the overarching theoretical foundation of this research, we are not committed to any particular theory. We strive to avoid imposing pre-conceived concepts to data we will find in the field. We adopt an inductive approach aiming at building theory according to the tenets of grounded theory [36]. Thus, data collection and analysis will occur in tandem until reaching theoretical saturation – the point where new data does not provide new theoretical insights. As regards the stream of grounded theory, we favour the Glaserian version [37] over the Straussian one [38]; the former allows theory to emerge from the data.

In the course of our investigation, we will pay special attention to the context where the crime report system is operating in order to capture the nuances of the phenomenon under investigation [39]. We will include in our analysis the organisational culture, team dynamics, resource allocation and dominant practices in order to obtain a holistic understanding of this sociotechnical system.

EXPECTED THEORETICAL AND PRACTICAL CONTRIBUTION

From a theoretical perspective, this study should shed light on how the tensions between human agency and structures are negotiated. It will explain how the agency attributes of human actors are manifested through computer-mediated work practices and how the role played by the structures constraints these agency properties. The major practical contribution of this research-in-progress is expected to be the understanding of how information technology is shaping the working practices – and maybe creating new ones – of the Peruvian National Police Corps. The objective is to be able to pinpoint the technologies and areas where the impact can be maximised with the lowest investment.

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Research Paper

Building a proactive attitude by using ICT among local leaders in developing countries

by

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ABSTRACT

The article attempts to determine optimal ways of communicating with local leaders. It is the analysis of tools used today (as well as training programs, coaching and mentoring). In this study local leaders are people characterized by above average activity, undertaking and inspiring activities involving local communities. These are people operating in three sectors - local governments, businesses, NGO members. The phenomenon of the “competence gap” in developing countries is a starting point for discussion about the importance of human capital for social and organizational life.

Keywords:

proactive attitude, local leaders, developing countries

Introduction

Reflections on this subject should begin with the introduction of the concepts of “competence gap” and “proactive attitude”. For purposes of this paper it is assumed that the competence gap is individually assessed lack of psychological features, appropriate knowledge and skills to ensure efficiency in the individual and social activities. Individual competency gaps accumulate in the collective lack of adaptation to the requirements of the changing socio-cultural conditions. Proactive attitude, in the accepted sense, is based on needs of activity, develop, learn and personality traits, such as openness to experience, social contacts and socio-cultural diversity.

Another important in this article terms are “local leader” and “effectuality”. As already indicated in previously published articles from this domain – “Local leaders are individuals operating within the three sectors of the economy - local governments, businesses, persons involved in NGO, but also the clergy and people positively motivated to create local

initiatives, with qualifications of leadership and involved in relationships with the residents of the local community"⁴². Inextricably linked with the concept of the leadership is term "effectuality", which is positively evaluated compliance of the result with the planned goal⁴³.

Historical and structural sources of competence gap of Eastern Europe societies

Modern economics more and more often uses the sociological and psychological tools for describing the behavior of people in the economic life. The modern economics searches subjective factors inherent not only in human psychological mechanisms, the cognitive schemas, stereotypes and prejudices, but also in attitudes rooted in a culture, based on a various normative systems and religious beliefs. M. Weber wrote about the importance of cultural factors, especially the religious beliefs in "The Protestant Ethic and the Spirit of Capitalism" – one of the most famous works of social science. He was proving that, the cultural factors are crucial for economic prosperity of the societies. Capitalism did not expand from the start so fast, if there were no specific cultural factors, such as stronger than in the other countries "culture of individualism" and the characteristic values for the Protestant tradition. Although some Weber's arguments has been criticized repeatedly, however, which is confirmed by numerous studies of the late 20th century, the main thesis remains still current: culture has a huge impact on the economic and social processes. "Culture Matters" - under such a title⁴⁴ at the beginning of this century was released collection of works of the most eminent representatives of the social and economic sciences (e.g. D. Landers, M. Porter, J. Sachs, R. Inglehart, F. Fukuyama). In these reflections is repeated thesis, that cultural differences have a substantial impact on social life and possibilities to instill a change or

⁴² Ł. Haromszki, *Liderzy lokalni w kontekście barier administracyjnych w zarządzaniu gminą*, Dysfunkcje i patologie w sferze zarządzania zasobami ludzkimi, Vol. 4, Red. Z. Janowska, Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2011; *Skuteczni liderzy lokalni, Efektywność zarządzania zasobami ludzkimi*, red. B. Urbaniak, Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2011.

⁴³ *Słownik Zarządzania Kadrami* (red.) T. Listwan, Wyd. C. H. Beck, Warszawa 2005, p. 142.

⁴⁴ *Culture Matters. How Values Shape Human Progress. Polskie tłumaczenie wydane przez Zysk i S-ka*, 2000.

development. Even if the poorer countries copy from the richer their institutional arrangements, bring the free market and rule of law, there can be no assurance that it will end in success⁴⁵. This is confirmed by many historical and sociological analysis. Noteworthy is the book of the American political scientist R. Putnam – "Democracy in Action"⁴⁶, where the differences between regions of the world shown in the context of cultural and religious factors reaching up to the Middle Ages⁴⁷. Also, today is developing the new discipline of economics, which remains in close relation with sociology and social psychology. The scientists seek neurophysiological cause for economic behavior. This discipline is neuroeconomics. Neuroeconomists from the United States and Switzerland focus attention on the impact of subjective factors (personal conditions, prejudices and stereotypes) on a trust and cooperation between societies, and consequently the economic and social relations⁴⁸.

Many studies of cultural differences in the social sciences using the term “national character” – having, according to some authors – a great influence on the development and organization of social life. The content of this concept are usually typical socially efficient attitudes and typical organizational skills – but always culturally, historically diverse and could be a relatively constant feature that occurs more frequently in one group than in others. For example, a prominent Polish ethnographer and sociologist, K. Dobrowolski, singled out two strata of a collective nature: constitutional inborn and acquired social. He believed that a collective character concern the various territorial communities and their parts (classes and strata). The character of each group (class, stratum, the nation) changes due to biological selection, transformation of living conditions⁴⁹ and the changing aspirations of contemporary

⁴⁵ See: E. Bendyk, *Nieufny jak Polak*, „Tygodnik Polityka”, 2005, 3 września, n. 35, p. 17.

⁴⁶ R. Putnam, *Demokracja w działaniu*, Wyd. Znak, Warszawa 1999.

⁴⁷ See: E. Bendyk, *Nieufny jak Polak*, op. cit., „What interesting, in many contemporary decisions of Poles until today one can also see the legacy of such events as Poland’s partition. In 2003 during the referendum on the accession of Poland to the EU the map of the schedule of votes still agreed almost precisely with the map of the partition division”.

⁴⁸ More: A. G. Sanfey, J. K. Rilling, J. A. Aronson, L. E. Nystrom, J. D. Cohen, *The Neural Basis of Economic Decision-Making in the Ultimatum Game*, Science, June 13, 2003.

⁴⁹ See: P. Sztompka, *Socjologia. Analiza społeczeństwa*, Znak, 2002, p. 229.

societies, which in the context of dynamic changes of globalization is crucial to proper understanding of this category.

The methodological question arises in this context: whether it is legitimate to talk about "the specifics of the societies of Eastern Europe", "typical social behavior," "national mentality" and finally, the "national character". Does the concept of national character in general can relate to the national community⁵⁰. In spite of various methodological and definitional questions sociologists, ethnologists and historians use these terms. There is a need for some theoretical category which allows to identify and compare the ethnic communities and understand their actions. There is a rich scientific literature about this question⁵¹.

⁵⁰ A. Kłoskowska, *Charakter narodowy a osobowość we współczesnej problematyce badań społecznych*, „Kultura i Społeczeństwo”, 1957, Vol.1, n. 1, p. 10.

⁵¹ At the prepared work under the aegis of UNESCO Dutch scientists collected the bibliography including as many as 988 items, and on this base distinguished six types of the definition of national character and all at the same time six methodological various options. (Also see: E. Lewandowski, *Charakter narodowy Polaków*, Aneks, Warszawa 1995, pp.10-11). In Polish social sciences it is possible to show this theoretical category supporters and opponents. For example A. Kłoskowska belongs to opponents. She says that, the national society is more a sum of diverse subcultures than a synthesis. J. Topolski, who makes it out as the expression of the anthropomorphism, the psychologism and the evolutionism typical of the social science of the 19th century is also an determined opponent of a theory of national character. H. Kubiak is taking a similar stance. J. Szczepański, T. Łepkowski, K. Dobrowolski, A. Kępiński are supporters of this theory. With some reservations also W. Markiewicz, who similarly to J. Szacki, thinks that "little it will be possible to say according to high scientific standards about the problem of national character, but it is worthwhile after all trying, every because methodical reflection is in this case better than mindless copying the stereotypes included in the popular thinking". J. Szczepański assume existence of national character ("psyche of the nation", "national mentality"). But stating that e.g. the Polish national character influences public processes in Poland, simultaneously he is emphasize: "I don't mean here some biologically determined, unchanged features, but historically formed, typical attitudes, models of proceedings, hierarchy of recognized values". See: J. Szczepański, *Rozważania o Rzeczypospolitej*, PiW, Warszawa, 1971, p. 25.

This position seems to be closest to the present consideration of the genesis of a typical eastern specificities of developing countries. *Typicality* for these countries often is understand as a determined layout social relations, organizational skills, entrepreneurial skills, level of social trust etc. This is also the ethos of civil (attitude complex⁵²) and patterns of behavior common for the majority, historically shaped and perpetuated through the generations. This concept doesn't analyze a specific features of individuals, but models of thinking, valuing and behaving shared for the majority in the social and economic life.

Reflecting on the sources of the “competence gap” in societies of developing countries, the researchers of this matter, apart from the ancient historical conditions (described by the category of national character and mentality), refer to days after Second World War, which have had great importance in shaping the identity of the societies of the Eastern Bloc Area. Effect of politically imposed socialism on a widely understood processes of building social resources⁵³, should be considered from the perspective of development of

⁵² Numerous reports of studies are attesting to the permanence of these attitudes. In the work “*Mentality of Poles (2003)*” authors presented findings from 1988 and 1998. Both reports are confirming that invariably among a lot of Poles a “defensive, conservative, claim” attitude is dominating”. It is tendency for avoiding unnecessary effort and to searching for facilitation and additional privileges. It is correlated with the strong claim orientation both in the relationship to the state and parents. See: J. Koralewicz, M. Ziolkowski, *Mentalność Polaków, Sposoby myślenia o polityce, gospodarce i życiu społecznym 1988-2000*, SCHOLAR, Warszawa, 2003 p. 180.

⁵³ It is possible to understand categories of resources diversely, depending on the scientific perspective. “Resources” in economics are the essential elements of the economic growth, belong to them earth (her area, atmosphere, waters, plants, materials etc.) human resources (supply of the work, educating etc.) capital (machines, equipment, buildings etc.). See: *Encyklopedia Gazety Wyborczej*, PWN 2005, Vol. 20, p. 484. At the contemporary psychology the term “resources” most often appear in the context of issues of the stress and dealing with his sources and consequences. Also other people, objects and traumatic experience can be a resource of the person, if are used in the constructive way. H. Alder and B. Heathem are representatives of such understanding term of resources. (See: H. Alder, B. Heather, *NLP w 21 dni*. Poznań: Dom Wydawniczy REBIS 2000, p. 317). There are defining

the "civic nation" within the meaning of democracy. For the formation of a pro-active attitudes of citizens need to root the values such as: private property, free market, inequality, freedom, individualism, competition and pluralism⁵⁴. However, in the structures of Socio-Realism societies followed a process of marginalization of private-sector classes. Admittedly, some regions such as Poland, among other socialist countries (along with Yugoslavia) stood out the highest share of private-sector classes, especially peasants. In those days there wasn't real middle class, which, according to Z. Zagorski, is always "the mainstay of citizenship". Middle class is indispensable for formation of civil, co-operative attitudes, constructive organize of social groups, social activities, real ethos of labor and appropriate relationship to private property.

Multifaceted transformation in Eastern Europe that have occurred over the last twenty years, in a nutshell consisted of moving from a centrally planned socialist economy to market economy. Lack of civil liberties, imposed consensus, lack of competitiveness or policy of full employment and low wages that characterized the preceding period, encourage stagnation and perpetuate the passive-claim attitudes. Those determinates weren't conducive for perception of civic activity as autotelic value⁵⁵. That state of consciousness generated later demanding

resources as: "any mean, with which it is possible to lead the achievement of the result: physiology, self-feeling, thoughts, strategies, experience, people, events, owned objects".

⁵⁴ Z. Zagórski, *Strukturalne bariery transformacji i integracji a społeczeństwo Polski*, Wydawnictwo UW, 1996, p.7.

⁵⁵ Although in the period of the realistic socialism the active citizenship, the work and the diligence formally were valued, however it has often had an only propaganda dimension ("labor day", "leaders of workshop", "organizing oneself for the structure of the socialism "etc.) - in this period the civil ethos could not consolidate and develop as in the same way as in capitalist countries. Particularly in Poland the civil ethos developed after with influence of historical background e.g. underdeveloped native burgesses and therefore – are lacking in Poland of bourgeois revolution, the dichotomous social structure and the farm-villein system of the "Rzeczpospolita Szlachecka", the role of the conservative Polish Roman Catholic Church. Compare: M. Ossowska, *Moralność mieszczańska*, Polska Akademia Nauk, Wrocław, 1985; J. Tazbir, *Kultura szlachecka w Polsce*, Wyd. Poznańskie, 1998; M. Wańkowicz, *Geneza polskiego Chama*, Wyd. Łódzkie 1982; E. Lewandowski E., *Charakter narodowy Polaków*, op. cit.

attitudes and ineffective coping of many people in the new and dynamically changing reality. Discussion about influence of the period of real socialism on the current attitudes of people and their way of thinking about the state of democracy and free market economy is still live in many sociological works. Without a doubt, political changes have given many people the opportunity to demonstrate their own invention and organizational skills. Self-realization through hard work has become the social norm in many circles. Model of man absorbed and devoted work (including work for the next social environment) common in western countries, naturally moved to the post-socialist countries. Professional and social activity has become more important goal, than other dimensions of life. However, a significant part of the former Eastern Bloc societies unwillingly takes a pro-active attitudes. In addition to objective factors influencing the quality of social life resulting from inefficiency of economy (lack of capital, restructuring etc.), occurred the social barriers and psychological blocks – for example: lack of acquired entrepreneurial attitudes (in the Western sense), poor mobility of people, the low level of civilization and inefficient management of its own.

Social capital and building the network of social engagement

The theory of social capital in its most elementary formula says that if people are in contact with others, in a regular and repetitive manner work together to achieve shared goals, it leads to a permanent and positive impact on individuals, to strengthen the ties between them and the activities of the organization. In the literature one can see many versions of depictions and contexts in which potentially have social capital⁵⁶. Social capital refers to organizational features of society as: trust, norms and relationships that can increase the efficiency of society

⁵⁶ C. Trutkowski, S. Mandes, *Kapitał społeczny w małych miastach*. Scholar, Warszawa 2005, p. 46 and next, w: Organizacja i zarządzanie, I. Grzanka, *Badania nad wykorzystaniem kapitału społecznego przedsiębiorstwa*, Kwartalnik Naukowy, n. 4, Wydawnictwo Politechniki Śląskiej, Gliwice, 2008.

by facilitating coordinated actions⁵⁷. Trust is an essential component of social capital. As noted by K. Arrow, "almost every commercial transaction has within itself an element of trust, certainly any transaction conducted over a period of time. It can be plausibly argued that much of economic backwardness in the world can be explained by the lack of mutual confidence"⁵⁸. Network of civic engagement is the foundation of social order and the ground for harmonious development. This network is formed by previous successes achieved through cooperation⁵⁹. They can constitute a cultural pattern for future cooperation. There are some the structural sources of a culture of trust (or distrust) according to P. Sztompka, for example:

- Historical heritage;
- Current structural context (normative stability, existential security);
- Persistence of social order;
- The subordination of power to the rules of action;
- Implementing entitlements and enforcing duties⁶⁰.

Fundamental factors contributing to the strength of social engagement network, a culture of trust and the occurrence of proactive attitudes (for example personality traits such as: aspirations, activism, dispositional optimism, affirmation of success, the location of control) are an additional determinant. Above traits are part of a general pro-social orientation. There are also important the resources of individual such as education, wealth, network of relationships, health and other social characteristics⁶¹.

The above-mentioned structural source of a culture of trust that make up the network of social attitudes of engagement, a well explain the cause of deficits in the level of social capital in developing countries. Especially in countries such as Russia, Ukraine, and Belarus the subordination of authorities to officially declared rules is only a fiction of law. Persistence of the social order can be effectively achieved through intergenerational exchange of best

⁵⁷ R. Putnam, *Społeczny kapitał a sukces instytucji*, przekład J. Szacki, Kraków 1995, w: Socjologia, lektury, P. Sztompka, M. Kucia (red.), Wyd. Znak, Kraków 2005, p. 388 and next.

⁵⁸ Ibidem.

⁵⁹ Ibidem, p. 394.

⁶⁰ P. Sztompka , *Socjologia. Analiza społeczeństwa*, op. cit., pp. 318-319.

⁶¹ Ibidem, p. 320.

practice in terms of existential security and stability in the rules. Also, the societies of such countries as Poland, Hungary, Romania, Bulgaria and others "start learning" a culture of trust and proactive attitudes⁶². Major role in this process plays a part in the European Union. Unify patterns of social and institutional organization, clear legislation and, although imperfect, but the consistent policy of equal opportunities, it gives hope for further, sustainable development of human capital, relatively backward in many areas compared to the historically richer Western Europe.

Proactive dimensions of attitudes of local leaders in developing countries

Discussed the effectuality of leader refers to leadership, which in the modern world is a "relationship superordinate with subordinates (or co-workers, depending on the particular type of organizational leadership), aimed at achieving goals - a vision, dreams, plans, values - based on respect and trust the qualifications of the leaders, and often the fascination with him, rational or irrational commitment to the co-created vision of development"⁶³.

A successful local leaders are individuals who have reached the hierarchy of values with the high importance of moral values (integrity, honesty, kindness), convinced of their self-esteem (awareness of its strengths and possibilities of their use). Persons particularly pronounced shaping the reality of local communities are characterized by a proactive and positive thinking, optimism, creativity and belief in the predictability of the world and high probability of achieving success. Aware that the success of leadership depends on the executors of created initiatives, leaders increase their effectuality through the skillful cooperate with other people based on mutual respect and trust. Social influence depends on the persons concerned by the impact. The best tactic for the high qualified, self-esteem person, aware of his/her role in shaping the local welfare is rational persuasion. In other cases local leaders use tactics based on an emotional impact. An effective local leader of the

⁶² Although the fact of relatively lower social capital and "competence gap" among societies of developing countries, is well documented empirically, certainly one should carefully analyze all generalizing judgements.

⁶³ Ł. Haromszki, *Przywództwo w czasie kryzysu, Zarządzanie w sytuacjach kryzysowych podczas Euro 2012* red. T. Listwan, Wydawnictwo Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław 2010, p. 40.

modern world (such examples are known in Poland) is a person involving the local community in various initiatives by giving good examples, continuous improvement and support the ideas of the local community members.

There aren't outcomes, which show that predisposition to directing is determined genetically⁶⁴. Findings confirming the existence of one source of leadership don't exist⁶⁵. E. Aronson and M. Armstrong said that one must be the right person (to have the appropriate features) at the right time⁶⁶.

In such an approach importance of socio-cultural factors is growing. They shape all elements of leadership: leader, his co-workers (supporters) and the different dimensions and range of the action contexts (legislation, political, educational, developmental conditions etc.).

If we assume that the responsibility for our own lives, the needs of the activity, achievements, life optimism, belief in the predictability of the world and possibilities of creative shaping the surroundings (including other people) appear in primary socialization, the existing cultural conditions (particularly encouraged value systems) may predetermine residents of selected countries to take a leadership role with its associated rights and obligations.

Analyzing the results of G. Hofstede⁶⁷, F. Trompenaars, C. Hampden-Turner⁶⁸, B. Bjerke⁶⁹ researches we can perceive many dimensions of culture that shape various social

⁶⁴ Children of persons being successes in the business mainly don't have psychological similar characteristics. See: D. L. Landes, *Dynastie. Wzloty i upadki największych firm rodzinnych*, MUZA, Warszawa 2007.

⁶⁵ B. R. Kuc, *Od zarządzania do przywództwa. Dylematy władzy organizacyjnej*, Wyd. Menedżerskie PTM, Warszawa 2006, pp. 378-379.

⁶⁶ E. Aronson, T. D. Wilson, R.M. Akert, *Psychologia społeczna. Serce i umysł*, Zysk i S-ka, Poznań 1997; M. Armstrong, *Jak być lepszym menedżerem?* Dom wydawniczy ABC, Warszawa 1999, pp. 226-227.

⁶⁷ G. Hofstede , *Kultury i organizacje. Zaprogramowanie umysłu*, Warszawa 2007.

⁶⁸ F. Trompenaars, C. Hampden-Turner, *Siedem wymiarów kultury. Znaczenie różnic kulturowych w działalności gospodarczej*, Oficyna Ekonomiczna, Kraków 2002.

organizations⁷⁰. G. Hofstede mentions: individualism/ collectivism, power distance, uncertainty avoidance, masculinity/ femininity, time orientation. F. Trompenaars, C. Hampden-Turner are distinguished: rules and relationships, individual and group, the scope displays of affection, commitment and a way of seeing the world, a way of gaining position, the ratio of the time, the attitude to the environment. The dimensions shown by B.Bjerke: power distance (small, large), the tendency to avoid uncertainty (small, big), social orientation (individualistic, collectivist), approach to time (short-, long-term), attitude to change (the pursuit of stability, openness to change), trust in others (a lack of confidence, high level of confidence), goals (materialistic, idealistic), the attitude to the environment (exploitation, adaptation), the measure of success (self-realization, position in society), relationships (formal, informal), troubleshooting (traditional, scientific), the method of governance (democratic, autocratic), communication (low context, high context), desirable skills (system, people).

The analysis shows that there is no single recipe for successful leadership, because different local actors shape requires a different approach to inspire, motivate and coordinate their work. Distinctive feature of the world of civil societies from those who only aspire to it is the conviction that only the activity resulting from a strong internal motivation and translating into group action, brings successful community action. Already described in this article, historical factors meant that some residents of Central and Eastern Europe can't accept responsibility for local development, with no awareness that in democracy, the people are sovereign and exercising formal authority are executors of their will. Another element limiting the activity (for example Poles) is incapacitation the people through wrong actions taken by those shaping the education system in Poland. For example, commands instead of the inspiration for creative thinking and action, slight participation of design classes or low tolerance for errors.

Is it possible to reverse this situation shaping adults through the implementation of various training programs (including coaching and mentoring) available free of charge in the most democratic and unlimited space in the world – in the Internet?

⁶⁹ B. Bjerke, *Kultura a style przywództwa*, Oficyna Ekonomiczna, Kraków 2004.

⁷⁰ Which also includes the organized (planned and implemented) activities in local communities.

Activation programs forming the basis of civil society with the use of ICT

In Poland, for many years was carried out different activation programs financed by Batory Foundation, the Polish-American Freedom Foundation, the European Union. Since 1992, the mobilization of local communities, aiming to produce the basic mechanisms of civil society was implemented in the Phare programs:

- Social (Civic) Dialogue - PL9112, PL9412 - 1992,
- Democracy, LIEN; Partnership - 1993 – 1997,
- Pro-European Initiative (PHARE PL9707),
- ACCESS - 1999 (Macro-Project Scheme),
- 2000 - The Access 2000 PL0002,
- 2001 - Programs and PL0101.11 PL0101.10 and PL0102.05,
- 2002 - Program PL605.01.02,
- 2003 - Program PL379.01.01⁷¹.

Then, after the Polish accession to EU 01.05.2004 available for activating community activities have become a structural funds. NGOs could raise funds from the various programs of the two programming periods 2004 - 2006 and 2007 – 2013. The biggest opportunities for staff training, developing proactive attitudes has the Operational Programme Human Capital⁷². This program includes the central and regional priorities, broken down into specific activities. Priority I - Employment and social integration, Priority VII - Promotion of Social Integration and Priority IX - Academic Development and Promotion in the Regions offer bailout for creating a proactive attitude and support the initiatives of local leaders⁷³.

Each of the activities under the HCOP particularly appreciates the projects involving the development and use of ICT. It should be considered such actions as thoughtful and farsighted, since modern communications technologies can boost the development of civil society in a changing socio-cultural conditions. The term “democracy” has changed its meaning since the progress of information technology. We can also observe redefining the

⁷¹ www.npr.gov.pl, 30.05.2012.

⁷² www.fundusze-europejskie.pl, 30.05.2012.

⁷³ www.efs.gov.pl, 30.05.12.

role of citizens in the civic activity. The new conditions (the availability of the Internet) promote greater interactivity for the participation of citizens in the exercise of power (the ability to communicate, influence through the fastest growing medium in the world). Ease of access to information, including examples of good practices, manners of the problem solving, training programs, coaching and mentoring can help change social attitudes to those characterized by greater openness to people and new experiences than is currently.

Such action can only occur in a situation of universal access to the Internet and the skill efficient and effectual use of its resources. The Social Diagnosis 2011⁷⁴ shows that two thirds of households in Poland has a computer. Internet access is at 61.1 % homes. The increase in computerization is slower than several years ago. According to research one of the main reasons for the lack of access to the Internet is not having basic skills - knowledge and conscious needs. Programs implemented to modernize the way people communicate, (i.e. OPIE) aren't always fulfill their role, because a current identification of actual needs of people isn't being conducted. The information collected within the Social Diagnosis in 2011 found that people use the Internet have a much more social activity:

- Commitment to local community (18.9% of Internet users and 10.4% of other respondents),
- Participation in public meetings (25.1% using the Internet and 18.9% of other respondents),
- Membership in organizations and associations (17.5% using the Internet and 10.8% of other respondents),
- Volunteering (24.5% using the Internet and 12.1% of other respondents).

Community development can take place through the introduction of programs funded and coordinated by the Polish American Freedom Foundation, including:

- Act Locally,
- Local Partnerships PAFF,
- Library Development Program,
- PAFF Leaders,
- New Technologies Locally,
- "Pro Publico Bono" Competition,

⁷⁴ www.diagnoza.com, 30.05.2012.

- Support for NGOs,
- Citizen and Law.

These activities will create the social activity of citizens, support the leaders and share new technologies. For example, the aim of the "New Technologies Locally" Program is to broaden knowledge and skills in the practical use of modern information and communication technologies. The program comprises an educational component and a support system, including financial aid. Activities under the program are prepared for diagnosed systematically needs of the selected local communities.

The programs implemented in Poland in the area to educate the public and support local leaders conducted since the early 90s led to a substantial increase in the activity of local communities. Developing new attitudes towards challenges of socio-economic reality of 21st century manifest itself with convincing about the feasibility even very complex and time-consuming projects in the situation of financial means reduced or hard to reach.

The level of development in the forming of the civil society has caused, that institutions which projects activating and changing the social awareness carried out had moved their action to countries more slowly changing in this respect which citizens also expect changes in the democratization of life and the decentralization of power. This action is e.g. a Program the East East of Batory Foundation, the part of the East East Beyond Borders regional program coordinated and financed by Open Society Foundation⁷⁵. The aim of the program is to support international exchange of experience, expertise, and knowledge, and contribute to spreading the values of an open society. The program was created in 1991 to support cooperation between the countries of Central and Eastern Europe, Central Asia, and the Caucasus. At present, the East East Program encourages innovative initiatives, which contribute to joint development of good models of social action and to solving problems on a regional scale.

Helsinki Foundation for Human Rights also conducts Internet training and consulting aimed at the countries of Central and Eastern Europe and Central Asia⁷⁶. HFHR due to the large potential of knowledge and experience of the activities forming the basis of civil society also implements projects in cooperation with the Ministry of Foreign Affairs. Projects co-

⁷⁵ www.batory.org.pl, 30.05.2012.

⁷⁶ www.hfhr.pl, 30.05.2012.

finance are in frameworks of the program of the Polish developmental cooperation Ministry of Foreign Affairs the Republic of Poland.

In 2011 there were funded projects for citizens of Belarus, Ukraine, Georgia, Moldova, Armenia, Azerbaijan, Central Asia:

- affecting the development of communication,
- supporting the equalization of the competence gap along with the advisory help by the Internet.

Along with advisory activities funds for the purchase of the necessary equipment (e.g. computers), software, language learning etc. are finding their way to beneficiaries⁷⁷.

The evaluation of the effectuality of described programs directed at the local community is demonstrating, that in spite of identical proposals for various regions in Poland and in Central-Eastern Europe not all proposals are meeting with a favorable response. Persons being characterized by needs of the activity and the execution of tasks for the local communities realize deliberate objectives even in situation of financial, administrative and social difficulties Findings of this type are showing that the situation not always creates the leader. Responsibility for the development of the local community assume a person with an appropriate, optimal set of traits, knowledge and skills useful in a particular place and time. In this perspective, the situation is only a "detonator" starting creating the leadership relation with the project concerned members of the community. Apart from suitable qualifications an appropriate attitude accepted towards the own life and the social reality turns out to be essential to act. Whether it is possible to gain such an attitude in members not-revealing to the tendency to the group activity of the local community via ICT?

It is necessary to start the attempt to explain of reasons of unsuccessful changing the attitude of the local community members from psychological factors. In this regard, mechanisms for changing behavior is usually explained by three main concepts: social judgment theory, processual model of persuasion and two-track theory of persuasion⁷⁸. The theory of social judgment take into account only two determinants of the effectuality of persuasion: discrepancy between transmission and the attitude of receiver and the validity of this attitude. However the processual model of persuasion assumes, that the final effect of

⁷⁷ www.msz.gov.pl. 30.05.2012.

⁷⁸ J. Strelau, *Psychologia. Podręcznik akademicki*. Wyd. GDP, Vol. 3, pp. 92-97.

persuasive communication depends on the four stages of processing: attention, understanding its content, yielding to his/her arguments and to maintain this altered attitude in the face of counter-propaganda. Two-track theory of persuasion combines detailed theory of social judgment, and a wide range of phenomena characteristic of a processual model of persuasion. Two-track theory of persuasion assumes that attitude change can occur to the existence of two different tracks – central and peripheral. The central transmission is characteristic of recipients carefully analyzing the transmission and senders with abilities to arouse favorable cognitive reactions of the recipient. Peripheral track of persuasion based on the superficial identification of a signal suggesting a positive or negative attitude to the stance offered in the transmission. Determinants of the effectual attitude change are: sender, recipient, content, organization and medium. Social judgment theory assumes that the involvement of the recipient makes it difficult to change his opinions. The study of B. Johnson and A. Eagly⁷⁹ shows that the phenomenon of change attitudes is more difficult when the increase in the commitment results of connecting the attitude with important values of the subject. In this approach, adults with an individual hierarchy of values with which strongly they are identifying itself are definitely less willing to the change of attitudes than children.

In addition to above-mentioned, there are also a number of socio-cultural factors, already described in the introductory part of the article, such as: inheritance of helplessness, lack of identification with the state, authority, organization – resulting from the situation of Central and Eastern Europe societies for the last decades before changing the system and exodus from the Warsaw Pact, which can significantly hinder the change of attitudes.

Conclusion

Based on studies of the local leaders⁸⁰ it is possible to risk the thesis, that beneficiary of prepared activation programs, also of the ones carried out via ICT (of especially an

⁷⁹ B. T. Johnson, A. H. Eagly, *The effects of involvement on persuasion: A meta-analysis*, Psychological Bulletin, 106, 1989, pp. 290-314.

⁸⁰ Findings of local leaders in provinces of Lower Silesia and Silesia in the years 2006 – 2011 were presented i.a. in : Ł. Haromszki, *Strategia rozwoju turystyki dla miasta i gminy Wisły w latach 2007-2013* (współautor), Wrocław 2006; Ł. Haromszki, *Strategia rozwoju turystyki dla miasta Oleśnica w latach 2009-2013* (współautor), Wrocław 2008; Ł. Haromszki,

Internet) are already active persons which are seeking the possibility of the implementation of planned or begun investments. Interest in such programs is large, because the implementation of promoted activities is connected with obtaining financing, often in the form of non-repayable grants. The elements that may limit the effectuality of proposed solutions based on information and communication technologies are the lack of competence particularly in the use of computer programs, efficient use of Internet resources and a lack of knowledge of the languages in which such communication is carried out (modern variants of Polish language variations and foreign languages). It is impossible not to notice that in the field of knowledge and skills of people positive changes occur. The dynamic growth in the proportion of people using ICT is a good omen for the future. In Poland, currently 55% of the adult population actively uses both a computer, Internet and mobile phone. In comparison to previous years has seen the rapid growth of people actively using ICT and decrease in the number of people who have any of these technologies do not use⁸¹. Even in 2005, people such was near 40%, in 2011 only 13.3%. Similar trends can be noted in all the countries of Eastern Europe. It is well known that a proactive attitude are closely related to the use of ICT tools in the private and professional life. In Poland people using the Internet show a much more social activity than other citizens. Nearly two times more likely they engage in the local community activities than other community members. Persons, who using the Internet, more often take part in various public meetings and are members of organizations and associations then other citizens⁸².

It should be noted that the relationship between social activity and widely understood active attitudes socially don't result directly from the ability of using ICT tools and inversely

Koncepcja Subregionalnego Produktu Turystycznego „Ślęza” (współautor), Wrocław 2009; Ł. Haromszki, *Liderzy lokalni w kontekście barier administracyjnych w zarządzaniu gminą, Dysfunkcje i patologie w sferze zarządzania zasobami ludzkimi*, Vol. 4, Red. Z. Janowska, Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2011; Ł. Haromszki, *Skuteczni liderzy lokalni, Efektywność zarządzania zasobami ludzkimi*, red. B. Urbaniak, Wydawnictwo Uniwersytetu Łódzkiego, Łódź 2011. Ł. Haromszki, *Aktywność liderów lokalnych jako szansa rozwoju organizacji trzeciego sektora w powiecie dzierżoniowskim, Szanse i zagrożenia rozwoju organizacji w społeczeństwie informacyjnym*, Kraków 2012.

⁸¹ *Diagnoza społeczna 2011*, p. 311 and next.

⁸² Ibidem, p. 321.

(it isn't straight causal relation). A number of explaining factors of the change in attitudes in the discussed scope, it is necessary to seek in, what sociologists are calling, "features of the generation" and process associated with it more widely of "generation exchange". Apart from the general increase of the knowledge of societies, change of a lifestyle and aspiration – at least many times strongly connected with individualistic values – is giving the chance of cultural strengthening proactive attitudes among next generations of leaders of the local communities.

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A survey of parallel local search methods application in scheduling and logistics

by

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ABSTRACT

The main issue considered in the paper is concerned with solving difficult optimization problems in parallel calculating environments, such as multiprocessor computers, clusters or distributed calculation nodes in networks, by applying algorithms which use various parallelization technologies. Strongly sequential character of the scheduling algorithms is considered to be the main obstacle in designing sufficiently effective parallel algorithms. On the one hand, up till now sequential algorithms exhausted the possibilities of significant growth in the power of solution methods. On the other hand, parallel computations offer essential advantages of solving difficult problems of discrete optimization, pushing towards theory, methodology and engineering of solution algorithms.

Keywords:

Parallel algorithms, discrete optimization, metaheuristics.

INTRODUCTION

The development of optimization methods, particularly applied in production tasks arrangement, has proceeded towards modern and more effective sequence approaches since the beginning of this field. At the end of the 1970s, the turning point in the combinatorial optimization methods was the branch and bound (B&B) method regarded those days as a remedy for nearly all problems of great size which could not be solved by means of methods applied at that time. However, it soon occurred that the B&B method only slightly extended the scope of solvable problems (e.g. for a sum-cost, single-machine scheduling problem this size extended from 20 to 40 - 50 tasks). What is more, the cost necessary to obtain an optimal solution is much too high compared to economic benefits and its use in practice. The conclusion of these investigations was the definition of a bounded area of the B&B scheme application.

The next breakthrough concerned the occurrence of advanced metaheuristic methods: first the simulated annealing method and next the method of genetic algorithms and the tabu search method. Enthusiasm lasted much longer: until around 2005 several dozen of different metaheuristics had been proposed though again those methods reached the limit of their abilities to the moment where the size of effectively solvable problems (i.e., these for which an average deviation from the optimal solutions was smaller than 1%) might be shifted to a number reaching thousands, but not millions or hundred millions. Eventually the concept of 'no-free-lunch' by Wolpert and Macready [29] finished the discussion. With reference to rough methods this concept may be paraphrased in the following way: without using special attributes of examined problems considerable advantage of one metaheuristic over the other cannot be obtained. What is interesting Wolpert and Macready proved that 'free-lunch' was possible to be obtained in co-evolutional, multi-cultural metaheuristics, i.e., parallel in a natural way. Since the mid-1980s, indeed, parallel many-levelled metaheuristics had been developed, firstly as simple paralleling of the most time-consuming elements of sequence algorithms (usually as the goal function determination), then since the end of the 1990s as multi-track methods.

A marked enhancement of the quality of designed algorithms started when producers of computer equipment realized that further increase of the speed (i.e., the clock frequency) of processors was very costly, while this goal could be more easily obtained applying multi-core constructions, i.e., parallel calculating environments (and in this context among producers of hardware there also exist the term `no-free-lunch'). Today processors of popular producers

such as Intel or AMD have got 4 cores (some Intel processors have 9 cores, and prototypes even 80 cores) and GPU processors (Graphic Processing Unit) at first being used exclusively as graphic processors and nowadays also as strictly computing ones possess even 960 processors (e.g. products of nVidia Tesla series).

SCHEDULING PROBLEMS

Some elementary notions are used in mathematical model building of a job scheduling problem: a *job* and a *resource*. The job consists in executing a sequence of operations which need some resources. A number of data can be connected with the job: *due date* or *deadline*, possibility of breaking the job (*divisibility*), ways of operation execution (specific requirements of resources, alternative ways of execution), etc. Resources can be renewable (processor, machine, memory) or non-renewable (operational materials, natural resources) and dual-bounded (energy, capital). The features of the resources include: accessibility (in time windows), cost, amount, divisibility. All of these features have to be mathematically formalized by constructing a mathematical model of a problem.

Let $J = \{1, 2, \dots, n\}$ be a set of jobs which have to be executed by using a set of types of machines $M = \{1, 2, \dots, m\}$. Each job i is a sequence of o_i operations $O_i = (l_{i-1} + 1, l_{i-1} + 2, \dots, l_i)$, $l_i = \sum_{k=1}^i o_k$, $l_0 = 0$. Operations inside a job have to be executed in a defined technological order (in the defined sequence), i.e., an operation j has to be executed after having finished an operation $j - 1$ execution and before starting the execution of an operation $j + 1$. A set of operations of a job i will be denoted by O_i for simplicity of notation. For each operation $j \in O$, $O = \bigcup_{i=1}^n O_i$ the following terms are determined:

M_j – sequence of m_j subsets of machines which define alternative methods of operation execution; $M_j = (M_{1j}, M_{2j}, \dots, M_{mj})$, $M_{ij} \subseteq M$; an operation j needs a set of machines M_{ij} for its execution, where $1 \leq i \leq m_j$,

p_{ij} – time of execution of an operation j by the i -th method (i.e., on the i -th machine),

v_j – method of executing the operation (decision variable),

S_j – term of an operation execution beginning (decision variable),

C_j – term of an operation execution finishing, $C_j = S_j + p_{v_j j}$ if the operation cannot be broken.

In turn, for a job i the following terms are needed to be determined:

o_i – number of operations in the job,

r_i – the earliest possible term of the job execution beginning,

d_i – due date of the job execution finishing,

S_i – term of the job execution beginning, $S_i = S_{l_{i-1}+1}$,

C_i – term of the job execution finishing, $C_i = C_{l_i}$,

L_i – non-timeliness of the job execution finishing, i.e., being tardy or early,

$L_i = C_i - d_i$,

T_i – tardiness of the job execution finishing, $T_i = \max\{0, C_i - d_i\}$,

E_i – earliness of the job execution finishing, $E_i = \max\{0, e_i - C_i\}$, $f_i(t)$ – non-decreasing cost function connected with the job i execution finishing in a time $t \geq 0$,

F_i – a time of flow of the job i through the system, $F_i = C_i - r_i$,

U_i – unitary tardiness of the job i .

The majority of scheduling problems do not need to define all the above data and decision variables. Usually a minimal set of notions which is sufficient to describe the model is used. For example, if for each $j \in O$ we have $m_j = 1$, $|M_{1j}| = 1$ it means that the problem has dedicated machines, therefore decision variables v_j do not undergo any choice. Then v does not occur in the model of the problem.

Taxonomy. To describe precisely the scheduling problem a three-field notation $\alpha|\beta|\gamma$ is applied. This notation was proposed in [18] and next developed in [22]. It has three fields $\alpha|\beta|\gamma$ specifying the execution environment α , additional constraints β , and the objective function γ .

Here we propose an extended Graham notation which includes representations of hybrid systems or flexible systems with parallel machines. This kind of scheduling problems cannot be described by the original Graham notation. We propose to set the symbol α as a composition of three symbols $\alpha_3\alpha_2\alpha_1$ which have the following meaning. The symbol α_1 describes a finite number of machines in the system: 1, 2, ...; if this number is not specified then an empty symbol is put here which means any number of machine m . The symbol α_2 describes the method of jobs flowing through the system, where the following traditional ways are enhanced:

F – flow shop in which all the jobs have the same technological path and they all have to be executed on all the machines; each machine needs to determine different sequence of input jobs,

F^* – permutation flow shop, a model which has the same assumptions as F with an additional requirement that a sequence of job execution on all the machines has to be the same (compatible with the order of the sequence of jobs input into the system),

J – job shop, in which jobs can have different (in terms of the number and the order of visiting machines) technological paths,

G – general shop, in which each job is a single operation and technological relationship is given by a graph,

O – open shop, in which all the operations of jobs have to be executed, but the technological order of operations inside the job is not specified.

The number of machines $\alpha_1 = 1$ implicates that both α_3 and α_1 symbols have to be empty. The symbol α_3 determines the mode of executing each operation. If α_3 is an empty symbol then we assume that for each operation a machine has been dedicated on which it will be executed, that is $m_j = 1$, $|M_{ij}| = 1$, $j \in O$. Otherwise, we assume that $m_j \geq 1$, $|M_{ij}| = 1$, $i = 1, 2, \dots, m_j$, $j \in O$ and an operation can be executed on exactly one machine from a set of:

P – identical parallel machines,

Q – uniform machines, or

R – non-uniform machines.

As we have already mentioned both α_3 and α_1 symbols can be empty, which means that any realization mode can be accepted, or (α_1 empty symbol) any (but fixed) number of machines can be used.

The symbol β determines the existence of additional assumptions and constraints, e.g. different release times (the earliest possible times of beginning job execution, r_i), existence of a partial technological order of job execution (*prec*), constraints *no wait, no store, no idle* (without time gaps), $p_{ij} = 1$ (all times are identical and equal 1), *pmtn* (jobs can be stopped and started again), etc.

The last parameter γ has the symbolic form of the criteria function. Two classes of this function occur in theory and practice of job scheduling, namely

$$f_{\max} = \max_{1 \leq i \leq n} f_i(C_i)$$

and

$$\sum f_i = \sum_{i=1}^n f_i(C_i),$$

where $f_i(t)$ are some non-decreasing functions. These classes include, among others, many frequent criteria from the practice, for example: the length of the schedule (makespan)

$$C_{\max} = \max_{1 \leq i \leq n} C_i,$$

an average time of the job flow

$$\sum F_i = \frac{1}{n} \sum_{i=1}^n F_i.$$

In the second case we may include a different weight of jobs $w_i \geq 0$ in the cost function $f_i(t) = w_i t$. For jobs with due dates d_i one can construct measures $f_i(t) = \max\{0, t - d_i\}$ or $f_i(t) = w_i \max\{0, t - d_i\}$. Therefore, we obtain

$$T_{\max} = \max_{1 \leq i \leq n} T_i = \max_{1 \leq i \leq n} \max\{0, C_i - d_i\}$$

or the weighted sum of job tardiness

$$\sum w_i T_i = \sum_{i=1}^n w_i T_i = \sum_{i=1}^n w_i \max\{0, C_i - d_i\}.$$

The most frequent considered (in the literature) are the following criteria: makespan (C_{\max}), sum of job finishing times (C_{sum} , $\sum C_i$) and weighted sum of job tardiness ($\sum w_i T_i$). The criteria cited above are known as typical in practice and they generate troubles during optimization (they are difficult).

LOGISTICS PROBLEMS

The Vehicle Routing Problem (VRP) belongs to the NP-hard problems class. Solving it provides a key for increasing efficiency in transportation management. It was first described in 1959 by G. B. Danzig and J. H. Ramser [14]. Since that time VRP literature was enriched with thousands of new positions containing a variety of different VRP types. VRP solving tools provide great savings (about 5-30% [17]) for society every day. Exact methods are not capable of solving instances of VRP problems that contain more than 50-100 customers in reasonable time so there is still much need for research, particularly for large scale rich instances [17]. This is a very important limitation, when taking into account that the number of customers can reach several thousand for bigger companies.

The problem described by Danzig and Ramser was Capacity constrained VRP (CVRP). It is one of the simplest types of VRP problems. In CVRP there is:

- a constant number of homogeneous vehicles with a specified capacity,
- a constant number of customers,
- a demand with specified size (capacity needed) and a localization is assigned to each customer,
- the vehicles are able to pick up the demands from the customers but the sum of demand sizes that have been handled by a vehicle cannot exceed its capacity,
- the vehicles are located in a single depot which is the start and end point of their tour,
- travel costs between localizations (customers and depot) are given,
- each customer has to be served exactly once.

The sum of travel costs between localizations of a tour is the cost of the tour and the sum of tour costs is the cost of the solution. The goal of CVRP optimization is to find a set of K (the number of vehicles) tours with minimal total travel cost and preserving problem assumptions.

As stated before CVRP is one of the simplest VRP problems but there are many other simple types often quoted in literature. One of them is the *Multi Depot VRP* (MDVRP) which is a

generalization of the *Single Depot VRP* (SDVRP) [10]. The most significant characteristic of MDVRP is that the number of depots can take values greater than one. Therefore the vehicles can start from multiple depots but still have to return to the start depot at the end of the travel.

In the *Periodic VRP* (PVRP) a time horizon is added [16]. Thanks to that the PVRP can be used to provide solutions for situations where delivery routes are constructed for a period of time. A real life case is for example collecting trash from customers three times a week.

The *Distance constrained VRP* (DVRP) is very similar to the CVRP [HaKl, Ka]. The difference lies in the constrained dimension. In DVRP the travel length or duration for each vehicle cannot exceed a given maximum value. Another basic model the *Distance and Capacity constrained VRP* (DCVRP) which utilizes the limitations present in both models can be constructed by combining them.

The *Vehicle Routing Problem with Time Windows* (VRPTW) [2] should be applied for modeling services like bank or postal deliveries where the time of the delivery has to be taken into consideration. The routing plan has to be constructed in such a way that each customer demand is served within a given time interval. Depending on the VRPTW subtype the time windows can be either soft (the window can be violated at a cost) or hard (vehicles are not allowed to arrive at a customer after the given interval).

The type of VRP that needs to be used strongly depends on the real life case. When analyzing real life cases there is almost always a need to use more complex (rich) VRP types e.g. *Fleet Size and Mix VRP with Multiple Time Windows* (FSMVRPMTW) [17]. The example model includes optimal composition of a fleet of heterogeneous vehicles that can satisfy customer demands in alternative time windows.

VRP problems are generalizations of the Traveling Salesman Problem (TSP) which is one of the most famous optimization problems. In its simplest form it includes [5]:

- a constant number of cities,
- one traveling salesman,
- travel costs between cities,
- the Salesman has to begin and end his tour in a specified start city and visit the other cities exactly once.

The sum of travel costs between cities is the cost of a tour. The goal of TSP optimization is to find a tour with minimal travel cost and preserving problem assumptions. In order to create an instance of TSP by using CVRP the following assumptions have to be made:

- the start city is the depot,
- number of vehicles is set to 1 (number of traveling salesman),
- the number of customers is set to the number of cities minus one,
- the capacity of the salesman is unlimited.

PARALLEL ARCHITECTURES

In recent years, several theoretical models of parallel computing systems were proposed. Up till now some of them have been physically realized. These theoretical models take into account only the ways of manipulating instructions (instruction set) and the type of data streams. We extend this taxonomy by adding memory architectures.

The fundamental classification of parallel architectures was given by Flynn [15]. Here we present it based on a survey taken from [1].

- **SISD machines.** *Single Instruction stream, Single Data stream.* Classic serial machines belong to this class. They contain one CPU and hence can accommodate one instruction stream that is executed serially. Many large mainframes can have more than one CPU but each of them execute instruction streams that are unrelated. Therefore, such systems still should be regarded as multiple SISD machines acting on different data spaces. Examples of SISD machines are mainly workstations like those of DEC, Hewlett-Packard, IBM and Silicon Graphics.
- **SIMD machines.** *Single Instruction stream, Multiple Data stream.* These systems often possess a large number of processing units, ranging from 100 to 100,000 all of which can execute the same instruction on different data. Thus, a single instruction manipulates many data items in parallel. Examples of SIMD machines are the CPP DAP Gamma II and the Quadrics Apemille. Other subclasses of the SIMD systems embrace the vector processors which manipulate on arrays of similar data rather than on single data items using CPUs with special instructions (e.g. MMX, SSE2). If data can be manipulated by these vector units the results can be delivered at a rate of one, two and three per clock cycle. That is why vector processors work on their data in a parallel way but this only refers to the vector mode. In this case they are several times faster than when executing in conventional scalar mode. An extension of the vector processing idea is GPGPU.

- **MISD machines.** *Multiple Instruction stream, Single Data stream.* This category includes only a few machines, none of them being commercially successful or having any impact on computational science. One type of system that fits the description of an MISD computer is a systolic array which is a network of small computing elements connected in a regular grid. All the elements are controlled by a global clock. In each cycle, an element will read a piece of data from one of its neighbors, perform a simple operation and prepare a value to be written to a neighbor in the next step.
- **MIMD machines.** *Multiple Instruction stream, Multiple Data stream.* MIMD machines execute several instruction streams in parallel on different data. Compared to the multi-processor SISD machines mentioned above the difference lies in the fact that the instructions and data are related because they represent different parts of the same task to be executed. Therefore, MIMD systems can run many subtasks in parallel in order to shorten the time-to-solution for the main task to be executed. There is a large variety of MIMD systems and especially in this class the Flynn taxonomy proves to be not fully adequate for the classification of systems. If we focus on the number of system processors this class becomes very wide, from a NEC SX-9/B system with 4-512 CPUs or clusters of workstations to a thousand processors IBM Blue Gene/P supercomputer and Cray XT5-HE (224162 cores) which breaks the petaflops barrier.

Memory architectures. The Flynn taxonomy does not recognize memory architecture. In our opinion memory architecture types have an influence on parallel algorithm efficiency. Therefore, we propose to select two classes here.

- *Shared memory systems.* They have multiple CPUs all of which share the same address space (shared memory). It means that the knowledge of where data is stored is of no concern to the user as there is only one memory accessed by all CPUs on equal basis. Shared memory systems can be both SIMD and MIMD. Single-CPU vector processors can be regarded as an example of the former, while the multi-CPU models of these machines are examples of the latter. The abbreviations SM-SIMD and SM-MIMD are usually used for the two subclasses.
- *Distributed memory systems.* Each CPU possesses its own associated memory in this class. The CPUs are connected by a network and they may exchange data between their respective memories if necessary. Unlike with the shared memory machines the

user has to be aware of the data location in the local memories, besides they will have to move or distribute these data explicitly if necessary. The distributed memory systems may be either SIMD or MIMD.

Although the difference between shared- and distributed-memory machines seems to be clear, this is not always entirely the case from the user's point of view. Virtual shared memory can be simulated at the programming level. For example, a specification of High Performance Fortran (HPF) was published in 1993 [19] which, by means of compiler directives, distributes the data over the available processors. That is why the system on which HPF is implemented in this case will look like a shared memory machine to the user. Other vendors of Massively Parallel Processing systems (sometimes called MPP systems), like HP and SGI, are also able to support proprietary virtual shared-memory programming models due to the fact that these physically distributed memory systems are able to address the whole collective address space. Therefore, for a user such systems have one global address space spanning all of the memory in the system.

The other important issue from the user's point of view is the access time to each memory address of the shared memory. If this access time is constant, we say that the system is of UMA (uniform memory access) type, if it is not we call it NUMA (non-uniform memory access). Additionally, there is a distinction if the caches are kept coherent (coherent cache or CC-NUMA) or not (non-coherent cache or NC-NUMA).

For SM-MIMD systems we can mention OpenMP [11] that can be applied to parallelize Fortran and C++ programs by inserting comment directives (Fortran 77/90/95) or pragmas (C/C++) into the code. Also many packages to realize distributed computing are available. Their examples are PVM (Parallel Virtual Machine, [16]), and MPI (Message Passing Interface, [25]). This programming style, called the 'message passing' model has become so accepted that PVM and MPI have been adopted by nearly all major vendors of distributed-memory MIMD systems and even on shared-memory MIMD systems for compatibility reasons. In addition, there is a tendency to cluster shared-memory systems, for instance by HiPPI channels, to obtain systems with a very high computational power. E.g., the NEC SX-8, and the Cray X1 have this structure. Thus within the clustered nodes a shared-memory programming style can be applied, whereas between clusters a message-passing should be used. Nowadays, PVM is not applied a lot any longer and MPI has become the standard.

Distributed systems are usually composed of a set of workstations (so-called cluster) connected by a communication network such as Infiniband, Myrinet or Fast Ethernet. Such a *cluster of workstations* (COW) has better price-to-performance ratio, and it is more scalable and flexible compared to multiprocessor systems. On the other hand, MPP (*massively parallel processor*) systems are composed of thousands of processors, which can belong to multiple organizations and administrative domains, creating so-called *grids*, built on the basis of the Internet infrastructure.

Recent trends. For the last few years GPGPU parallel programming model has been used for massive shared-memory applications. GPUs are regarded as SIMD processors (or MIMD when the processors can handle multiple copies of the same code executing with different program fragments, e.g. counters, see Robilliard et al. [24]). In the CUDA programming environment, developed by nVidia, the GPU is viewed as a computing device capable of running a very high number of threads in parallel, operating as a coprocessor of the main CPU. Both the host (CPU) and the device (GPU) maintain their own DRAM, referred to as the host memory and device memory, respectively. One can copy data from one DRAM to the other through optimized API calls that utilize the device's Direct Memory Access (DMA) engines.

The GPU is especially well-suited to address problems that can be expressed as data-parallel computations – SIMD – with high arithmetic intensity (the number of arithmetic operations is significantly greater than the number of memory operations). Because the same program is executed on many data elements and has high arithmetic intensity, the memory access latency can be hidden with calculations instead of big data caches. In practice GPU programming is very close to the PRAM machine model from the programmers' point of view, offering a simple tool for checking the theoretical PRAMs algorithm efficiency (see Bożejko et al. [7]).

PARALLEL METAHEURISTICS

Metaheuristics based on the local search method can be presented as processes of a graph searching in which vertices are the points of the solution space (e.g. permutations) and arcs correspond to the neighborhood relation – they connect vertices which are neighbors in the solution space. We will call it *neighborhood graph*. For all NP-hard problems the related neighborhood has an exponential size. Moving on such a graph defines some *path* (in other words, *trajectory*) in the solution space. Parallel metaheuristic algorithms make use of many processes for parallel generation or search of the neighborhood graph.

One can define two approaches to parallelization of the local search process in relation to the number of trajectories which are concurrently generated in the neighborhood graph:

1. *single-walk parallelization* (single trajectory): fine-grained algorithms for fast communication purposes (the most computationally expensive parts of the algorithm are parallelized),
2. *multiple-walk parallelization* (many trajectories): coarse-grained algorithms, communication is less frequent, compared to the single-walk parallelized algorithms.

These approaches demand that the algorithm meet some requirements as regards communication and synchronization frequency, which implies the kind of granularity. Single-walk parallel metaheuristics are usually fine-grained algorithms (e.g. Bożejko, Pempera and Smutnicki, [8]), multiple-walk metaheuristics – coarse-grained (e.g. Bożejko, Pempera and Smutnicki, [6]).

Single-walk parallel algorithms. Single walk algorithms go along the single trajectory, but they can use multithread calculations for the neighborhood decomposition (see *representatives* method, [23]) or parallel cost function computation. For example, calculations of the cost function value for more complicated cases are frequently equivalent to determining the longest (critical) path in a graph, as well as maximal or minimal flow.

Multiple-walk parallel algorithms. Algorithms which make use of a multithread multiple-walk model search concurrently a solution space by searching threads working in parallel. Additionally, these algorithms can be divided into subclasses due to communication among threads (information about current search status): (1) *independent* search processes and (2) *cooperative* search processes. If the multithread application (i.e., concurrently running search processes) does not exchange any information we can talk about *independent* processes of search. However, if information accumulated during an exploration of the trajectory is sent to another searching process and used by it, then we can talk about *cooperative* processes (see Bożejko et al. [6]). We can also come across a mixed model, so-called *semi-independent* (see Czech [13]) executing independent search processes keeping a part of common data.

Implementation. Due to the specificity of the metaheuristic type, as well as parallel environment architecture (SIMD, MIMD, shared memory, etc.) different programming languages are used for coding. As we can see in Table 2 SIMD algorithms for GPU are implemented in C++ with CUDA programming library – nowadays it is the most commonly

used programming environment for nVidia GPUs. SIMD algorithms for multiprocessor computers without shared memory are implemented in Ada95 high-level programming language, due to the simplicity of designing them. Algorithms for distributed MIMD clusters are implemented in C++ programming language with the use of MPI (*Message Passing Interface*) communication library, also the most commonly used tool for programming clusters.

PARALLEL LOCAL SEARCH METHODS

Let us consider a *discrete optimization problem* formulated as follows. Let \mathbf{X} be a discrete solution space and let $F: \mathbf{X} \rightarrow \mathbf{R}^+$ be a non-negative function defined on the solution space \mathbf{X} . We are looking for the optimal element $x^* \in \mathbf{X}$ such that

$$F(x^*) = \min_{x \in \mathbf{X}} F(x).$$

A major class of discrete optimization problems solving algorithms (apart from population-based methods) is a *local search* approach, in which an algorithm creates a searching trajectory which passes through the solution space \mathbf{X} . Before its parallelization, let us formally describe this class of methods.

The well-known local optimization procedure begins with an initial solution x^0 . In each iteration for the current solution x^i the neighborhood $N(x^i)$ is determined. Next, from the neighborhood the best element $x^{i+1} \in N(x^i)$ is chosen (i.e., with the best cost function value $F(x^{i+1})$) constituting the current solution in the next iteration. The method is exhaustive. An outline of the local search method is presented in Figure 3. The method generates a solutions sequence $x^0, x^1, x^2, \dots, x^s$ such that $x^{i+1} \in N(x^i)$. We called this sequence a *trajectory*. The problem (2.1) can be replaced by

$$F(x^A) = \min_{x \in \mathbf{Y}} F(x),$$

where

$$\mathbf{Y} = \{x^0, x^1, x^2, \dots, x^s\} \subseteq \mathbf{X}.$$

We call the mechanism of a neighbor generation a *move*. More precisely, the move μ is a function $\mu: \mathbf{X} \rightarrow \mathbf{X}$ which generates solutions $\mu(x^i) = x^{i+1} \in N(x^i) \subseteq \mathbf{X}$ from a solution $x^i \in \mathbf{X}$.

A crucial ingredient of the local search algorithm is the definition of the neighborhood function in combination with the solution representation. It is obvious that the choice of a good neighborhood is one of the key factors ensuring efficiency of the neighborhood search method. A neighborhood $N(x)$ is defined as a subset $N(x) \subset X$ of solutions ‘close to’ a solution $x \in X$. A metric of the ‘nearness’ can be a distance metric in this solution space (e.g. Hamming’s or Caley’s), or the number of moves.

Parallel local search strategies. Generally, several approaches to convert LSM to parallel LSM (p-LMS) can be formulated:

1. calculating $F(x)$ faster for a given $x \in X$,
2. making a choice of $x^{i+1} \in N(x^i)$ faster,
3. making a space decomposition among p searching threads, i.e.,

$$F(x^A) = \min_{1 \leq k \leq p} F(x^{Ak})$$

where

$$F(x^{Ak}) = \min_{x \in Y^k} F(x), Y^k = \{x^{0k}, x^{1k}, \dots, x^{sk}\}.$$

4. using cooperative trajectories.

Alba [1] proposed the following classification:

- *Parallel multi-start model.* In this model several local search processes are executed concurrently, each one starting from the different solution. Either homogeneous or heterogeneous version of this model can be applied. They can be based on the same searching strategy, or have different strategies. Multiple working searching processes can also start from the same starting point, but with different searching strategies (e.g. with different parameters). Simple classification of such algorithms on the tabu search metaheuristic example was proposed by Voss in [28]. This model belongs to the multiple-walk parallelization class.
- *Parallel moves model.* This is a low-level parallelization model which consists in neighborhoods concurrent searching. The main metaheuristic which uses this kind of parallelism, computes the same results as the sequential version but faster. Each

processor evaluates a part of neighborhood preparing the best element (so-called representative) as the proposition for the controlling processor which chooses the best solution from all representatives. This model is usually implemented as a master-slave model of parallelization, yet it can be developed both as the single-walk method and the multiple-walk parallelization (i.e., inside a hybrid method as a low level parallelism).

- *Move acceleration model.* The goal function value is calculated in a parallel way in this model. Such a parallelization is problem-oriented and strongly dependent on the goal function form. For example, it is difficult or even impossible to parallelize the function which has a recurrent form. Usually loops, minimum or sum calculations, are parallelized in this model. Because of the input-output intensity that kind of parallelism needs a shared-memory fine-grained parallel environments such as multi-processor mainframe computers or GPUs. Similarly to the previous (parallel moves) model it can be developed both as the single-walk method and as the multiple-walk parallelization.

Most survey works consider only parallel multi-start model of parallel local search metaheuristics, see [Alba, Ba, Bo, CrGe, Kn, Ta]. This is due to the difficulty of designing parallel moves and move acceleration models which are strongly dependent on the optimization problem formulation (see Bożejko [9] and Steinhöfel et al. [26]). This parallelization also needs to take advantage of the special properties of the optimization approach, i.e., neighborhood determination method, cost function calculation and methods of calculations distribution among processors.

Here we propose an *extension* of Alba taxonomy of parallel local search methods by including (at least) the following additional model:

- *Parallel tree-based model.* In this model, local search processes are concurrently executed; each one starting from the solution found by another process, i.e., as soon as its best solution is found. The most frequent approaches are: the blackboard broadcasting method using shared memory, and the master-slave model in which the master process is controlling the whole searching process and local search threads are executed on slave processors.

CONCLUSIONS

We present a survey of modern multithreaded (parallel and distributed) approaches of solving hard problems of discrete optimization, especially in the field of scheduling and logistics. Parallel machines architecture and programming environment was presented. We propose a new extended taxonomy of parallel local search strategies used by parallel and distribute metaheuristics approximate algorithms.

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Emerging Technologies for Traceability Platforms Design

by

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ABSTRACT

In the last decades, traceability proved its capability by bringing multiple advantages and improving different business processes from various fields. Nowadays, traceability is viewed as a needed strategic service in any production context. This paper describes some technologies that could emerge for new track and trace platforms development, as a response to recent business challenges.

Keywords: Traceability, eBusiness, Internet of Things, RFID, Multi agent systems

INTRODUCTION

E-business, as mentioned in the e-Business Watch Report constitutes an essential lever in facing issues such as traceability, logistics, and a series of internal processes. If we consider the case of chain traceability, according to the ISO 9001:2000 standard, chain traceability is the ability to trace the history, application or location of an entity by means of recorded identifications throughout the entire supply chain. Traceability is viewed as a needed strategic service in any production context. In recent years various organizations, businesses, end users and authorities in various markets around the world, have recognized the many potential benefits of traceability process. Thus, tracking and tracing individual entities (people, animal or objects) proves to be a very important feature, essential to many applications in various domains, like, elderly and patient care, supply chain applications, logistics, asset management, counterfeit detection, and product recalls. Still, there is a need to take down the barriers that impede the efficient and error-free traceability, such as the non-homogeneous information kept at various traceability partners.

Radio Frequency Identification (RFID) technology is a wireless technology that allows the precise and automatic identification and localization of individual entities (objects, people and animals). This paper proposes the use of RFID technology for implementing the traceability of various entities. The justification relies on some of the main characteristics and functionalities of the RFID systems. Thus, by attaching radio frequency tags to different

entities (people and objects), RFID technology can provide the identification, tracking, locating, and the security, but also other features for various entities, by attaching radio frequency tags to these entities (people and objects). In fact, researchers consider that this technology has the potential of bridging “the growing gap between the digital networked world and the physical world” [1].

The traceability process is characterized by shared and distributed data and requires the communication flow of complex and disparate forms of information between various information systems of traceability partners or/and other settings. But, currently, in the systems of various organisations, the same information can be represented in many ways. There are no standards regarding either the internal organisation of the trading partner or the technology. And now, more than ever, due to the current economic crisis, consumers need to use systems which are cost-effective and do not fall into obsolescence. Developing a software multi-agent system that integrates with existing information systems of the traceability partners will support complex traceability queries or cross-organizational query processing.

This paper proposes an RFID-based traceability platform, named COHERENT, Comprehensive RFID-based Traceability Platform for the Internet of Things. The proposed platform will not substitute the existing information systems. Instead of trying to integrate the applications of traceability partners we accept their existence as autonomous entities, and take into consideration a holistic approach that addresses important aspects of the traceability process. Thus, this platform will focus on the interoperable traceability of the exchange of information among partners. Thereby it will prove to be a viable solution for the reduction of costs involved in acquiring infrastructure components of partner information systems and services. Also, it will contribute to improving the quality of products and to reducing costs.

The reminder of this paper is structured as follows: the first section gives a brief introduction to the RFID technology and Internet of Things concept. The next section summarizes the state of the art on the aforementioned topics. Section 4 presents a traceability solution that offers a holistic approach to Internet of Things. The paper ends with conclusions.

ENABLING TECHNOLOGIES

RFID Technology

Radio Frequency Identification technology (RFID) is an Automatic Identification and Data Capture (AIDC) wireless technology that allows the precise and automatic identification and locating of individual entities (objects, people and animals).

The basic RFID system architecture has two components: contactless electronic tags and an RFID reader. The RFID tag is used to store unique identification data and other specific information whereas the RFID reader allows the reading and writing of these tags. Tags fall into three categories: active (battery-powered), passive (the reader signal is used for activation) or semi-passive (battery-assisted, activated by a signal from the reader). An RFID tag is attached to or embedded in the individual that is to be identified, thus allowing identification, tracking, locating, etc. Moreover, by combining RFID with sensor technology, the number of applications increases tremendously. For example, contactless RFID technology could be used to monitor various physical conditions during the production process or shipping of goods.

This paper proposes the use of RFID technology for the traceability of entities, justified by some of the main characteristics and functionalities of RFID systems: (1) Achieving low costs and power efficiency; (2) Non-contact and non line-of-sight functionalities that allow data access in harsh environments and through various substances; (3) Allowing data storage on RFID tags; (4) Allowing the integration of RFID with sensor technology.

RFID systems require software, network and database components that enable the information flow from tags to the information infrastructure of an organization, where the information is processed and stored. The systems are application-specific [21].

RFID technology is viewed as a key enabler for the Internet of Things concept. Next, we present a multi-agent background.

Multi-agent systems

Currently, there are numerous agent definitions, but one of the most comprehensive definitions of agents is the one provided by Wooldridge and Jennings (1995). They define an agent as “a hardware or (more usually) a software-based computer system that enjoys the following properties: autonomy - agents operate without the direct intervention of humans or others, and have some kind of control over their actions and internal state; social ability - agents interact with other agents (and possibly humans) via some kind of agent-communication language; reactivity: agents perceive their environment and respond in a timely fashion to changes that occur in it; pro-activeness: agents do not simply act in response to their environment, they are able to exhibit goal-directed behaviour by taking initiative” [26]. We consider an agent as a software component that has a well-defined role in the operation of a system. Also, an agent must have the ability to communicate with other

agents or human users. A multi-agent system is a collection of such entities that cooperate with each other. The multi-agent systems include independent components that communicate in a reactive way, some of them can be instantiated and removed dynamically on demand. By using the multi-agent technology in the system implementation, the following advantages could be obtained [25]:

- *High performance*: agents can run in parallel. They can be cloned when their tasks and goals are very important;
- *High flexibility*: an agent can be developed for any context, providing the interface for different ontologies;
- *High modularity*: the number of connected sources can increase practically without limit.

Thus, developing a software multi-agent system that integrates with existing information systems of traceability partners could offer many advantages, like: scalability, intelligence, systematic management, logging of the information flows, and efficient interaction of users with the information system.

The Internet of Things (IoT) infrastructure will allow connections between different entities (i.e., human beings, wireless sensors, etc.), using different but interoperable communication protocols and makes a dynamic multimodal/ heterogeneous network. In this infrastructure, these different entities have the ability to discover and explore one another, gather, provide or transmit information that we can use to implement the traceability process. Next section presents some considerations about this new Internet of Things concept.

Internet of Things

In the Internet of Things concept the term "thing" can refer to people, objects (e.g., product, sensor, machine, etc.) and information. At the present moment, there are various definitions of "Internet of Things" and they vary depending on the context, the effects and the views of the person giving the definition. Thus, from a things-oriented and Internet-oriented perspective, the Internet of Things is viewed as "a world where things can automatically communicate to computers and each other providing services to the benefit of the human kind" [22]. According to [23], Internet of Things is viewed in a semantic-oriented perspective as "a world-wide network of interconnected objects uniquely addressable, based on standard communication protocols". Most of the definitions of the Internet of Things have much in common, such as [24]:

- the ubiquitous nature of connectivity,
- the global identification of every thing,
- the ability of each thing to send and receive data across the Internet or across the private network they are connected into.

According to the identified research agenda for the Internet of Things [2], further research is needed in the development, convergence, and interoperability of technologies for identification and authentication that can operate at a global scale. Also, there is a need for an open architecture to maximise interoperability among heterogeneous systems and distributed resources including providers and consumers of information and services, whether they are human beings, software, smart objects or devices [2].

STATE OF THE ART

Food safety, product tracing, and product recalls are currently at the forefront of both government regulations and industry concerns around the world [4]. For instance, in the U.S. food-borne pathogens are estimated to cause 76 million illnesses and 5,000 deaths each year and societal costs are estimated between \$2.9 and \$6.7 billion per year [5]. Due to the recent high incidence of recalls in the food supply chain, government agencies and industry groups focus on the issues of traceability and food safety [20].

Traceability systems should be able to store minimum information related to a particular entity (usually a product) and show the route of this entity along all partner organisations (e.g., along the whole supply chain from the supplier to the retailer and distributor and finally to the customer). Throughout this process, secure, reliable and automatic product identification is crucial for providing effective and efficient traceability. In the past, barcode technology has been used for the identification of products. But these barcode-based systems do not meet the current traceability requirements pronounced by the current governments. Thereby, a new technology that allows automated recording of information is needed. To this extent, researchers propose various solutions and among them the RFID technology.

The radio frequency identification technology enables the association of some easily-accessible data to a specific entity (e.g., person, product). Thus, using RFID tags, a product for example might become an information-storing and processing item, named a smart product. Then, this smart product can be connected to the enterprise information system, or even to the global network, constituting thus an Internet of Things as integrated part of the

Future Internet. But the large-scale adoption of RFID-based traceability solutions is delayed due to technical, social and educational constraints. Because the existing solutions are mostly centralised and closed-loop, they are only effective in small-scale RFID tracking applications. As a result, to facilitate trade today, some researchers suggest the implementation of international standards and ensure the interoperability of the traceability systems. We propose a comprehensive platform as an easy to use solution to enable accessing traceability data efficiently and effectively across independent organisations (e.g., enterprises) in the Future Internet.

As a part of the future trends and developments the emerging Internet of Things and Future Internet will shape the world and the society. In order to reply to this challenge, the Future Internet has become the main focus of several research and development initiatives all over the world, from EU to Japan, and from USA to China and Korea. For example, European Commission's Framework Programme 8 (FP8) presents the research community's perspective of the Future Internet Assembly (FIA) on the priorities for Future Internet research. The Cluster of European Research Projects on the Internet of Things (CERP-IoT) developed in 2009 its Strategic Research Agenda (SRA). Also, Future Internet Research and Experimentation – FIRE, CALL 8, Objective 1.6. could be mentioned here.

On a worldwide level, one element that is increasing exponentially the diffusion of RFID in the automate logistics processes is the asserting of some international standards related to goods traceability, such as EPCglobal ([10]-[12]), GS1 (Global Standard 1) ([3], [4]) and ebXML (Electronic Business using extensible Markup Language) ([6]). The EPCglobal consortium, mainly represented by the GS1 organization, defines the standards for developing a universal identification system and an open architecture, able to guarantee interoperability and data sharing in a complex multi-vendors scenario. It proposes the Electronic Product Code (EPC) for uniquely identifying each item. The EPCglobal consortium proposes the EPCglobal network architecture as a computer network used to share product data between trading partners. In order to ensure the traceability, this architecture is composed of a set of standards for hardware devices (e.g., reader), software systems, network services, and data interfaces. Although, the use of these technologies promises many benefits, today's RFID and EPC adoption and deployment in the healthcare [3] and pharmaceutical sectors is still limited due to open issues, such as [13]: (i) hardware technology current weaknesses [14], [15] (e.g., data reliability, read rate in critical conditions, lack of unified standard for interoperability), (ii) software weakness (e.g., scalability, single-

point of failure, integration with information systems), (iii) relatively high costs related to tags, software customization and systems integration, (iv) security issues [16], (v) lack of scientific literature on the evaluation of potential effects of RFID exposure on molecular structure and potency of drugs [17]-[19].

Agent technology is increasingly contributing to the development of value-added information systems for large organizations. Thus, developing a software multi-agent system that integrates with an existing information system could offer many advantages, like: scalability, intelligence, systematic management, logging of the information flows, efficient interaction of users with the information system. Also, a multi-agent system could be a time, cost and human effort-saving tool.

Worldwide, there are some multi-agent approaches to the traceability and supply chain issues. Thus, the multi agent system for optimal supply chain management developed by Choi et al. [7] is a multi-agent system based on the scheduling algorithm, a cooperative scheduling methodology which enables the formation and management of an optimal supply chain. By means of active communications among internal agents, a multi-agent system for optimal supply chain management makes it possible to quickly respond to the changes in the production environment such as machine failure, outage of outsourcing companies or the delivery delay of suppliers.

Al-zu'bi proposes MASSCM, a Multi-Agent System (MAS), in order to support the Electronic Supply Chain Management (E-SCM). The proposed model consists in a set of agents that are working together to maintain supplying, manufacturing, inventory and distributing. The main operations of the software agents include: (1) receiving information from customer orders (2) checking the inventory (3) making the production schedule (4) issuing the order of raw materials from the suppliers (5) receiving the raw materials (6) production (7) delivering products to the customer [8].

Charfeddine et al. [9] choose the multi-agent methodology for the design and implementation of an intelligent framework for traceability of containerized goods.

Middleware for RFID applications is used in order to facilitate communication between enterprise systems and automatic identification devices. Most of the conventional existing middleware solutions are costly, non-portable and heavily dependent on the dedicated software. Also, their performances dramatically decrease once with the increase of the number of working readers. There is a need for a robust and flexible RFID-based

middleware, ensuring the interface between applications and various RFID readers. But the new technologies will help ongoing research work continue to develop solutions for traceability open issues.

Next, we propose an RFID-based traceability platform, named COHERENT, Comprehensive RFID-based Traceability Platform for the Internet of Things.

COHERENT OVERVIEW

Rather than developing new information system to change the ones already installed and in use, the COHERENT platform will implement various mechanisms to collect traceability information records and to develop the interoperability of various existing information systems. Thus, in contrast to most existing approaches which focus on specific layers, the COHERENT platform (Figure 1) offers a holistic approach to the Internet of Things, considering heterogeneous systems and distributed resources from various types of manufacturers (like, mobile phones, various dedicated devices, RFID tags, various condition sensors such as motion detection, temperature, humidity and vibration, etc.) and diverse hardware and software, specific for each device.

Here are some assumptions regarding the assuring of a global traceability process within the COHERENT platform:

- A traceable entity (a person or an object) must carry an RFID tag that assures a global and unique identification within all data sources containing information related to that entity;
- The identification carrier (RFID tag) must remain attached to the traceable entity until that entity is consumed, sold for consumption, or destroyed;
- The RFID tag must store some information in order to be linked with the data sources of the traceability partners;
- Each traceability partner must ensure internal traceability;
- A minimum amount of traceability data must be exchanged between traceability partners in order to synchronize with the physical flow of the entities;
- The RFID-tagged entity (person or moveable object) can be tracked using RFID readers.

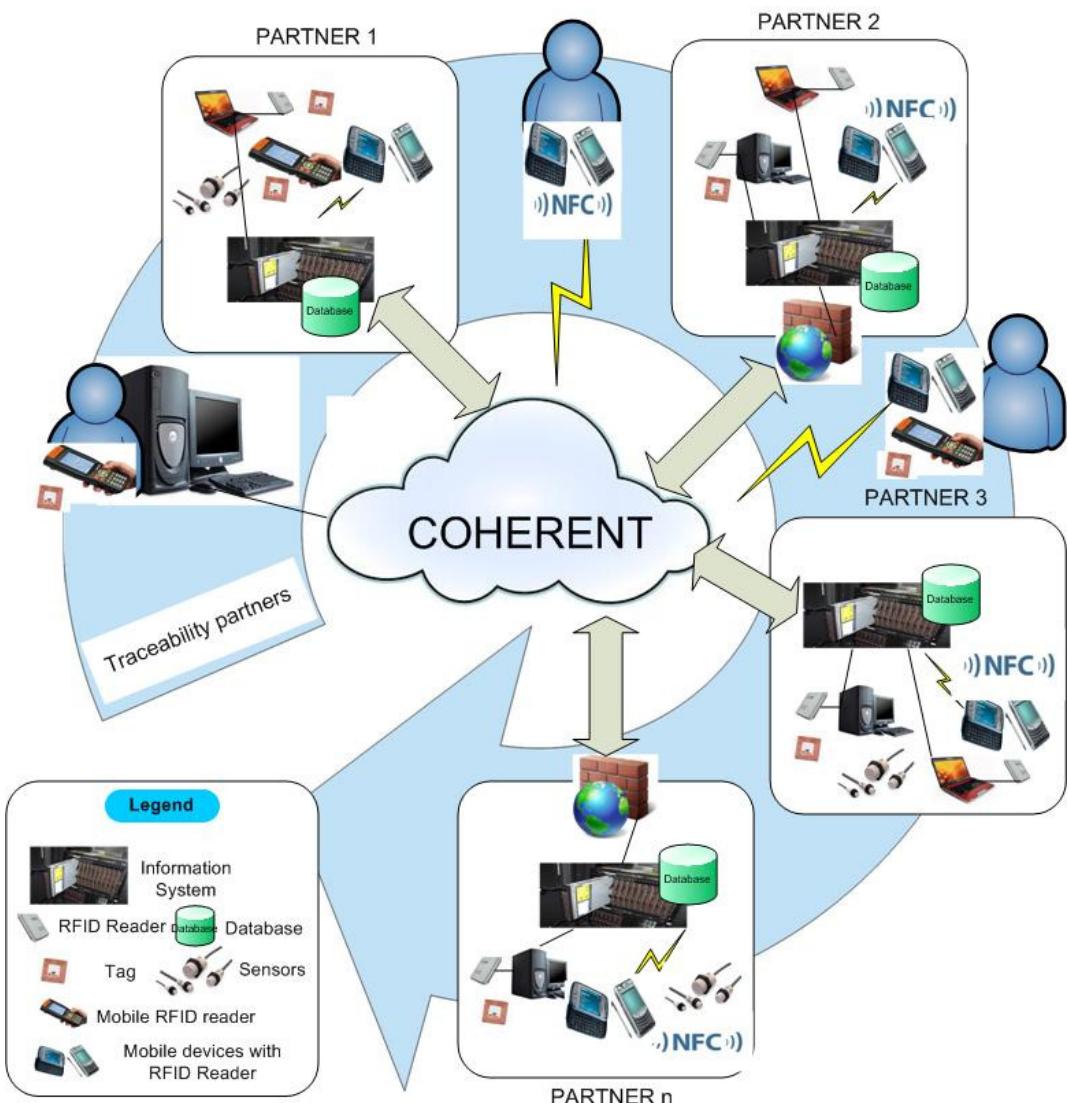


Figure 1. COHERENT platform

COHERENT platform will allow every group of traceability partners to define the desired traceability data set, necessary in order to meet their specific data requirements. Any traceability partner may request the tracing of any RFID-tagged entity. Because the traceability information is not all available internally, it must be requested from an external traceability partner. Thus, this user's request for tracing may trigger other tracing requests; the traceability query propagation is thus initialized, in order to answer traceability partner questions regarding the tagged entities.

Developing and integrating a multi-agent system will support complex traceability queries or cross-organizational query processing. Also, this multi-agent system will allow hiding data distribution across multiple databases from the applications of the traceability partners. Thus, we could define various agents, for example, to allow easy retrieval of traceability data from

different individual repositories, or to handle the semantic mediation among heterogeneous systems of traceability partners.

But traceability is not only about obtaining the information history of an entity by means of pre-recorded identifications; it also implies the localisation of an entity. Our platform will offer a solution to assure the 2D or/and 3D indoor and outdoor localisation of an RFID-tagged entity. In order to assure the localisation of an entity, we can use various devices and methods. For example, to implement the outdoor localisation, we propose using GPS and/or GSM that allows the implementation of tracking applications. Indoor localisation is more challenging, given the weak GPS signals and the high spatial accuracy required. We propose to consider an RFID-based solution, allowing the localisation of an entity based on the localisation of nearby fixed things identified in Internet of Things. A hardware device with localisation capability would offer its functionality, for example, as a web service. Thus, device integration will be seen as service integration, and the user will focus rather on the functionality of the device than on its particular technology.

Through its high-level of generality, COHERENT platform allows the specific particularisation for the identification and traceability of various physical entities in space and time. Requiring no software modifications, the platform could be used in various fields of activity. The platform will only need to be configured to the users' requirements, and will ensure high performance and flexibility. The graphic user interface will be easy to use and allow various configurations, depending on the user's preferences and necessities. Thus, the related information regarding the traceability process can be displayed in a user-friendly interface on PC and/or mobile devices (like PDA, mobile phones).

Thus, the COHERENT platform could be easily adopted by just about every traceability partner.

Since COHERENT does not substitute the existent information systems, it is a viable solution for reducing the costs involved in acquiring infrastructure components for the information system and services of traceability partners. Economically, the level of interoperable supply chain information-exchange among partners is expected to reach considerable values. By focusing on the interoperability of supply chain information systems, it will be possible to improve the product quality and reduce costs. Also, the COHERENT platform will support design and implementation solutions that approach new technologies in order to extend the operational life of software. The interactions of enterprises with COHERENT platform will

provide them with good opportunities to strengthen their abilities to survive the current worldwide economic crisis and to sustain their competitive position into the future.

CONCLUSIONS

RFID technology is gaining significant momentum for tracking and tracing individual entities. The existing solutions for entity traceability are mostly centralised and closed-loop, being only effective in small-scale RFID tracking applications. The business of today's complex organizations such as supply chain partners relies on sophisticated information systems which often inherit many weaknesses from the past.

In contrast to most existing approaches which focus on specific layers, the COHERENT platform offers a *holistic approach* to the Internet of Things, where things are heterogeneous systems and distributed resources (e.g., mobile phones, various dedicated devices, RFID tags, various condition sensors such as motion detection, temperature, humidity and vibration sensors). Therefore, the COHERENT platform could assure interoperability among heterogeneous systems and distributed resources including providers and consumers of information and services, whether they are living or non-living entities (viewed as things). Procedures of tracking and tracing individual entities (things) could have impact in many applications from different domains, like, elderly and patient care, supply chain applications, logistics, asset management, counterfeit detection, product recalls, etc.

The actual increase in international supply chain contacts and the real need to exchange product-related information among partners (even in cross-border contexts), pave the way towards the implementation of such systems in the field of supply chains.

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Memetic algorithm approach for multi-criteria network scheduling

by

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ABSTRACT

In the era of Internet-based services and cloud computing the nature of Web services is evolving. Instead of resource-retrieval, which takes a few milliseconds, the clients' requests may contain a considerable amount of data and require minutes or even hours to perform all necessary computations and to produce a proper response. This is also true in the case of server farms or computer clusters that use a single dispatcher or a load-balancer to control the access to back-end servers. However, with such high computation time and increase in clients' requirements regarding the Quality of Service, it is possible to use more sophisticated methods of dispatching the clients' requests and meeting various service criteria. We use the online version of enhanced Local Search Elitist Non-dominated Sorting Genetic Algorithm (or LSNSGA-II) for multi-criteria scheduling of incoming requests and compare it with other approaches to load-balancing including Round Robin, Shortest Job First and Earliest Deadline First implementations.

Keywords:

Multi-criteria network scheduling, load balancing, memetic algorithms, Pareto efficiency, quality of service.

INTRODUCTION

In the era of Internet-based services and cloud computing more and more tasks that previously had to be performed on a local machine can now be done remotely. The users of such services no longer require any specialized equipment or software on their own. Client software and network connection is all that is needed to access particular service and perform required task or computation on a remote server. Moreover, a single service is often

implemented by a set of identical back-end servers. In order to manage multiple requests certain algorithms are used to assign requests to specific back-end servers. In case of classic requests (*e.g.* HTTP site request) the time is crucial, so simple and fast algorithms (Round Robin, for example) are used to choose back-end machine that will fulfill a given request. Those approaches perform load balancing by distributing the requests equally among available servers and by meeting Quality of Service, most commonly understood in terms of computer network conditions, like latency time or throughput.

In this paper we tried a different approach. We consider special class of requests and services, where time needed to produce a response is long enough, that more sophisticated and time-consuming methods – like genetic or memetic algorithms – can be used to schedule incoming requests. We also consider Quality of Service on a higher level: both service users and service providers may specify several criteria (like response time for the users, completion time for the providers and tardiness for both) they would prefer to optimize. Therefore we use a memetic algorithm for multi-criteria network scheduling and compare the results against a few fast and simple constructive algorithms. The remainder of this paper is organized as follows. In Section 2 we present a short overview of the problem of network scheduling and load-balancing in its classic meaning, and then, in Section 3, we focus on our approach to multi-criteria network scheduling of time-consuming tasks. In section 4 we describe our memetic algorithm used for network scheduling and its background. Section 5 contains results of comparison research of our algorithm and several constructive algorithms. Finally, Section 6 presents the conclusions and the summary of the paper.

CLASSIC NETWORK SCHEDULING

In classic network scheduling a single Internet service is most commonly implemented as a set of back-end servers that are either identical or differ in terms of performance (*i.e.* the time needed to produce response for a given request), typically in the form of a server farm. Commonly, requests are relatively short and simple, and can be handled by any of the back-end servers. In this case, the requests are dispatched as soon as they arrive in the system and fast algorithms like Least Busy Machine or Round Robin are used to divide the work equally amongst the servers, thus implementing basic load-balancing. This allows to reduce the number of overloaded or idle machines (and, in result, the power usage), the average time needed to produce a response and balance the transfer in computer network itself. This, in turn, is observed by the client and determines whether certain Quality of Service (QoS) conditions have been met. Unfortunately, the desired level of QoS is rarely specified by the

client and mostly remains as a low-level parameter of the computer network connection. However, other quality factors, like Quality of Experience or Quality of Service, exist and can be used to measure quality on a higher level.

When discussing the problems of request dispatching and load-balancing it is important to consider the place in the system where above tasks will be performed. Cardellini *et al.* [1] distinguish four different types of request dispatching:

1. Client-based. In this approach clients themselves are able to choose the server they want to send requests to. It also includes proxy servers, which can store past responses. This approach has limited applications and lacks scalability.
2. DNS-based. This situation typically involves mapping single URL to several different Internet Addresses (IPs), each on different machine, through the use of Domain Name Service. This approach is a low-level solution, however, the back-end servers remain transparent to the outside world and the users.
3. Dispatcher-based. In this case all client-server routing is managed by single centralized network component. It allows much higher level of control, but can lead to performance problems, when network packets are overwritten with the address of the actual back-end server. Decentralization may also cause a bottleneck, since the dispatcher is the only component with knowledge of back-end servers and all requests must pass through it.
4. Server-side. In this approach servers themselves have the ability to dispatch tasks and perform load-balancing. Initially, the request is send to one of the back-end servers by the use of one of the previous approaches. The difference is: the chosen server may decide to redirect the task to another server. This means that the server-side approach is an example of a distributed system, where back-end servers have knowledge about other servers and may cooperate to solve tasks.

The first and second approach lack in scalability or control, so we will not consider them any further in this paper. The fourth approach requires more consideration. Distributed systems, where the tasks may migrate between different nodes are quite common and perform tasks dispatching in various ways. Some approaches (see [2] for example) assume that the nodes are cooperating, so an overloaded node can pass some of its tasks to another one. When no such “helper” node is available, special centralized nodes are used as temporary load-balancers. Other solutions force the nodes to compete with each other. In the case of

approach presented in [3], each node has a limited budget and tries to obtain tasks by buying them (similar to a real-life auction). In this way tasks can change nodes, but they must return to the initial node in the end. The nodes are concerned only with their own benefit, but this, in turn, results in better performance on the whole system.

In this paper we focus on the last of the mentioned types of request dispatching where all load-balancing and scheduling is done by single dedicated network component (or more generally, one such component for every back-end servers group), which simplifies the problem. In this case some approaches exist as well. For example Cheng *et al.* in [4] tried to balance the load and meet QoS conditions (namely average bandwidth and latency) by using software adaptation mechanisms. Changes in the system's parameters are detected and the certain adaptation actions are carried out. These actions include: starting-up new servers, shutting down idle servers and switching users to another server group. This allows to increase the chosen parameters of QoS without the need to interfere directly with the process of dispatching tasks. Aside from that, there are some approaches that propose solutions between centralized and distributed tasks dispatching. One such example was presented in [5], where the load-balancer is seemingly centralized, but the nodes inside the network of workstation or a computer cluster can exchange data or tasks. That work also analyses the differences between centralized and distributed approach to load-balancing, as well as making distinction between global and local load-balancing, where each local group of nodes is managed by a single centralized task dispatcher.

When optimization criteria are considered, most of above solutions assume only one criterion such as: mean response time, makespan or power usage. Multi-criteria approaches are much less common, but they still appear. For example: Ben-Bassat and Borovits [6] consider two separate criteria: maximum jobs executed per unit of time and the minimum idle time per machine. They, however, consider the third criterion which is a combination of the previous ones. As another example, Garg and Singh [7] consider two conflicting criteria: execution time (makespan) and total cost of workflow execution. They consider a grid system and solve the problem using Non-dominated Sort Particle Swarm Optimization (NSPSO) approach with the choice of the final solution left to the user.

OUR APPROACH

We consider a computer system with M machines acting as back-end servers (*i.e.* nodes) and a single machine acting as a task dispatcher, which performs load-balancing and scheduling.

The back-end servers cannot exchange data between themselves and each of them is connected to the dispatcher via a computer network. Next, we have a set of N tasks (requests) to be executed. We assume that the tasks are executed in batch mode (without interaction from the user). All of them arrive at the dispatcher and have to be ultimately assigned to one of the back-end servers. Each task j has: arrive time A_j (*i.e.* time at which the task arrive in the system, and the earliest time it can be dispatched and the execution started), deadline time D_j (*i.e.* the latest time the task should be completed without penalty) and execution time E_j (*i.e.* the time needed to complete the task). The back-end servers are identical, meaning each task can be executed on any server, the execution time is not dependent on the machine in our case. We also assume that the tasks cannot be suspended (with the exception described below), restarted or switched to another machine.

Arrive and deadline times are easily established, but the execution time is harder to determine. Not many tasks have predictable execution time, so we assume that task with unknown execution time are given some time to finish (depending on the priority for example). If they are not completed by that time, they are suspended and scheduled once again later on. We also assume that the time needed to transfer the task's data to the back-end server and the response back to dispatcher is included in the task's execution time.

C_j is the time when the task j completes (*i.e.* it is send back to the client as response). $P_j = \max(0, C_j - D_j)$ is the penalty of the task j , while $R_j = C_j - A_j$ is its response time. We also assume $L_j=1$ when tasks j is late (*i.e.* $P_j > 0$) and $L_j=0$ otherwise. Then we consider minimizing the following criteria:

1. Mean penalty of all tasks: $\frac{1}{N} \sum_{i=1}^N P_j \leq \text{min}$.
2. Mean response of all tasks: $\frac{1}{N} \sum_{i=1}^N R_j \leq \text{min}$.
3. Makespan (*i.e.* maximal completion time of all tasks): $\max C_j \leq \text{min}$.
4. Number of late tasks: $\sum_{i=1}^N L_j \leq \text{min}$.
5. Maximal penalty: $\max P_j \leq \text{min}$.
6. Maximal response time: $\max R_j \leq \text{min}$.

These criteria are high-level (compared to low-level network QoS parameters like bandwidth) and can be used to specify the requirements of end-user, as well as the system's managers. Some of the above criteria are important for the client (mean response and mean penalty for example), while others have a greater meaning for system managers (makespan, maximal and mean penalty). In our research, we use objective function combining two or three criteria and we use different sets of criteria.

The crucial assumption of our work is that the executed tasks are time-consuming, *i.e.* mean execution time of a task is high enough, so the dispatcher has enough time to perform more sophisticated scheduling algorithms. This situation does not occur when tasks consist of simple requests like HTTP website serving, so we have to perform little calculations or serve single file up to 1 MB. However, we can also consider complex engineering calculations or simulations (especially now, when many services are migrating inside computing clouds and are thus performed remotely). In that case the tasks may take minutes or hours to complete and our approach becomes applicable. Therefore, we add incoming tasks to a queue of non-dispatched tasks and wait for the moment when further dispatch delay is no longer acceptable. Then, we use a memetic algorithm based on the Local Search Elitist Non-dominated Sorting Genetic Algorithm (or LSNSGA-II) to find a schedule for all accumulated tasks.

ALGORITHM DESCRIPTION

In paper [8] Deb *et al.* suggested an Elitist Non-dominated Sorting Genetic Algorithm. Based on the non-dominated sorting GA (NSGA), it was criticized for high computational complexity of non-dominated sorting, lack of elitism and need for specifying the sharing parameter, so they modified the approach to alleviate those difficulties. By applying fast non-dominated sorting, density estimation and crowded comparison operator it allowed to lessen the computational complexity and guide the selection process of the algorithm towards a uniformly spread out Pareto-optimal front, *i.e.* Figure 1.

Fast non-dominated sorting divides solutions, obtained by current iteration of memetic algorithm into Pareto-frontiers (see Figure 2 for example) with at most $O(mN^2)$ computations. Each solution is assigned two features: (a) the number of times the solution

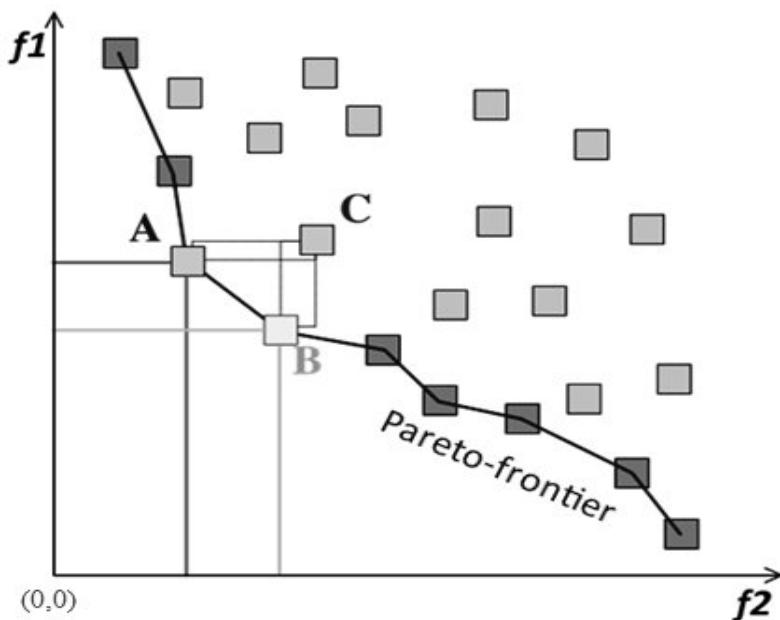


Fig. 1. – Non-dominated solutions – Pareto-frontier

was dominated (n_i) and (b) a collection of solutions dominated by the solution. To begin with, all the solutions, which were not dominated, are moved from the solution collection to the first Pareto-frontier. For each solution in the frontier, we check the set of solutions it dominates, and for each member of that set we decrease the number n_i . Now all of the new non-dominated solutions from the remaining collection are moved to the second Pareto-frontier and again we decrease number of times their members were dominated.

In order to estimate the density of solutions surrounding a particular point in its front the average distance of the two points on either side of this point along each of the objectives is taken. This quantity serves as an estimate of the size of the largest rectangle enclosing that particular point without including any other point in the population. Deb *et al.* called this the crowding distance [8]. Figure 3. shows the crowding distance of the i -th solution in its front, marked with solid circles, as the average side-length of the rectangle, which is shown with a dashed box.

The crowded comparison operator guides the selection process at the various stages of the algorithm towards a uniformly spread out Pareto-optimal front [8]. That is, between two solutions with differing non-domination ranks it is preferred to take the point with the lower rank. Otherwise, if both points belong to the same front, then we prefer the point which is located in a region with lesser number of points, meaning that the size of the rectangle inclosing it is larger.

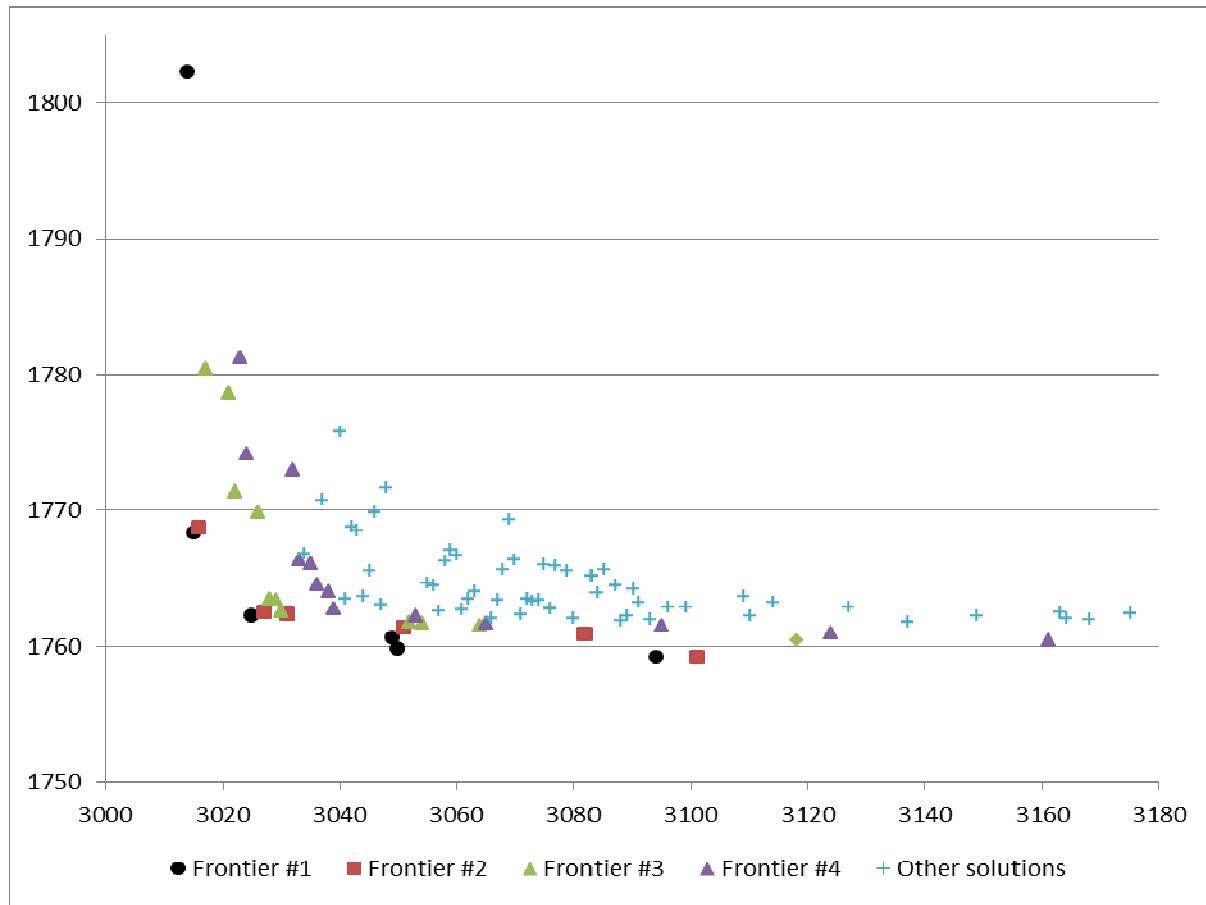


Fig. 2. – Sample of Pareto-frontiers from production scheduling

While developing our memetic algorithm, we decided to use fast non-dominated sorting, in order to decrease computational complexity. We also used the sum of standardized criteria values as an order evaluator in each frontier, which allowed us to select one multi-criteria solution without involving a decision maker or analyzing previously made decisions. This way we eliminated additional computational time needed to provide a solution. Each solution represents a number of job sets equal to the number of nodes, and is submitted to genetic operations, *i.e.* mutation, crossover and selection. We used a partially matched crossover (PMX) scheme and swap functions for mutation purposes [9]. Additionally we used tournament selection on randomized solutions list. Fitness value is based on frontier number, the lower the better, and standardized criteria values.

Diversified job sets, delivered by operators of genetic algorithm, are not scheduled and do not provide us with optimal solutions. Consequently, for each solution in offspring population the constructional algorithm is performed on every job set, one per node, in order to enhance the offspring. It uses a set of jobs assigned to a node and constructs a schedule

from scratch minimizing (maximizing) criteria functions values. We based that method on the idea of job insertions [10]. We begin with inserting jobs with the lowest deadline or the highest job processing time value. Each job is inserted into all available positions in partial schedule and the one with lowest criteria value is selected [11], then other jobs are fitted into schedule until there are no unassigned jobs left.

In order to enhance the performance of our algorithm, four constructional solutions of the algorithm are inserted into initial population. This way, our algorithm cannot perform worse than other known algorithms and is guided towards good solutions from the beginning. It means that we can perform less iterations of the algorithm and still work well. We prepared the algorithm to be flexible, and the population size, as well as the number of iterations, can be increased or decreased in order to accordingly provide better solutions with higher probability or speed up the algorithm if needed.

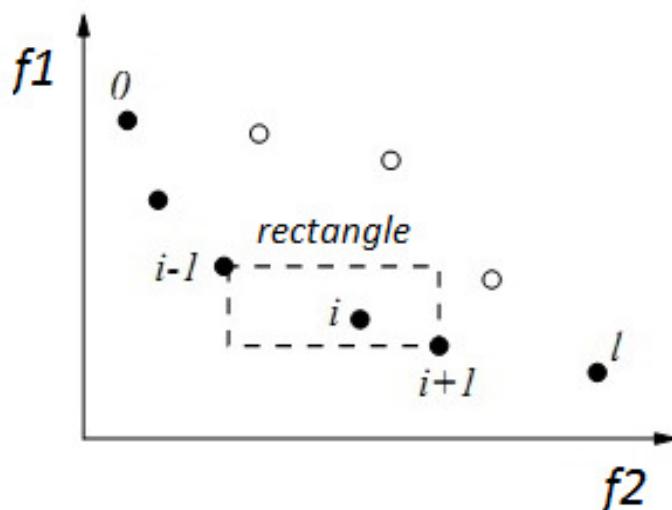


Fig. 3. – Crowding distance calculation

Our algorithm works on-line, but unless there are at least few jobs in the awaiting list, it does not start the memetic part and only distributes jobs between unoccupied nodes. Subsequently, it is an offline algorithm applied to specific online scheduling problem. When it is actuated, it works with constraints of partially occupied nodes and takes their busy time into consideration while computing criteria values. During tests, for each problem instance, the algorithm had run multiple times for different subsets of calculated jobs, added to the buffer throughout the work time of nodes.

RESEARCH

We compared the results of our memetic algorithm (MA) with the solutions supplied by four constructive algorithms:

1. Round Robin (RR). Dispatches the task as soon as it arrives, assigning it to the next machine on the list (when there are no more machines, the machine counts goes back to the first machine).
2. Least Busy Machine (LBM). Dispatches the task as soon as it arrives, assigning it to the least busy machine. In our case, it means that the machine that has the lowest estimated completion time of all machines.
3. Shortest Job First (SJF). Adds incoming tasks to the task list when they arrive. Dispatches all accumulated tasks only when there are empty machines. It sorts the list of tasks by their execution time in ascending order, so the shortest tasks are dispatched first. Then the SJF algorithm assigns each task along the list to the least busy machine at the time.
4. Earliest Deadline First (EDF). Works exactly like the SJF algorithm, but sorts the tasks according to their deadline time, so the most important tasks are dispatched first.

In order to compare the quality of the solutions supplied by the algorithms, we consider following methodology. Let us consider the problem instance I (a set of tasks). First for each algorithm A_i we calculate two numbers: $B[A_i]$ and $W[A_i]$ as follows:

$$B[A_i] \equiv \sum_{j=1}^J \sum_{c=1}^C d[A_i, A_j, c] \quad (1)$$

$$W[A_i] \equiv \sum_{j=1}^J \sum_{c=1}^C d[A_j, A_i, c] \quad (2)$$

where:

- C is the number of criteria considered,
- J is the number of algorithms (since we compare 5 algorithms, it is always equal to 5),
- $d[A_i, A_j, c] \equiv 1$ when algorithm i is better than algorithm j over the criterion c (*i.e.* $A_i \sqsubset A_j \sqsubset c$) and $d[A_i, A_j, c] \equiv 0$ otherwise.

In short: $B \llbracket A_i \rrbracket$ denotes how many times a given algorithm was better than other algorithms (according to the given criterion) and $W \llbracket A_i \rrbracket$ denotes how many times the same algorithm was worse than other algorithms. Now we calculate $Q \llbracket A_i \rrbracket = B \llbracket A_i \rrbracket - W \llbracket A_i \rrbracket$. Thus, for a given instance I we end with single quality parameter $Q \llbracket A_i \rrbracket$ for each tested algorithm.

We construct our instances as follows: arrive time A_j of task j is generated randomly using the normal distribution approximation from the Box-Muller transform. Moreover, $A_j \in [0, f \cdot N]$, where N is the number of tasks and coefficient f is in range $[0.8, 1.2]$. Execution time E_j is generated randomly using the uniform distribution. E_j is in range $[10, 50]$. Deadline time $D_j = A_j + k \cdot E_j$, where k is generated randomly from uniform distribution in range $[1.1, 1.4]$. We considered instances with 20, 50, 100 and 200 tasks (*i.e.* the number of tasks that are accumulated and dispatched at once). The number of machines ranged from 5 to 15. For each such instance type we have prepared 10 instances. As for criteria we considered four different criteria sets:

1. Mean penalty \bar{P} and mean response \bar{R} .
2. Mean response \bar{R} and maximal completion time $\max C_j$.
3. Maximal penalty $\max P_j$ and mean response \bar{R} .
4. Maximal response $\max R_j$, number of late tasks L and maximal completion time $\max C_j$.

For example the results of $Q \llbracket A_i \rrbracket$ parameter research in the case of 10 instances with 50 tasks and 5 machines with the last criteria set (maximal response, number of late tasks and maximal completion time) are shown in Table 1.

Table 1. – $\mathcal{Q}[\mathbb{A}_i]$ results for instances with 50 tasks and 5 machines

Algorithm	RR	LBM	SJF	EDF	MA
Instance 1	0	-6	0	3	3
Instance 2	1	-9	2	3	3
Instance 3	-4	4	-4	2	2
Instance 4	-11	5	3	0	3
Instance 5	-11	-3	5	4	5
Instance 6	-11	-1	6	0	6
Instance 7	-2	3	0	-4	3
Instance 8	-11	-3	5	4	5
Instance 9	-8	3	4	-3	4
Instance 10	-2	3	0	-4	3
Total	-59	-4	21	5	37

The results show that constructive algorithms are unreliable when multiple criteria are specified, as the number of times an algorithm dominates other algorithms or is dominated by them changes abruptly with instance, even though all instances are of the same category. However, there are criteria sets (like mean response and mean penalty set) when one constructive algorithm is visibly dominating the other constructive ones. Above table also shows the summary of each algorithm and that our memetic algorithm is the most successful in generating non-dominated solutions.

Next we present the research of $\mathcal{Q}[\mathbb{A}_i]$ parameter in relation to the instance category and criteria set. Results are shown in Tables 2 and 3. First we consider different criteria sets (Table 2). In all cases, the Round Robin algorithm appears to be a poor choice and is easily dominated by other algorithms. Looking at the first criteria set (*i.e.* mean penalty and mean response), it seems that Shortest Job First is performing well and outclasses both Earliest Deadline First and Least Busy Machine algorithms. However, each subsequent criteria set proves, that EDF and LBM are dominated less and less often, and, finally, when 3 criteria are specified, they even manage to generate solutions of quality equal to SJF algorithm. That is because constructive algorithms lack the explicit definition of objective function, and

Table 2. – Summarized $\mathcal{Q}[\mathbb{A}_i]$ results for all instances in relation to criteria set.

Algorithm	RR	LBM	SJF	EDF	MA
Set 1	-366	-170	270	-32	298
Set 2	-355	-59	229	-39	224
Set 3	-276	-12	64	78	146
Set 4	-307	59	61	60	127

thus, lose their reliability when multiple criteria are specified. Our memetic algorithm, however, has no such weakness and easily outclasses all constructive algorithms. The only exception is the SJF algorithm, which is dominated less often. In the case of the second criteria set (*i.e.* mean response and max completion) the SJF algorithm seems to dominate over MA. This rare situation can occur when MA improves one criterion (so it is better than other 4 algorithms on this criterion), but in the process worsens the other one so much, that it becomes worse than all 4 algorithms. In result the $\mathcal{Q}[MA] \equiv 0$. On the other hand, SJF is better than 3 algorithms on the first criterion, while it loses only to MA on the second criterion, thus $\mathcal{Q}[SJF] \equiv 2$. In result SJF has better $\mathcal{Q}[\mathbb{A}_i]$, even though our algorithm has better total objective function value.

Table 3. – Summarized $\mathcal{Q}[\mathbb{A}_i]$ results for all instances in relation to instance category.

Algorithm	RR	LBM	SJF	EDF	MA
20 tasks, 5 machines	-216	-69	134	-8	159
50 tasks, 5 machines	-277	-80	141	35	181
100 tasks, 5 machines	-270	-8	116	22	140
100 tasks, 10 machines	-266	-32	151	-21	168
200 tasks, 15 machines	-275	7	82	39	147
Total	-1304	-182	581	67	795

In Table 3 we present the values of $\mathcal{Q}[\mathbb{A}_i]$ parameter in relation to different instance categories. This time all criteria sets are summarized, showing that MA is the most successful

at dominating other algorithms, surpassing SJF by at least 10% and over 30% on average. We also notice, that when our 4 criteria sets are considered, the algorithms can be ordered by their total $Q \lceil A_i \rceil$ value with MA being the best (but most complex) algorithm and RR being the worst, but simplest solution. Moreover, the order of algorithms remains constant in relation to the instance category.

CONCLUSIONS

In this paper we presented our approach to multi-criteria network scheduling of time-consuming tasks with the criteria specified by the end-user (as part of Quality of Service) or by the system managers. We used memetic algorithm based on the Local Search Elitist Non-dominated Sorting Genetic Algorithm and compared it to four known constructive algorithms in terms of their ability to generate non-dominated solutions. The results prove that our algorithm is significantly better than the SJF algorithm and easily outclasses other algorithms. The main advantages of our approach are: (a) explicit objective function, (b) use of constructive algorithms for the creation of the initial population, and (c) great flexibility. Our MA algorithm can be easily modified to use different crossover and mutation operators, as well as different methods of selection. Adding support for weighted criteria is also possible. The size of the population or the number of iterations can be changed depending on the amount of time left for scheduling. Even when the time runs out, the algorithm can be stopped and the results of the last iteration can be used to obtain solutions. Finally, the solutions obtained are always at least as good as the solutions provided by the constructive algorithms and they can be often improved. However, the level of improvement depends heavily on the chosen criteria and the tasks set's parameters (*i.e.* the profile of the tasks), so the efficiency of our approach will change with different systems and needs of the users.

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Scheduling problem with uncertain parameters

by

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ABSTRACT

In the paper we consider a *strong NP-hard* single-machine scheduling problem with deadlines and minimizing the total weight of late jobs on a single machine. Processing times are deterministic values or random variables having normal distributions. For this problem we study the tolerance to random parameter changes for solutions constructed according to tabu search metaheuristics. We also present a measure (called stability) that allows an evaluation of the algorithm based on its resistance to random parameter changes.

Keywords: scheduling, weight tardiness, normal distribution, tabu search, stability.

1. INTRODUCTION

In many applications serious difficulties occur while indicating parameters or when the data comes from inaccurate measurement equipment. Due to short realization terms, short series and production elasticity there are no comparative data and no possibility to conduct experimental studies that would enable one to determine explicit values of certain parameters. Furthermore, in many economy branches like tourism, agriculture, commerce, building industry, etc., the processes that occur have by their nature random character (they depend on weather, market conditions, accidents, etc.). Making decisions in the conditions of uncertainty (lack of exact values of parameters) becomes quotidian.

Problems of taking decisions under uncertainty are solved by application of probabilistic method or through fuzzy sets theory. In the first case (Dean [3], Vondrák [18]) knowledge of distribution of random variables is of crucial importance. Some processes are characterised

with randomness by nature. They depend on weather conditions, traffic intensity, number of accidents, geological conditions, device's failure, etc. If they, nevertheless, posses certain "history", it is possible to define their distribution on the basis of statistical data.

In many issues the uncertainty of data is not of random nature but it results from uniqueness of a process, error in measurement, etc. In such a case a natural method of representing uncertainty are fuzzy numbers (Iscibuchi et all. [6], Ishii [7]). In this case a huge problem is posed by a proper choice of membership function and defuzzification method. They have crucial influence on the quality of taken solutions.

In this paper we examine a scheduling problem on a single machine with the latest possible processing times and cost minimizing for the belated jobs. The delays needed to accomplish the jobs are deterministic or random variables with normal distribution. In this case we study the resistance to random parameter changes on solutions constructed according to the tabu search metaheuristics. We also present a certain measure (called stability) that allows one to evaluate the resistance of solutions to random data perturbations.

2. PROBLEM DEFINITION

In this paper we consider the scheduling problem on a single machine. The machine can perform only one job at a time. For job i ($i = 1, \dots, n$), let p_i , w_i , d_i be: the processing time, a weight function of costs and the deadline expected. If for a given sequencing the deadline of job i exceeds d_i , the delay U_i is 1, if not, U_i is 0. The problem of minimizing the total weight of late jobs on a single machine (TWLJ) consists in finding a job sequence that minimizes the sum of delay costs, i.e. $\sum_{i=1}^n w_i U_i$. The problem can be written as $1 \parallel \sum w_i U_i$, and though its formula is so simple, it is *NP-hard* (Karp [8]). Such problems have been studied for quite long together with many variations, especially with polynomial computational complexity.

For the problem $1 \mid p_i = 1 \mid \sum w_i U_i$ (all the processing times are identical) Monma [13] has presented an algorithm with $O(n)$ complexity. Similarly, for the problem $1 \mid w_i = c \mid \sum U_i$, (where the cost function factors are identical) there is the Moore algorithm [14] with $O(n \ln n)$ complexity. Lawler [11] has adapted the Moore algorithm to solve the problem $1 \mid p_i < p_j \Rightarrow w_i \geq w_j \mid \sum w_i U_i$. Problems with the earliest starting times compose another group r_i . Kise et al. [9] have proven that even the problem of late jobs minimization

($1|r_i|\sum U_i$ without the cost function weight) is *strongly NP-hard*. They have also presented a polynomial algorithm that has computational complexity $O(n^2)$ for a particular example, the $1|r_i < r_j \Rightarrow d_i \leq d_j|\sum U_i$ problem. If a partial order relation is given on the set of jobs, the TWLJ problem is *strongly NP-hard* even when the job realization times are unities. Lenstra and Rinnoy Kan [12] have proven that if a partial order relation is a union of independent chains, the problem is also *strongly NP-hard*.

There have been only a few exact algorithms solving the TWLJ problem published. They are based on the dynamic programming method (Lawler and Moore [10] – with $O(n\min\{\sum p_i, \max\{d_i\}\})$ complexity and Sahni [17] – with $O(n\min\{\sum p_i, \sum w_i, \max\{d_i\}\})$) complexity and on a limitation and division method (Villarreal and Bulfin [18], Potts [15], Potts and Van Wassenhowe [14], Bożejko, Grabowski and Wodecki [1], Bożejko and Wodecki [2] and Wodecki [20]). The last one is a parallel algorithm.

The scheduling problem on a single machine can be formulated as follows:

The problem: There is a set $J = \{1, 2, \dots, n\}$ of jobs that have to be processed without interruptions on a machine that can work on one job at a time. The job can start at time zero. For job $i \in J$ let p_i be the processing time, d_i the expected deadline, and w_i costs function weight. We want to determine a job sequence that minimizes the weight of late jobs.

For a given sequence let C_i be the date of accomplishing of job $i \in J$. Then $f_i(C_i) = w_i U_i$ is the cost (penalty) of a late job, where

$$U_{\pi(i)} = \begin{cases} 0, & \text{if } C_i \leq d_i, \\ 1, & \text{otherwise.} \end{cases} \quad (1)$$

Let Φ be the set of permutations of J . The cost of the permutation $\pi \in \Phi$ is defined as follows:

$$W(\pi) = \sum_{i=1}^n w_{\pi(i)} U_{\pi(i)}, \quad (2)$$

where $C_{\pi(i)} = \sum_{j=1}^i p_{\pi(j)}$ is the processing time of the job $\pi(i) \in J$. The problem of minimizing the total weight of late jobs (TWLJ) boils down to finding an optimal permutation $\pi^* \in \Phi$ which satisfies

$$W(\pi^*) = \min_{\pi \in \Phi} \left(\sum_{k=1}^n w_{\pi(i)} U_{\pi(i)} \right).$$

Exact efficient algorithms to solve the TWLJ problem only exist when the number of jobs does not exceed 50 (80 in a multiprocessor environment Wodecki [20]). That is why in practice we use approximate algorithms (essentially the correction type).

3. TABU SEARCH METHOD

In solving *NP-hard* problems of discrete optimization we almost always use approximate algorithms. The solutions given by these algorithms are satisfactory applications (they often differ from the best known solutions by less than 1% search methods).

The tabu search method (TS - proposed by Glover [4] and [5]) is a metaheuristic approach designed to find a near-optimal solution of combinatorial optimization problems. The basic version of TS starts from an initial solution x^0 . The elementary step of the method performs, for a given solution x^i , a search through the neighborhood $N(x^i)$ of x^i . The neighborhood $N(x^i)$ is defined by move (transitions) performed from x^i . A move transforms a solution into another solution. The aim of those elementary search is to find in $N(x^i)$ a solution x^{i+1} with the lowest cost functions. Then the search repeats from the best found, as a new starting solution, and the process is continued. In order to avoid cycling, becoming trapped to a local optimum, and more general to conduct the search in "good regions" of the solution space, a memory of the search history is introduced. Among many classes of the memory introduced for tabu search (see. Glover [4]), the most frequently used is the short term memory, called the tabu list. This list records, for a chosen span of time, solutions or selected attributes of these solutions (or moves). The search stops when a given number of iterations or current neighborhood is empty

In this section we present some properties which are the base of a new neighborhood's construction and, further, very fast tabu search algorithm.

3.1. CLASSIC TABU SEARCH ALGORITHM

In solving *NP-hard* problems of discrete optimization we almost always use approximate algorithms. The solutions given by these algorithms are, in their appliance, fully satisfying (they often differ from the best known solutions by less than 1%). Most of them belong to the local search methods group. Their acting consists in viewing in sequence a subset of a set of

acceptable solutions, and in pointing out the best one according to a determined criterion. One of this method realizations is the tabu search, whose basic criterions are:

- *neighborhood* - a subset of a set of acceptable solutions, whose elements are rigorously analyzed,
- *move* - a function that converts one solution into another one,
- *tabu list* - a list containing the attributes of a certain number of solutions analyzed recently,
- *ending condition* - most of the time fixed by the number of algorithm iterations.

Let $\pi \in \Phi$ be any (starting) permutation, L_{TS} a tabu list, W costs function, and π^* the best solution found at this moment (the starting solution and π^* can be any permutation).

Algorithm Tabu Search (TS)

```

repeat
    • Determinate the neighborhood  $N(\pi)$  of
      the permutation  $\pi$ ;
    • Remove from  $N(\pi)$  the permutations
      forbidden by the  $L_{TS}$  list;
    • Determinate the permutation  $\delta \in N(\pi)$ ,
      in which
        
$$W(\delta) = \min\{W(\beta) : \beta \in N(\pi)\};$$

    • if ( $W(\delta) < W(\pi^*)$ ) then
        • Include  $\delta$  parameters on the  $L_{TS}$  list;
        •  $\pi := \delta$ 
    until (ending_condition).

```

The computational complexity of the algorithm depends mostly on the way the neighborhood is generated and viewed. Below we present in details the basics elements of the algorithm.

3.2. THE MOVE AND THE NEIGHBORHOOD

Let $\pi = (\pi(1), \dots, \pi(n))$ be any permutation from the Φ , and

$$L(\pi) = \{\pi(i) : C_{\pi(i),m} > d_{\pi(i),m}\},$$

a set of late jobs in π .

By π_l^k ($l = 1, 2, \dots, k-1, k+1, \dots, n$) we mark a permutation received from π by changing in π the element $\pi(k)$ and $\pi(l)$. We can say at that point that the permutation π_l^k was generated from π by a *swap move* (*s-move*) s_l^k (it means that the permutation $\pi_l^k = s_l^k(\pi)$). Then, let $M(\pi(k))$ be a set of all the *s-moves* of the $\pi(k)$ element. By

$$M(\pi) = \bigcup_{\pi(k) \in L(\pi)} M(\pi(k)),$$

we mean an *s-moves* set of the late elements π in the pemerutation. The power of the set $M(\pi)$ is top-bounded by $n(n-1)/2$.

The neighborhood $\pi \in \Phi$ is the permutation set

$$N(\pi) = \{s_l^k(\pi) : s_l^k \in M(\pi)\}.$$

While implementing the algorithm, we remove from the neighborhood the permutations whose attributes are on the forbidden attributes list L_{TS} .

3.3. TABU LIST

To prevent from arising cycle too quickly (returning to the same permutation after some small number of iterations of the algorithm), some attributes of each move are saved on so-called tabu list (list of the prohibited moves). This list is served as a FIFO queue, see Bożejko, Grabowski and Wodecki [1]. Making a move $i_j^r \in M(\pi)$, (that means generating permutation π_j^r from $\pi \in \Phi$) we save attributes of this move, triple $(\pi(r), j, F(\pi_j^r))$, on the tabu list. Let us assume that we consider a move $i_l^k \in M(\beta)$ which generates permutation β_l^k . If there is a triple (r, j, Ψ) such that $\beta(k) = r, l = j$ on the tabu list, and $F(\beta_l^k) \geq \Psi$, then such a move is eliminated (removed) from the set $M(\beta)$.

The dynamic length lTS of tabu list L_{TS} is a cyclic function defined by the expression:

$$lTS(iter) = \begin{cases} low, & \text{if } S(k) < iter \leq S(k) + h, \\ low + \alpha, & \text{if } S(k) + h < iter \leq S(k + 1), \end{cases}$$

where: $iter$ is the number of iteration of the algorithm, $k = 1, 2, \dots$ is the number of the cycle. Integer number $\alpha > 0$, $S(k) = (k-1)(h+H)$, here $S(0) = 0$. Low is the standard length of the L_{TS} list (by h iterations of the algorithm) and H is the width of the pick equal $low + \alpha$.

If ITS decreases then a suitable number of the oldest elements of tabu list L_{TS} is deleted and the search process is continued. All parameters of length of the tabu list are empirical, based on preliminary experiments. Changing the tabu list's length causes diversification of the search process.

4. PROBABILISTICS JOBS TIMES

Let $\theta = \langle p, d, w \rangle$ be an example of deterministic data for TWLJ problem. We assume that times of execution of jobs $i \in J$ are independent random variables with a normal distribution, i.e. $\tilde{p}_i \sim N(p_i, \sigma_i)$. The expected value of times $E(\tilde{p}_i) = p_i$. Then data $\tilde{\theta} = \langle \tilde{p}, d, w \rangle$, where $\tilde{p} = [\tilde{p}_i]_{1,2,\dots,n}$ is a matrix of random variables, we call a probabilistic data, and the problem - probabilistic (TWLJP in short).

Let $\pi \in \Phi$ be some sequence of jobs execution at objects. In order to simplify the calculations we assume that moments of completion of separate works have also a normal distribution

$$\tilde{C}_{\pi(i)} \sim N\left(\sum_{j=1}^i m_j, \sqrt{\sum_{j=1}^i \sigma_j^2}\right).$$

The equivalent of delays (1) are random variable

$$\tilde{U}_{\pi(i)} = \begin{cases} 1, & \text{if } \tilde{C}_{\pi(i)} > d_{\pi(i)}, \\ 0, & \text{if } \tilde{C}_{\pi(i)} \leq d_{\pi(i)}. \end{cases}$$

The mean of random variable $\tilde{U}_{\pi(i)}$, $i = 1, 2, \dots, n$,

$$\begin{aligned} E(\tilde{U}_{\pi(i)}) &= \sum_x x * P(\tilde{U}_{\pi(i)} = x) = \\ 0 * P(\tilde{C}_{\pi(i)} \leq d_{\pi(i)}) + 1 * P(\tilde{C}_{\pi(i)} > d_{\pi(i)}) &= 1 - \Psi\left(\frac{d_{\pi(i)} - \sum_{j=1}^i m_{\pi(j)}}{\sqrt{\sum_{j=1}^i \sigma_{\pi(j)}^2}}\right), \end{aligned}$$

where Ψ is distribuant of random variable with a normal distribution $N(0,1)$.

By solving a TWLJ problem (with a random times of jobs execution) for a cost function (4) we assume

$$\begin{aligned} FP(\pi) &= E(F(\pi)) = E\left(\sum_{i=1}^n w_{\pi(i)} * \tilde{U}_{\pi(i)}\right) = \\ \sum_{i=1}^n w_{\pi(i)} * E(\tilde{U}_{\pi(i)}) &= \sum_{i=1}^n w_{\pi(i)} * \left(1 - \Psi\left(\frac{d_{\pi(i)} - \sum_{j=1}^i m_{\pi(j)}}{\sqrt{\sum_{j=1}^i \sigma_{\pi(j)}^2}}\right)\right). \end{aligned} \quad (3)$$

Tabu search algorithm of solving TWLJP problem (with a goal function (3)) we call a probabilistic one, **TSP** in short.

5. SUSTAINABILITY OF ALGORITHMS

Sustainability is some property which enables estimating of the influence of data perturbation on changes of goal function values. We present a method of generating a set of instances as the fist priority.

Let $\delta = \langle p, d, w \rangle$, where: $p = [p_i]_{i=1,2,\dots,n}$, $d = [d_i]_{i=1,2,\dots,n}$ and $w = [w_i]_{i=1,2,\dots,n}$ are respectively, the matrix: of work execution times, completion times and penalty coefficient, will be some instances of (deterministic) data for TWLJ problem. By $D(\theta)$ we denote a set of data generated from θ through perturbation of time execution. This perturbation consists in changing of $p = [p_i]_{i=1,2,\dots,n}$, elements into randomly determined values (i.e. numbers generated in accordance with certain distribution, for instance monotonous, etc.). Any element of $D(\theta)$ set takes form of $\langle p', d, w \rangle$ where perturbed elements of matrix $p' = [p'_i]_{i=1,2,\dots,n}$, are determined randomly. Thus, $D(\theta)$ set includes instances of deterministic data for TWLJ problem, different from one another only by values of jobs' execution times.

Let $A = \{TS, TSP\}$, where **TS** and **TSP** algorithms are: deterministic, fuzzy and probabilistic respectively. By π_δ^A we denote a solution (permutation) determined by A algorithm for δ data. The value of expression $W(\pi_\delta^A, \varphi)$ is cost (4) for an instance of deterministic φ data, when objects are executed in a sequence of (permutations) π_φ^A (i.e. in a sequence defined by A algorithm for δ) data. Then

$$\Delta(A, \delta, D(\delta)) = \frac{1}{|D(\delta)|} \sum_{\varphi \in D(\delta)} \frac{W(\pi_\delta^A, \varphi) - W(\pi_\varphi^{TS}, \varphi)}{W(\pi_\varphi^{TS}, \varphi)},$$

We call a sustainability of π_δ^A solution determined by A algorithm on a set of $D(\delta)$ perturbed data. Determining π_φ^{TS} , for a starting solution of **TS** algorithm π_φ^A was denoted and next

$$W(\pi_\delta^A, \varphi) - W(\pi_\varphi^{TS}, \varphi) \geq 0.$$

Thus, $\Delta(A, \delta, D(\delta)) \geq 0$. The value of expression $\Delta(A, \delta, D(\delta))$ is an average relative deviation of the best π_δ^A solution for the best set solutions, for every instances of perturbed data $\varphi \in D(\delta)$.

Let Ω be some set of deterministic instances for TWLJ problem. *Sustainability* coefficient of A algorithm on a Ω set we define as follows:

$$S(A, \Omega) = \frac{1}{|\Omega|} \sum_{\delta \in \Omega} \Delta(A, \delta, D(\delta)). \quad (4)$$

The smaller the coefficient, the more sustainable the solutions set by A algorithm i.e. small changes in value of data cause small changes of goal function value.

6. NUMERICAL EXPERIMENTS

The algorithms presented in this paper have been tested on many examples. Deterministic data for one machine problem with delay cost minimization $1 \parallel \sum w_i T_i$ were generated in a randomized way (see [20]), and are available on the OR-Library. For a given number of n jobs ($n = 40, 50, 100, 250, 500$) we have determined n triples (p_i, w_i, d_i) , $i = 1, \dots, n$, where the processing time p_i and the cost w_i are the realization of a random variable with a uniform distribution, respectively from the range $[1, 100]$ and $[1, 10]$. Similarly, the critic lines are drawn from the range $[P(1 - TF - RDD/2), P(1 - TF + RDD/2)]$ depending on the parameters $RDD, TF = 0.2, 0.4, 0.6, 0.8, 1.0$, while $P = \sum_{i=1}^n p_i$. For every couple of parameters RDD, TF (there are 25 such couples) 5 examples have been generated. The whole deterministic data set Ω contains 525 examples (125 for every n).

For every deterministic data example (p_i, w_i, d_i) , $i = 1, \dots, n$, we have defined a probabilistic data example (\tilde{p}_i, w_i, d_i) , $i = 1, \dots, n$, where \tilde{p}_i is a random variable with normal distribution representing the processing time (the exact description in Section 4). We denote the set of examples by $\bar{\Omega}$.

The deterministic **TS** and probabilistic **TSP** algorithms were started from identity permutation. Moreover, we have adopted the following parameters:

1. dynamic length of tabu list ($ITS(iter)$):

$$h = \lceil n/4 \rceil, H = \lceil n/10 \rceil, low = \lceil \sqrt{n} \rceil, \alpha = \lceil \sqrt{n/4} \rceil,$$

2. the maximum number of algorithm iterations: $n/2$ or n .

The deterministic algorithm **TS** has been performed on Ω , and the probabilistic algorithm **TSP** – on $\bar{\Omega}$. In order to evaluate the stability coefficient (4) of both algorithms, 100 examples of perturbed data have been generated for every deterministic data example from Ω (we have presented the way of generating these examples in Section 4). Then, all these

examples have been solved by the **TS** algorithm. Based on these calculations, we have determined the stability coefficient of both algorithms. The results are presented in Tables 1.

Table 1. Stability coefficient (relative average error $S(A, \Omega)$) for $n/2$ and n iterations.

Number of jobs n	Deterministic algorithm TS		Probabilistic algorithm TSP	
	$n/2$ iterations	n iterations	$n/2$ iterations	n iterations
40	0,094	0,111	0,033	0,039
50	0,118	0,139	0,042	0,051
100	0,289	0,303	0,046	0,057
250	0,403	0,362	0,053	0,069
500	0,415	0,487	0,076	0,094
avg.	0,261	0,280	0,050	0,062

The average stability coefficient ($n/2$ iterations) for the deterministic algorithm is, $S(TS, \Omega) = 0,261$ and for the random algorithm $S(TSP, \Omega) = 0,050$. This means that the perturbation of the solution determined by the **TS** algorithm causes a target function value deterioration of about 26%. In the **TSP** algorithm the deterioration is only about 5%. So the medium error for the deterministic algorithm is more than 5 times that for the probabilistic algorithm.

Table 1 contains too the results of a two times bigger for n iterations. The fact that the stability of both algorithms has slightly deteriorated is a little surprising. The stability difference is more advantageous for the random algorithm in $n/2$ iterations, even if this algorithm is still significantly more stable than the deterministic one. In this case the medium error of the **TS** algorithm is more than 10 times that for the **TSP** algorithm. Moreover, the data perturbation causes (for the solution determined by the probabilistic algorithm) a target function value deterioration of around 6,2%.

We have also made calculations for more iterations ($n \log n$, n^2). The stability coefficient for both algorithms have slightly deteriorated, as well as the stability difference between the deterministic and the probabilistic algorithm (even if the random algorithm maintains its superiority). The number of $n/2$ iterations in the tabu search method is very small (usually we make n^2 iterations). Based on the results obtained, we can say that in this

case it is not only sufficient, but even optimal. For this reason the medium calculation time for one example, on a personal computer with a 2,6 GHz Pentium processor is very short and does not exceed one second.

The experiments conducted have shown without doubt that solutions determined by the probabilistic algorithm are very stable. The perturbation (change) of the processing time causes a medium deterioration of a few percent (maximum about a 11%). From the point of view of its utility in practice, this is completely satisfactory.

7. CONCLUDING REMARKS

In this paper we have presented a method of modeling uncertain data using random variables with normal distribution. We have presented an algorithm based on the tabu search method in order to solve a certain scheduling problem on a single machine. For this problem, we have evaluated the solution stability, which means its resistance to random changes in job parameters. The experiments have shown that the algorithm in which the processing times are random variables with normal distribution, is very stable. The medium relative error for perturbed data does not exceed 5% when the iteration number is small, and the calculation time is short.

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An Integrated model for Pharmaceutical Supply Chain Security through IT

by

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ABSTRACT

How to ensure non-manipulated, original pharmaceutical products to be sold to the final consumer is a matter of national interest. In this contribution we are going to present an approach which combines both information technology as well as process reengineering to ensure pharmaceutical correctness and safety of the drugs sold. Firstly, requirements for a model will be determined. Secondly, existing approaches and their pitfalls are presented. Finally, we will introduce a new model for controlling the security of pharmaceutical supply chains.

Keywords:

Pharmaceutical Supply Chain, RFID, Counterfeit Drugs.

INTRODUCTION

A pharmaceutical company which is already approved by national health services would also be able to manufacture adulterated drugs for economic interest. This could be one source of adulterated drugs, the other source is related to the supply chain from the pharmaceutical company to the pharmacy or medical institution where drugs are issued or sold to the patients [5].

Counterfeit drugs that contain erroneous ingredients, an improper amount of active ingredients, no active ingredient, and/or those drugs that are labeled and packed unsupervised [27] also present a major challenge for the health system.

Various single approaches (see for example [18, 17, 6]) have been produced to address single issues within the supply chain such as evaluating RFID chips on drugs. Through the

publication, an integrated approach based on RFID-technology is elaborated and compared against the current dominant barcode based approach.

THEORETICAL BACKGROUND

The following chapter contains theoretical concepts to be used within the contribution; the first section deals with the business process modeling approach and the latter with the basics of the corporate infrastructure.

Knowledge Modeling and Description Language

Compared to other languages for business process modeling and knowledge related activities, the knowledge modeling and description language (KMDL) [10, 9, 2] facilitate the visualization of tacit knowledge through integrating individuals and allows to describe variants and instances of knowledge related activities through its conversion-based view. Therefore, in this contribution the modeling approach KMDL is used. It is only briefly introduced here due to a space limit (please refer to [10, 9, 2] or <http://www.kmdl.de> for a full introduction). Figure 6 contains selected objects included in KMDL.

The recent version 2.2 of KMDL uses three layers which are also called modeling views: The process-based view, the activity-based view and the communication-based view.

The process-based view describes the operational course of the business process from the perspective of process steps. This layer shows which task should be completed before the next task begins and which alternatives exist. The task assignment of each resource also takes place in this layer. These tasks describe the logical sequences of the business process and are executed by roles.

The activity-based view provides a more detailed description of the knowledge conversions performed of complete tasks in the process. It is commonly used only for the knowledge-intensive tasks identified in the process-based view. These tasks are analyzed closer and decomposed into knowledge conversions. These conversions are derived from the concept of knowledge generation introduced by [15]. Four conversion types can be differentiated:

- From tacit to tacit knowledge: Socialization means the exchange of experiences, where shared mental models and technical skills can be created. This can happen, for example, during a personal dialogue or through imitation. Tacit knowledge is gained through experiences.

- From tacit to explicit knowledge: Externalization means the articulation of tacit knowledge into explicit concepts. Tacit knowledge can be expressed in a way that it will be understood by third parties using, for example, metaphors, analogies or models.
- From explicit to explicit knowledge: Combination: Existing explicit knowledge is put together by combination, resulting in new explicit knowledge. Different forms of explicit knowledge can be added to the existing knowledge through the use of media such as telephone calls and e-mails or reconfiguration and categorization.
- From explicit to tacit knowledge: Internalization: Internalization means the conversion of explicit to tacit knowledge. It is very closely related to learning-by-doing. Experiences gained through socialization, externalization or combination can be integrated into the existing individual knowledge basis. This way, it becomes part of the individual know-how or a mental model.

Conversions are used to describe intermediate steps that eventually lead to the desired knowledge which then is used to perform a task. By studying the knowledge origin and information objects, their use as well as knowledge flows, statements about the creation of knowledge and information and their use within the process can be made. Each conversion uses information and knowledge objects as input and generates output as information and knowledge objects. Knowledge objects reflect tacit knowledge and are always attached to persons. Attributes are used to describe the qualification of each knowledge object. It is possible to define requirements for every conversion. A differentiation between functional, methodical, social and technical requirements is made. The technical requirements can be covered by functions of information systems. The coverage of the remaining requirements is ensured by - also differentiated - knowledge objects of persons / teams. Start- and end-objects of conversions can be both information objects and knowledge objects. Knowledge objects can be related to persons, teams or undefined persons. A task in the process-based view can consist of multiple conversions, and means an abstraction of the application area.

The communication-based view provides the basis to model the communication within an organization.

KMDL includes a procedural model in order to identify, visualize and improve knowledge-intensive business processes. It facilitates an integral visibility of knowledge flows within the modeling of business processes.

In this contribution only the modeling language is used. A focus is set for a process description of the pharmaceutical model.

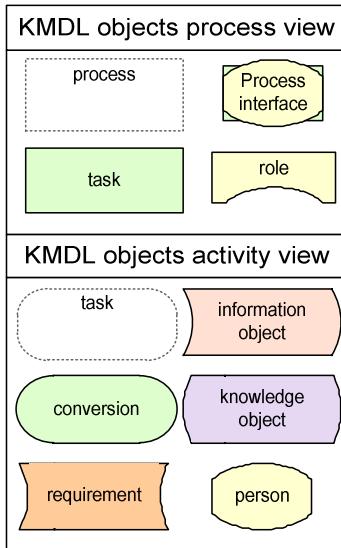


Figure 6: Selected KMDL Objects

Corporate Architecture

According to [1], the corporate architecture consists of the organizational architecture, the comprehending of business processes as well as the organizational entities.

Business processes are defined as a collection of activities that take one or more kinds of input to create an output, namely value to the customer [11]. A similar definition was presented by [7], but there is no emphasis on the creation of value.

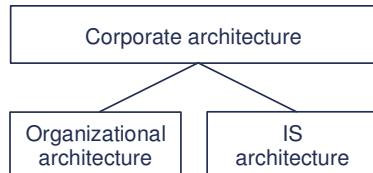


Figure 7: Corporate architecture [1]

DERIVATION OF A MODEL

Various concepts exist for solving the counterfeit problem. These differ in strategically concept, organizations and participants involved as well as in the technologies used. These criteria form the basis of a model which will subsequently be constructed.

A common idea of enabling transparency in pharmaceutical distribution is the so called Supply Chain Visibility [26]. It is the basis of the fight against drug counterfeiting. For this

purpose, it must be made clear how the distribution in the pharmaceutical environment looks. Figure 3 shows the distribution concept of pharmaceutical industry.

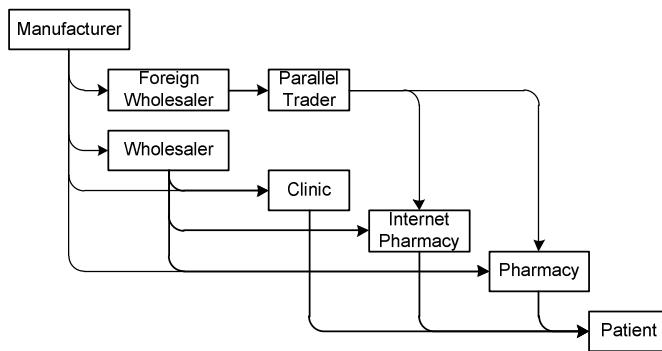


Figure 8: Distribution concept of pharmaceutical industry [26]

Since the model consists of layers, here refer to Information Management (IM)-layer model of Wollnik [22], which provides a systematic structuring of problem and task fields along the dimension of Technology Nearby. In this model, as shown in Figure 9, each layer sets requirements to next layer down and provides support services for next layer above. The upper/strategic level addresses the required information for decision-making and problem-solving. This includes all areas of responsibility that are directly associated with information. This includes, in particular, the questions of who needs what information and how to make them available to users. The users and creators of this information are in the participant layer. The process layer results lead to requirements for the underlying technology layer. This will include the design of information systems regarding the procurement, processing and provision of decision-relevant information as well as the technical infrastructure (computers, networks, system software, and others) on the lowest layer.

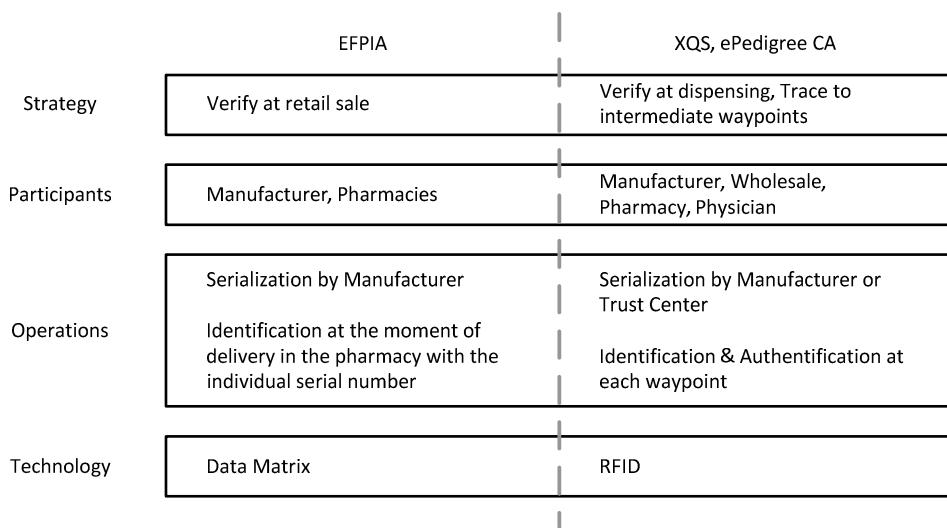
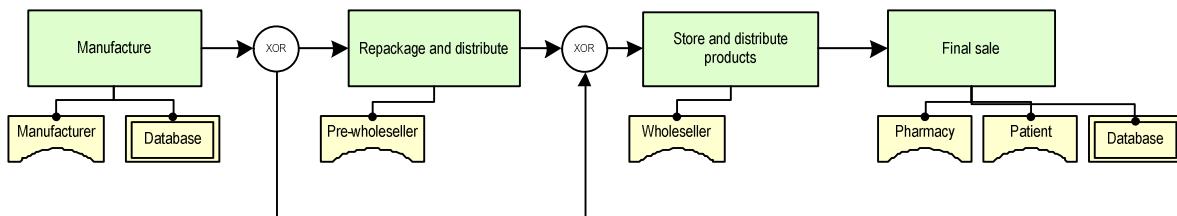
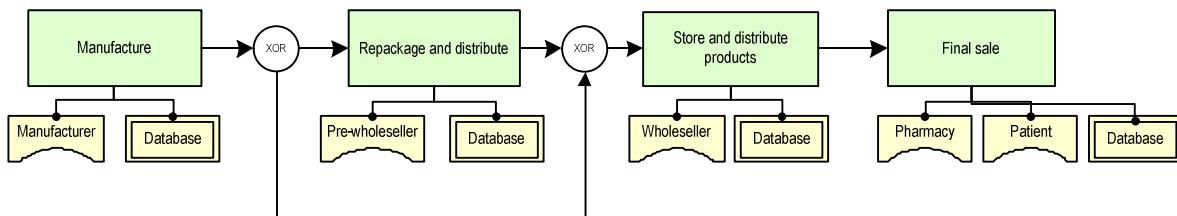


Figure 9: Layered Concept Comparison

Serialization is the key in both concepts, either through data matrix or RFID. However, the main difference is still on strategic level. The EFPIA-model depicted in Figure 10 provides an exclusive verification before the retail sale and no traceability of intermediate waypoint of trade before.

**Figure 10: EFPIA-Model**

The RFID-based model [23, 24, 25, 19] depicted in Figure 11 introduces feedback authentication at every waypoint. On the one hand, it increases the transparency in the pharmaceutical supply chain significantly; on the other hand, it allows other process improvements for all parties involved.

**Figure 11: XQS Model**

Comparison on Strategy layer

The EFPIA model (which is favored by associations, for example PHAGRO, ABDA, vfa) follows a strategy of avoiding efforts among the supply chain by verifying the pharmaceutical product at the retail site, intentionally leaving out the wholesaler. The lack of consistent tracking before the pharmaceutical products are sold is aimed at creating transparency among the supply chain.

The RFID-based model strategy is to follow the pharmaceutical product along the supply chain to each waypoint.

Comparison on Participants Layer

Only the manufacturer and the pharmacy participate within the EFPIA model. The XQS Model based on RFID comprehends an interaction between the manufacturer, the wholesaler, the pharmacy and the physician.

Comparison on Process Layer

In the pharmaceutical and health care industry the RFID technology are not only increase efficiency for all partners in the logistics chain, but also enables the traceability in the supply chain and protect patients from counterfeit drugs. In the United States the ePedigree model has been implemented: related to gray and parallel imports and subsidy fraud laws have been adopted to create a guarantee that the origin for drugs follows a complete documentation from the owner of the drug in the supply chain. Traceability in Pharma encompasses by this model:

- Flow of goods along the supply chain
- Manufacturing steps
- Route to all distribution channels
- Formulation and consignment, which is patient-related
- Hand over
- Medication (Bedside verification)
- Medicines Control (Drug Utilization Review)

Traceability is a core process improvement. The origin, interim stages and ambient conditions arising along the entire value chain for drugs and medicinal products can be traced independently of time and place. Traceability – in other words, the gap-free tracing of every stage in the entire value chain – requires persistent storage of data relating to drugs immediately after production, including the information on packages, their content and ambient conditions, delivery information and time of receipt. Traceability includes temperature and order histories, drug flows and statistical evaluations. Those data is used to detect irregularities, such as the purchase of large quantities which never reappear in the market. In this sector, these “black holes” may be linked to illegal exports, counterfeiting and product manipulation.

If a cooling chain is interrupted, damaged or sensitive medication bottles are shaken, their use has serious consequences [14]. A study from Ireland found that 37.8% of family physicians allowed their vaccines to be stored outside the specified temperature range [8]. According to the researchers Weir and Hatch³ humans pose a dangerous security risk for the cool chain [21]. In Germany there are currently about 250 sorts of drugs which require such cooling chains [14]. In most cases, the active ingredients are rich in protein. These include vaccines, antibiotics, insulin, blood products, different eye drops and botulinum toxin preparations [16]. The volume of drugs which must go through a cooling chain is steadily increasing. Since the enlightenment of the human genome, the number of known targets of endogenous proteins, such as antibodies, cytokines and hormones, are growing rapidly.

A special feature of the recombinant proteins with Natural models is common: a high sensitivity to environmental factors [3].

Possible enhancements among the supply chain are depicted in Figure 12 and explained further at a later point.

Temperature fluctuations which exceed the allowed range of storage and transport temperature often lead to irreversible changes to the active ingredients. Patient safety is at risk without explicitly knowing it: for example, if diabetics inject too little effective insulin than they are advised, it can lead to the hyperglycemic shock [4]. Children, especially premature babies and those with birth defects are often unable to receive proper vaccinations. Cytotoxic drugs, which have lost chemical effectiveness due to the violation of the prescribed temperature range in effectiveness, can ultimately lead to treatment failure for oncology patients. Large variety of temperature, low temperature and harsh impacts are important factors which can lead to hairline cracks in ampules or syringes, through which impurities (toxins or infectious agents) can get into the medicine. These unexpected adverse side effects carry potentially fatal consequences.

Another process improvement is to avoid false designations. False designations cost pharmaceutical companies millions of dollars in financial damages that can be avoided by using of RFID-based serialization.

The legally enforced mandatory discount of 16% since the 15th amendment of AMG from 1 August 2010 caused false, incorrect and superfluous identifications for pharmaceutical companies. Due to the data complexity and diversity, pharmacies cannot understand the route of their goods and the subsequent misused data leads to liability of these companies.

An aggravating factor is that on 08/01/2010 retroactive to 08/01/2009 there was a forced price reduction, which in addition to the 16% discount, must be paid by companies and can reach a percentage of almost 20%. With pharmaceutical sales of one billion Euros a potential risk of approximately 50 million Euros can plausibly arise now.

This amount is imposed on pharmaceutical companies, although there is no turnover. These illegal charges can be detected, and prevented solely by a serialization of the drugs. Though RFID technology is optimal for serialization purposes, and it also offers additional options like sensory (temperature, shock, etc.) which make an RFID-based system an ideal support structure for the supply reliability and cost efficiency in health care.

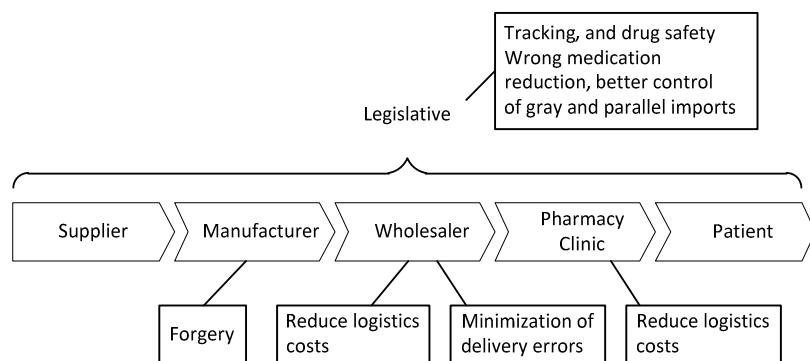


Figure 12: Process enhancements through RFID [26]

Comparison on Technology Layer

A comparison on this layer means to contrastingly juxtapose the both key technologies Data Matrix and RFID. Optical Methods such as Data Matrix have a significant advantage: it is inexpensive to print the package (0.1 to 1 cent). But it is chemically, mechanically unstable, provides no bulk reading ability. Each package must be shown to the camera and there is no support for additional sensors, either.

The RFID technology is more expensive and it is less trivial to affix a transponder to a package than to print it with a data matrix on the one hand. On the other hand RFID-transponders are tamper-proof, fault-tolerant, chemically and mechanically stable. They provide bulk reading ability, and additional sensors (for temperature and shock monitoring, etc.) are available. A detailed comparison of both key technologies can be found in [13].

CONCLUSION AND FUTURE RESEARCH

The EFPIA model is based on optical recognition of pharmaceuticals. Optical recognition requires each unit to be placed in front of a scanner requires a time-consuming scan of each bulk container. Furthermore, any damage of the image drastically reduces the reading ability

drastically. Additionally, legislation might impose certain transportation means and environments during the transport (e.g. a determined temperature and pressure). Optical methods do not provide additional sensors for monitoring the environment. Though the pitfalls exist, the cost of printing the optical character on the pharmaceutical product is very low for the manufacturer. The cost of scanning the pharmaceutical products is ultimately paid by the final consumer.

The RFID-solution provides a comprehensive approach that avoids previously mentioned shortages: Pharmaceutical products can be scanned from a bulk container without to remove each unit. Furthermore, a change in the environment (e.g. temperature or pressure change) can be detected and saved within the chip. Once the pharmaceutical product is sold to the patient, information recorded on the product can be accessed. The distribution of the costs in case of the RFID model disfavors the manufacturer since the RFID tag is more expensive than the printed barcode.

Overall, the EFPIA model can be implemented when low-cost medicine is manufactured and distributed. Once the price for the medication and requirements increases, the RFID based model will be more favorable from perspective of health care.

Various research issues are still remaining. One issue to be addressed is the increase of security by use of sensors detecting unexpected physical agitation and temperature changes. The second issue relates to regulatory bodies that should establish an equal level playing field for all participants within the supply-chain regarding by setting minimum standards. Another related research topic is the statistical analysis of the material flow to detect irregularities among the supply chain and alert respective entities if action is required.

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Communication noises in the tourist sphere

by

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ABSTRACT

The tourist sphere is "the place" for local communities, and "the tourist product" for tourists. It is shaped in the evolutionary process of adapting the urban and rural structure to ever new needs of its users. Therefore, it is possible to read a variety of cultural content, having the character of intergenerational code that shape people's sense of identity, and arouse the interest of tourists. However, the communication containing a reference to this code is being often deformed, and the presence of the syndrome of abnormal transmission of meaning within the tourist environment can be observed. Especially common are various communication noises, as: physical, psychological and semantic, which cause the loss of consistency both of physical space and social space, as well as results in the virtualization of a place.

Keywords: Tourist sphere, Environment as a medium, Morphological signs, Syndrome of an impaired transmission of meaning, Communication noise, Landscape architecture

INTRODUCTION

The tourist sphere, a product of economic activity and human exploration, is a functionally distinctive part of the geographical space. Its characteristic feature is the motion, which is a socio-economic phenomenon characterized by various forms of migration allowing the personal experiences and interpersonal relationships.

The material sphere of the tourism environment express various cultural content. This is due to the way, how it is being shaped according to the human needs of higher and lower order, and which is reflected in the rural and urban landscape. An information enclosed in the landscape is of interest of tourism, and is acting as a leading theme for people seeking an education and self improvement in it. This information allows to distinguish a particularly

place from others, as it refers to a sense of local identity and sense of otherness to the communities from outside the particular cultural sphere, including tourists in it.

The development of an information technology and widespread interest in this form of communication resulted in an extension of tourist activity to the virtual realm. This occurs in all phases of the tourist experience, which is being called in commercial terms as "the experiencing of the tourism product". It includes phases of: preparation, consumption, and finally memory. The Internet plays an important role in all phases, as it has become a search tool for selection of interesting sites and the planning of a tour, for obtaining and verifying an information about sites to visit, as well as recording and sharing materials documenting "the tourist experience", or even just the mere acquisition of "the tourist product".

Also on the supply side of the tourist product the Internet has become an indispensable tool for social and commercial tour operators. It plays a huge role in search of inspiration, and then shaping the image of a new tourism product and its promotion in the cyber environment. Very often it is connected with beautification of the reality, and the effort which is being put on the functional and attractive presentation of tourist offer is bigger than on the functional and aesthetic development of the tourist object, place or area.

Tourist Sphere as a Medium

The tourism environment is manifested in the occurrence in the integrated natural and anthropogenic environments of various tourist phenomena, which are meeting the human needs of leisure, knowledge and experience. This specific environment is divided into distinct taxonomic units which differ in scale, such as a tourist area, a tourist region, a tourist complex, and a tourist destination. The tourist area is characterized by uniformity of values, the tourist region – by a consistency of an urban environment, and the tourist complex – by a density and hierarchical forms a functional unit which includes several tourist places [1].

The history of the particular place, which acts as a tourist environment, but also as a single settlement unit, is readable in its layout, architecture and silhouette. In the views of interiors of streets, squares and panoramas, in the built-up stylistic traits – from the Romanesque to the postmodern sacral and secular buildings, as well as in the remaining regional forms, are being reflected the changing in time aesthetic, artistic, economic and social concepts [2]. This cultural content of the landscape constitutes values of the specific site, which are of the cognitive, religious and individual character, and which generate an interest in a city or a

village, triggers a sense of identity, as well as are a source of inspiration for the local citizens in the field of art, as well as entrepreneurship, including tourism entrepreneurship.

The tourism sphere can be understood in two ways: subjectively – as a "tourist attraction", or objectively – as a "tourist product". The "tourist attraction" is a characteristic feature of the site, as the landscape, climate, cultural heritage and tourist development – all of them arousing an interest of tourists. In turn, the "tourist product" is complete market offer consisting of material goods and services, where the geographical and social environment is for tourists an object and/or a location of the transaction.

Both, the "tourist attraction" and the "tourist product" contain an element of the mass media. The attraction makes/means an information concerning the identity of the site, which becomes part of the promotion. The same information about the landscape, the natural and cultural heritage, as well as the tourism development becomes a source of inspiration for the creation of the tourist product. It is characteristic, that the place which acts as the place of interest, and in other times plays the role of the tourist product features not only "attractiveness", "materiality" and "utility", but also its "idea".

It is noted, that there is an increase in the incidence of the phenomenon of the virtualization of the tourist environment, which refers not only to the development and promotion of its image in the web, but also to the management, which is mainly determined by attractiveness, not functionality. This is consistent with the more general trend, which is described as follows: "... The change in progress only seemingly is of the nature of the medium and the change of the technique. In fact, we are witnessing a profound change in the sense of physical phenomena and objects, which reflects on the type of sensitivity and the nature of needs of the people involved in the process of creation and reception of art, culture and science" [3].

SENDER AND RECIPIENT

In tourism, as in any other form of activity, the communication between the sender and the receiver means the transfer of messages in the form of verbal, vocal and nonverbal signals via the selected channel. This process is bidirectional in nature – the sender sends a message to the recipient, and the recipient in response to the sender sends his/her opposite signals [4]. These rules apply both to communicate at the level of interpersonal as well as mass, and whose goal is not only to share experiences, but also to participate in a community [5].

The sender of the message which is contained in the tourist environment are the local communities who inhibit various places – from a single settlement unit to a large region. All

of them are distinctive functionally or formally and they play two roles. They are a place of an everyday life, but a tourist destination at the same time. Therefore they are being managed by the residents to meet their physical and physiological needs, and to meet tourist' needs of education, experience and excitement. The villages and towns, as well as an open landscape become the tourist attractions, and thereafter the tourist products. This process applies both to the protection of universally recognized values of the natural environment and cultural heritage, as well as the creation of new values, which is a manifestation of entrepreneurship and artistry of contemporary society. These new values may result from the specificity of daily life, they can also be created on the motives having nothing to do with their everyday life, even apart from the specific, local cultural context.

Marika Pirveli in her study on communication by he means of morphological signs, which are readable in the urban and rural environment, defined the sender of the message in this way: "(...) a man of the particular cultural semantic code, both from the past and from the present. It includes every person who, because of his position and profession has, and had, an impact on the whole of the material elements of the urban subsystem (...). Broadcasters of the to date shaped a city or a village are also the ordinary people who are taking care of the utility and the image of their own land or premises and introduce changes more or less visible on the facade of the house (...). Authors of the media are also graffiti artists, and those who place different types of paintings or scribblings on the walls. Definitely it strongly affects the physiognomic characteristics and the reception of the city. Balconies, terraces cafés, street furniture, clothing, people, lighting, signs, advertisements, billboards, graffiti and everything that makes up the street gallery, produces an unique information about society which is the subject of social and semantic studies. These are like genitives settled in the existential space of people, as it is an information, that distinguishes cities and villages from one another and allows recipients to answer the questions: Who?, What? Whose? " [6].

From the multiplicity of morphosigns, which are the tourist values, or a tourist attraction emerges a number of diverse tourist products which appeal to the past, present and future of the site, and in case of the absence of the cultural context – to the created solely for the purposes of market virtual reality. In this context, the spatial development of a settlement or an area, which is the tourist area at the same time, is not so much planning, but directing, and which is, as noted by Anna Franta "(...) the design of space-man relation for the estimated in flexibly foreseen "the theater of everyday life" – a dynamic process of usage of urban-architectural spaces: the object intentionally beautiful, durable, useful, communicative in

perception (...)" [7]. In this specific environment residents become: scenario writers, stage directors, actors and set designers in the specific show prepared for tourists. Such theatricality of life can lead to loss of authenticity of the "own place" for the sake of attractiveness of "the tourist destination".

The second subject of the communication process, next to the sender, is the recipient of the message. Marika Pirveli points out that: "... The recipients of the spatial message are people living today. They are those who use human settlements, so they are residents of the city or village, but also tourists and people who have contact with this place due to their profession. The recipients are people who know – or seem to them that they know and feel – the estate, by the prescription or the literature, or from the mass media or stories, or hearsay" [8]. In the sphere of tourism, the recipient of the message which is contained in the space of a place or a larger area is a traveler who is still motivated by "Sun", "water" and "sand", but also more and more by "entertainment", "excitement" and "education". The traveler, depending on his interests and how he can realize them, plays the role of a stroller, a vagabond, a tourist, a player, a new flâneur, a coachsurfer, a backpacker and a tramp [9]. The traveler, as stated by Pola Kuleczka, regardless of which of these role models he represents, "... does not necessarily associate with the place where he comes, and learning a new culture, does not integrate him with it. Sometimes he is just looking at the new territory and its inhabitants, uses it, as far as he was allowed (...)" [10].

A variety of travel needs are realized both through individual observation and interpretation, as well as collective tourist activity in the group of persons having similar interests. It seems, however, that there is the tendency of individual search for experience, which results in a departure from the association of tourists in large organizations and their participation in the purpose, but random and unstable tourist groups. In this way an opportunity to effectively influence the decisions is limited, as to how development of tourism environment, which is shaped to the needs of tourists by the residents in accordance with their feelings and fashions. Lack of the feedback in the communication between residents and tourists is associated with functional and spatial decisions which are only commercially motivated, and which results in the loss of the most valuable asset of a tourist destination, which is its authenticity [11].

MESSAGE FORMULATION

The message contained in the tourist sphere refers to the history of the site, as well as to the contemporary manifestations of activity of its inhabitants. It includes the material realm of

the man-made structures, as well as non-material realm of beliefs, lifestyles and creativity of the local or regional community. Both, tradition and modernity are reflected in the landscape, which – depending on the phase of the development cycle of a place: perception, exploration, involvement, development, consolidation, stagnation, decline and renewal, features a variety of cultural landscape, such as cultivated, urban, urbanized and industrial use, and which may be of harmonious or degenerated character, depending on how they were managed. The physical characteristics of the site creates the message which refers to historical and contemporary content related to local citizens economic, social and cultural activities, and which is composed of the specific morphological signs.

Marika Pirveli explains: "(...) The term morphosign is formed by the combination of "morphology" and "sign". "Morpho" is from the Greek *morphe* (shape) and refers to a set of four indivisible elements of the physical plan of the city. "Mark" – a term borrowed of linguistics; it is the unit giving the conventional information about elementary physical elements of the city plan. Signs specific for each morphosigns are binary. Sign consists of the marker and the meaning. The marker is a pictorial code. Meaning – a semantic code. The graphic code is something that can be seen, which is easily visible both in the plan of the city, as well as in real space. The image, it means the appearance depends on the geometrical parameters of the sign, architectural features, building materials and finishing, but also on what is intended, or how the sign is being used (...). The semantic code is not visible. The basis of sophistication of its content is the attitude of residents of a town or village to the surrounding environment. The semantic code follows: a) the current intentional features (...) given by the local authority, b) the original purpose of the form, which is changing (...), c) the architectural value (...), d) the attitude of current users to the specific physical element (...)" [12].

The awareness of the phenomenon of "narration of the place" by means of traditional patterns of language allows for the stimulation of proper approach to urban and rural planning, taking into account the architectural tradition of the place. It is also a source of inspiration for a variety of cultural events taking place in the material sphere. In this way the real message is formed, associated with a particular site content, which aims to release in the local community the sense of territorial belonging, and the tourism sphere to awake the interest in the place.

Tourist is not only the passive observer of a place, but he also participates in creation of it, because he posses, as indicated by Kazimiera Orzechowska-Kowalska: "(...) the conditions

for knowledge, development, protection of cultural values. The development of tourism and culture inspires, enriches and promotes cultural property (...) [13]. This creates a feedback loop between tourists and residents, just at the stage of formation of inter-communication, by which it can acquire the characteristics of the expected and desired, without losing its authenticity, and thus credibility.

ENCODING AND DECODING

The content and the form of the message contained by the tourist place are mainly due to the characteristics of the site. As a rule, it has its historical character and is converted mainly to the needs of its residents. The place reflects, above all, the daily life of local communities, with the mode, style, aspirations, as well as changing fashions. These features provide the space for its authenticity, originality and uniqueness, and thus stimulate the interest of tourists, more and more intense due to various external factors: political, economic, cultural and technical, including the development, the ubiquity and influence of the media.

Traditional place of local communities is often being transformed into a place – a tourist product, and serves not only to shape people's sense of identity, but more to satisfy the specific tourists' needs of experience and distinction by participating in entertainment, experiencing excitement and expansion of education. Accordingly, the transformation of the material subspace takes place, which makes of it the theatrical scenery for various tourist enterprises. The same applies to the immaterial subspace, which becomes the storyboard of the events.

The preparation of the physical subspace for the tourism activities takes place in the scale of individual objects *in situ*, objects *ex situ*, civil engineering constructions, individual public buildings, churches and homes and their complexes, open-air museums, and entire villages and cities. The place developed for the purpose of the tourist consumption becomes a sphere of cultural tourism, in particular, its specific form - "architourism", whose participants have the special interest in both historic buildings, as well as in the new architectural icons – distinctive in form, less frequently function, and sometimes just the name of a prominent or flamboyant architect. Anna Jonarska writes: "(...) Architourism – it is traveling to see a particular architecture, often a particular building or facility, and coexisting with them cultural environment. (...) On the one hand there are sentimental returns to a particular place where the object is a specific value to us who might be the key to our spatial memory, existing in the imagination map of the area. (...) On the other hand there are iconic buildings

made famous by the mass media. Behind them lie the great ambitions of architects and investors who want to impress by artistry of the project, the size of the project or using high-tech. These buildings are a sign of the times and a symbol of the city, state, and even the whole nation" [14].

The exposition of values of the material subspace concerns such intangible forms of culture, like: philosophy, tradition, art in all its forms and styles of life and education. The place is a product of community spirit and allows its members to communicate and provides integration, and dimension of the unit is a catalyst for spiritual processes, triggers questions about the meaning of life and its own way, is a means of forming personality. An expression of this space is the message in the form of literary legends and stories associated with particular places, often non-existent now, or persons recorded in the collective memory because of their merits, and sometimes guilt.

This particular story is a kind of scenario useful for the site marketing. The spiritual space, there are also fun and play, as well as the ludic forms of art, and which do not have the characteristics of practicality, necessity and usefulness. Thus, nowadays in the public realm there are observed traces of pervasive commercialization and dramatization of life, which are characteristic for the post-modernity, and which reduce the tourism to the role of experience consumption and vain creations free from all obligations and responsibilities.

Decoding by tourists the message contained in the tourism place is based on an individual interpretation of the diverse content of historical, religious, social and aesthetic character, which is associated with a particular place. Reading and understanding of the content depends on the level of education, inquisitiveness and sensitivity of customers. As pointed out by Marika Pirveli: "(...) even when all conditions of communication (sender-message-receiver + common language) are met, the recipient is not able to fully receive the message"; (...) the degree of properness of the perception depends above all – not on the depth of our knowledge about the seen symbol, but – the code used by the recipient" [15].

Among the four orientation codes: monoconcrete (probabilistic, statistical), policoncrete (imagined), hierarchical (abstract) and creative (more than language), the first three can be developed in the educational process, while the latter is associated with the finding ability [16]. Hence it is essential to prepare the recipient of a message for an active role by shaping his cognitive attitudes by education, as well as by giving him additional tools in the form of published travelogues and reliable electronic sources. There is a place for social activities for

the dissemination and verification of cultural content, which is of interest both, to local people, as well as tourists. As examples are here numerous websites of communities gathered around interesting for them: country, region, city, part of the object, as well as websites of formal and informal tourist groups.

ABNORMAL TRANSMISSION OF MEANING

There are numerous obstacles in the communication between the local community and tourists by means of the local area. They are a consequence of different expectations of residents and tourists, as well as the wide variety of members of these groups in terms of intellectual and characterological features. Hence, the message contained in place is disturbed by the differences in perception, language differences, internal and external noise, excitement, a mismatch between verbal and nonverbal messages, and finally distrust.

Particularly important barrier in communication are noises, and this is due to the fact that they may be intentional, and a tool of manipulation, and thus provide false or deceptive content which is present in the message. Noise can occur during any communication stage – encoding and decoding, as well as in the communication channel. They can be of exogenous or external, depending on the intentions of the sender and/or perception capabilities of the receiver.

Internal noise, as indicated by Jan W. Wictor, "(...) is the distortion attributable to the personality characteristics of the participants of communication, formed mainly by a team of psychological variables, but also social, environmental. Noise of this type may be short-lived states of the body and behavior of the sender and recipient (...) as well as attitude, expressing persistent predisposition to a particular type of action, including stereotypes, prejudice, phobias, excessive ethnocentric attitudes that hinder the communication process." The external noise, as stated by the same author "(...) indicates the distortions arising from sources attributable to the participants in the process of communication environment, and thus applicable to them largely independent. External noise can be generated by a set of variables as wide as it is defined broadly in marketing and managing the concept of macro-, and micro-company environment, and is regarded as a set of conditions of behaviors and conduct of a buyer in the market" [17].

Taking into an account the nature and complexity of tourist place, as well as the multiplicity of users and the diversity of situations in which they are located, there can be distinguish three types of the noise: physical, psychological and semantic [18]. This corresponds to both

the specifics of the physical subspace as well as the spiritual subspace in its individual and collective dimension. These forms of noise are explicitly identified by users of space.

The physical noise is of an external character to the sender and recipient, and is manifested in the physical disruption of transmission or reception of signals. If tourist sphere can be, for example a landscape of the contemporary village, which historic layout has been deformed as a result of poor rural planning. Similarly, with regard to the physical noise of the urban landscape, there are taken out of context redevelopments of the whole urban blocks, transformations of public spaces, and introduction to them the new "icons" of architecture. The effect is that the people of settlement units in the quest for originality and attractiveness lose their intergenerational basis of language patterns, and tourists do not have the opportunity to learn the basics and logic of functioning of the traditional place. The tourists, realizing their main target, which is to fulfill needs of experiences and entertainment, choose the first such tourist products-objects that are somehow unique. They can be inspired by foreign cultural models, and even refer to a formula of kitsch, as long as they bring an interest and surprise.

The psychological noise results from the barriers of mental disturbances of the sender or recipient in the shaping or received message. And so, the inhabitants of villages and towns are primarily focused on the commercialization of its space tourism market, hence very often they develop it in ways having nothing to do with their cultural heritage. Zygmunt Kruczek writes "... The owners and entrepreneurs struggling for profit often forget the obligation to protect and interpret the past and are increasingly the executors of empty spectacles and noisy entertainment (...)" [19]. This is also often questionable as to economic effects of such attitudes [20]. In the same time tourists are looking for ever new things and they do not find them in ordinary life of visited communities, which limits their perception of reality, and also has serious ethical and political implications. This is due to that the reception of a message characterized by superficiality and a lack of reflection makes that the history is absent, cultural differences obliterate and a violence in resolving the national conflict is mitigated [21].

The semantic noise is a lack of the common to sender and receiver semantic language code, as well as symbols and forms, which leads to distortion of the message or even the lack of readability. This is in case of belonging to different cultural, social, and generational groups, differences in the level of education, and a different threshold of sensitivity. This applies to both the sender and the recipient of a message, hence the message in the encoding phase can

be deformed in consequence of the lack of clarity of communication formulated by non-homogeneous local community, as well as the decoding phase, as a result of interpreting the same meanings by the culturally diverse tourist community.

CASE STUDY – COMMUNICATION NOISES IN KŁODZKO LAND

The cultural landscape of Kłodzko land has been initiated by an early Slavic settlement (6th century – 13th century) and a medieval settlement of German colonization period (mid- of 13th century – first half of 14th century). Over the subsequent centuries, it underwent changes reflecting various forms of management, technical measures, as well as aesthetic views. Evolutionarily formed and valid for Kłodzko cultural code, including the architectural, functional and aesthetic issues, was interrupted by the great migrations after World War II. The local tradition has expired, including family relationships, neighborhood and community, rural production and folklore, giving way to behaviors and attitudes transferred here from the borderlands, as well as other Polish regions [22]. This led to neglecting, often even the rejection of unwanted places by the new residents for whom already existing patterns (morphological signs) were unreadable.

Nevertheless, the view of the significant historical assets of the area and richness of the material heritage in the cultural landscape is still a clear message of tradition. As the proof of this is an emotional description of Kłodzko made by Henry Waniek: "(...) The geographic area is an autonomous, tightly surrounded by mountain ridges. For this reason, for several hundred years the county was an area known as sovereign Kłodzko (*Grafschaft Glatz*). This enclave marked by a peculiar drama of history for hundreds of years was the theater of war and conflict. (...) It is reflected in it, as in a mirror, the drama of the history of Silesia, the Czech Republic, indirectly, the German Empire and to a lesser extent Poland, which has lost the interest in its western borderland in the fourteenth century. Had the same martyrdom been enough to sacrifice the land than would not been need for additional reasons to believe it to be a saint" [23].

In so consistent in terms of media content can be observed the presence of several type of noise. They are hindering the communication within the local community, which is threat to the basis of the sense of identity, as well as limiting the content of the message due to which it is of an individual and original character in the eyes of people from inside and outside this cultural circle, including tourists.

As the example of a physical noise in the message of the place can be the disturbed contemporary landscape of historic village Krosnowice. It is of the nature of the estate of the dominant features of non-agricultural sectors, although its landscape still shows signs of farming tradition dating back to the turn of the 13th and 14th century. The village has a characteristic configuration with many roads, and in places the original layout of the chain village. There are numerous monuments, such as a Gothic church, a Renaissance mansion, a Baroque palace, a hundred residential and commercial buildings from the 18th and 19th centuries, the first factory from the first half. of the 19th century, and numerous roadside shrines and statues from the 18th and 19th centuries [24]. There are also in its historic structure many contemporary residential buildings, which are, due to faulty location and wrong scale and / or form, a discord in the harmonious landscape of the village.

The depreciation of the landscape deepened after the economic transformation of the second half. of the 20th century, which has brought the commercialization of the properties in the village, which took place in conditions of very poor and ineffective local planning regulations. Thus, the historic layout of the village has been disrupted by the single new buildings, but also the entire groups of them. Their functional and formal layouts disrupt the communication of the traditional, typical for the site patterns (morphological signs), so do not build a sense of identity of the inhabitants.

Paradoxically, as the creator of the communication noise is also the Society of Friends of Krosnowice, which is focused on social and cultural activities, and does not show much interest to adverse changes in the landscape of the village. Lack of the harmony in the cultural landscape of the village causes a mismatch between the tourist offer and the nature of the tourism product. Therefore, tourists traversing Kłodzko land according to "The guide for the curious" [25], do not find it as described "unusual" or "magical", but rather banal.

As the illustration of the psychological noise is the deformity of the message concerning an offer of agritourism farms, that grow dynamically in Kłodzko since the 90s of 20 th century. Currently approximately 300 facilities operate in Kłodzko land, whose owners declare agrotourism activities and which, in fact, most of them reduced this activity to the provision of hotel services [26]. This demonstrates a lack of understanding of this form of tourism, despite the fact that it is supported by a number of various industry associations. Their members are mostly entrepreneurs managing holiday houses and taverns, which results in the lack of opportunities to develop working farm profile through the instruments at the disposal of these associations, and which could prevent a loss of traditional rural landscape values.

The dominant feature which is hospitality seems to confirm the nature of objects that are usually residential and service buildings with dozens of hotel type rooms, and which are not forming a part of the farmstead. The architecture of buildings and their interiors only exceptionally follow the regional tradition, and they are mostly with no style. Any reference to the tradition of offering agri-tourism sites have an incidental nature, which may wonder, due to offer of sightseeing submitted to tourists by almost all farms.

The negative effects are also sketchy local plans, which do not prevent entry into the rural tissue an alien, detached from the traditions architecture. As examples are here new buildings and villas of eclectic architecture in Goszów, and naively referring by detail to regional architecture chalets in Bielice, New Gierałtów and Goszów [27]. This demonstrates the lack of reflection on the objectives of tourism, which due to the approximation of tourists to the rural community should provide a platform for regional education, including both tourists and residents of the village.

As the example of the semantic noise in the tourism place is the project called "Jaunty Villages" run by the Foundation Kłodzka Wstępna Sudetów – Lokalna Grupa Działania. It is aimed at social mobilization of rural areas and revive the local economy through the use of local natural and cultural assets, as well as skills and interests of citizens. The essence of this project is to treat the villages of Kłodzko land as specific theme parks. They have – according to the authors of the project: "(...) serve as a unique, attractive, safe, fun and educational places (...)" [28]. And so, Konradów to act as a "Climbing Village", Chocieszów – "Sports Village", Katy Bystrzyckie – "Village of Tradition," Międzygórze – "Fairytale Village," Lutynia – "Art Village", Orłowiec – "Geo Village", New Gierałtów – "Village of Positive Energy, Ścinawka – "Ecological Village", Roszyce" – "Gardening Village", and Wójtówka – "Rural Village" (*sic!*).

Unfortunately the project, despite an ambitious declaration of its creators: "(...) We go a step further than most known and popular theme parks in the world, such as Legoland, the Museum of Technology in New York, and in Vienna (...)" [29], and the recognition by the Kapituła Fundacji Wspomagania Wsi (The Chapter of Rural Development Foundation) as one of the best agrotourist regional products in Poland in 2007, still remains a virtual environment. The reasons for this can be discerned in the sketchy and somewhat naive proposal. This almost completely detached from reality project have not convinced both residents as well as potential investors. Replacement the traditional code by the content drawn directly from the Disney Theme Parks has resulted in the disruption of

communication. It has brought the specific noise in the social space, distorting the message of the NGO message concerning self-government and participation in shaping the villages, which are places of community life, as well as the tourism products.

CONCLUSIONS

Tourist place is an expression of the historical transformation of the site, as well as contemporary community activity. There are encoded many morphological signs (patterns) of cultural content, which allow people to identify with the place where they live. The same signs are the basis for creation of various tourism products. In both cases this is done by transmitting the message relating to the cultural content of the site.

In the process of communication, there are various noises that hinder the transmission of the content, and which can cause misunderstanding between the sender and the recipient of the message. The noises can be of physical, psychological or semantic character. They are present in the physical and social spheres of the place, as well as in the virtual realm. The noise deformations manifest themselves in the morphology of urban and rural structures, in the bad management of the place due to the lack of understanding of the traditional principles, and finally in the formation of a defective image of the site based on global, not local patterns.

The communication noise cause the chaos in the physical, social, and cultural tourism sphere. It manifests itself in loss of unique features of the space, which is so important in modern tourism. Therefore, it is necessary to eliminate or at least reduce this specific noise. It can be done by referring in community activities to the local cultural code. In this way the reliable tourist offers based on local, traditional values, and not on borrowed patterns can be created. This leads to the introduction to a real, but not virtual image of the place.

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Technostress and technolust: coping mechanisms among academic librarians in Eastern and Southern Africa

by

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ABSTRACT

Several user studies have confirmed that academic libraries are under great pressure to adopt new technologies. This pressure has resulted in technostress and technolust among academic librarians. Technostress is defined as a feeling of anxiety or mental pressure caused by working with multiple and rapidly changing computer systems, and mediating between these systems and the demands of one's organisation, staff, customers, and personal life. Technostress results from poor technological change management. Technolust, on the other hand, is the continuous desire to have the latest and flashiest technological tool available even when it is not necessary.

Available evidence indicates that academic librarians experience physical and emotional stress in their efforts to adapt to the emerging technologies. Using survey research methodology, this study sought to unravel the mechanisms academic librarians in Eastern and Southern Africa employ to cope with the consequences of technostress and technolust. The findings indicate that education and training, effective time management and scheduling of tasks, resource mobilisation, maintenance of good health, improvement of personal image, and an appreciation of what technology can and cannot do, are some of the strategies academic librarians in Eastern and Southern Africa use to cope with the effects of technostress and technolust in their personal and professional lives.

KEYWORDS

Technostress, technolust, academic libraries, Eastern Africa, Southern Africa

INTRODUCTION

The environment in which academic libraries currently operate is changing drastically and becoming more complex. For instance, the emergence of new information and communication technologies, exemplified by the Internet, has changed the way people seek

information, communicate and collaborate. Thus, modern library users have embraced new information seeking behaviour as well as expectations for better usability, faster response times to needs, and constant access to unrestricted library services. As libraries struggle to cope with these changes and user expectations, some library users are already reducing their levels of usage, preferring to “Google” than visit a physical library. Similarly, library circulation statistics indicate that the usage of the traditional services and products is decreasing steadily while the usage of electronic resources and services is increasing. There is also a perceived increase in the usage of libraries which offer Internet access and other online services (D’Elia *et al.* 2002). This observation is also supported by the Public Access Computing Project (PACP)⁸³ studies which have provided anecdotal evidence that including Internet access points and other electronic services in libraries increases library usage (Kinney 2010).

The Centre for Information Behaviour and Evaluation Research (2007) also argues that modern library users seem to have embraced a new information seeking behaviour that is not compatible with the old library service model nurtured in a hardcopy system and, in many respects, still tied to it. Instead, this information seeking behaviour can be characterised as being horizontal, bouncing, checking and viewing in nature. Therefore, current library users are perceived as being “promiscuous”, diverse and volatile. This information seeking behaviour is described as a form of skimming activity, where people view just one or two pages from an online resource or site and then “bounce” out, perhaps never to return. The Centre for Information Behaviour and Evaluation Research (2007) further suggests that modern library users: 1) are generally more competent with technology, pick up these skills on the move through trial and error and expect a lot from ICTs; 2) prefer interactive systems and are turning away from being passive consumers of information; 3) have drastically shifted to digital forms of communication such as texting rather than talking; 4) multitask in most, if not all, areas of their lives; 5) prefer info-tainment approaches to traditional information provision; 6) have limited tolerance of delay in the provision of services; 7) find their peers more credible as sources of information than authority figures and structures; 8)

⁸³ This is a research organisation conducting studies on a number of librarianship issues and supported by the Gates Foundation and other philanthropic organisations. A number of these research findings and reports are available on various websites.

feel the need to remain constantly connected; 9) believe everything is on the web; and 10) are format agnostic.

Critically, most of these users do not presently perceive the academic library as the first or only stop for information. As the pace of change in academic libraries accelerates, the greatest challenge the libraries and librarians now face is how to keep up (Courtney 2007). Attempts to keep up have created immense pressure on the libraries to modernise and improve their services and products. Although there are several perspectives to library modernisation such as user-centricity, user participation, flexibility of operating hours, ease of access, ease of search across databases, round the clock access to library services and resources, renovation of the physical library spaces and library programming, most users seem to equate library modernisation with the adoption of the emerging technologies (Choh 2011). Indeed several user studies confirm that libraries are under great pressure to adopt new technologies. This pressure has resulted in technostress which is described as the stress resulting from inability to cope with technological change (Brod 1984; Kupersmith 2012) and technolust which is obsession with technology.

METHODOLOGY

The authors used a survey research methodology to unravel the mechanisms academic librarians in Eastern and Southern Africa employ to cope with the consequences of technostress and technolust. Data for the study was collected through a semi-structured, self-administered online questionnaire facilitated by SurveyMonkey software. The authors solicited the responses of academic librarians in Kenya and South Africa by sending the hyperlink of the online questionnaire to academic librarians selected purposively, based on an information-oriented sampling approach.

TECHNOSTRESS

Stress is defined as a psychological or physical response of the body that occurs whenever one attempts to adapt to changing conditions, whether those conditions are real or perceived, positive or negative. Selye (1979) defined the three stages of reaction to "stressors" in the environment as alarm, resistance, and exhaustion (in extreme cases where stress is serious and prolonged.) Symptoms of stress may be physical (muscle tension, rapid heartbeat, dry mouth and throat, shallow breathing, headaches, gastric problems), cognitive (mental fatigue, inability to concentrate, poor judgment), affective (irritability, anxiety, mental fatigue, depression, nightmares), or behavioural (impulsiveness, avoidance, withdrawal, loss of

appetite, insomnia) (Kupersmith 1998). Other symptoms of stress include feelings of isolation, frustration, self-deprecating thoughts and apologetic attitude.

The term technostress was introduced by Craig Brod in his book *Technostress: the human cost of the computer revolution* published in 1984 (Brod 1984; Kupersmith 1998). He argued that the computerisation of society can change people's attitudes and norms via the socialisation process, since the computer is held in high esteem. He emphasised that people should be aware of the impact of machines so that they control the machines rather than the machines socialising them. He described technostress as a modern disease of adaptation caused by an inability to cope with the new computer technologies in a healthy manner. He explained that technostress manifests itself in two distinct and related ways: in the struggle to accept computer technology, and in the more specialised form of over-identification with computer technology. Kupersmith (1998) adds that technostress is part of the price the modern generation pays for living in a time of revolutionary and dramatic change.

Technostress has also been described as a feeling of anxiety or mental pressure from overexposure or involvement with technology. It is any negative impact on attitudes, thoughts, behaviours, or body physiology that is caused either directly or indirectly by technology. One well-documented form of technostress is the escalating problem of information overload, colloquially called "data smog" (Kupersmith 2012). Technostress can also be associated with technology related performance anxiety (the feeling that one cannot use technology systems effectively or help others to do so), role conflicts (uncertainty about one's role), and disparity between increasing demands and decreasing resources (Kupersmith 1998). Poor user interfaces, lack of standardisation, networking and security issues, hardware and ergonomic problems may also cause technostress (Kupersmith 2012). Technostress is people's reaction to technology and its impact on them. It is becoming more prevalent with the increasing ubiquity of technology. Its impact permeates all spheres of life.

Prabhakaran and Mishra (2012) also explain that technostress results from poor technological change management. They explain that technostress is manifested by multitasking madness (inability to multitask efficiently), burnout, fatigue, frustration, withdrawal, and information overload.

Several scholars have studied technostress in libraries. Ennis (1997) studied technostress in the reference environment of college and research libraries in the United States of America and concluded that the majority (51 percent) of reference librarians experienced technostress.

A study by Kupersmith (2003) also revealed that 59 percent of librarians had experienced increased levels of technostress in the past five years prior to 2003. The study also found that 65 percent of those who had experienced increased technostress considered it a serious problem. Respondents to Kupersmith's (2003) study also identified information overload, networking problems, security issues, computer hardware and ergonomics, and vendor-produced databases as some of the causes of technostress in their lives. Other causes of technostress were identified as new things to learn or monitor constantly; irrational patron expectations of technology; dealing with other people's technostress; managing electronic subscription access; spam; un-described, unannounced, uncontrolled changes; working around limitations in library catalogue systems; and migrating to a new library systems. Bichteler (1986) explains that some librarians have reported a personality change as a result of being too technology-oriented. As a consequence, they have reported being more irritable and impatient when dealing with unorganised or illogical people. The librarians have also reported that they have increasingly lost their conversational capacity as a result of being more exposed to technology than human beings.

Prabhakaran and Mishra (2012) further explain that librarians have indeed experienced physical and emotional stress in their efforts to adapt to the emerging technologies resulting in higher levels of absenteeism and turnover. The situation has been exacerbated by the rapid pace of technological change (usually at the whims of vendors), lack of standards, expanding roles of librarians, rising costs of technology against dwindling library budgets, high expectations from users emanating from the belief that information is instantly available through technology, and information overload.

Isaacson (2006) argues that one way of dealing with technostress is by libraries seeking to only meet the needs of users, not their wants. There is contention, however, on who and how to determine library users' needs and wants. Isaacson (2006) justifies his view by explaining that a library should not try to compete with Barnes & Noble, which is interested in direct profits. He concludes that libraries should not experiment with populist ideologies and technologies but should be brave to tell the users that some questions need to be sifted, refined, checked in multiple sources, and perhaps even reframed before they can be answered adequately. He admits that there are occasions when the librarians may be wrong, but he also emphasises that the users cannot also always be right. He cautions that there is no need for "Wal-Mart greeters" in libraries. Stephens (2006) also suggests that modern librarians should control technostress by not adopting technologies just because it is "cool" to do so.

Kupersmith (2012) explains that moderate stress can be beneficial and stimulating. However he adds that severe and prolonged stress can have harmful physiological and psychological effects. It is also important to note that technostress is just one form of stress. In fact, it is rarely exhibited alone. It often synergises with other forms of stress to present compounded symptoms and effects. Therefore managing technostress requires a holistic approach. Prabhakaran and Mishra (2012) assert that technostress management is critical to librarians since most of them are older and are prone and are exposed to more stress factors and psychological disorders.

TECHNOLUST

Technolust is defined as the constant desire to have the newest, flashiest, fastest, shiniest technological gadget available even if one does not need it. Technolust can also be perceived as a passionate desire for technological fulfilment. Stephens (2008) adds that technolust is an irrational love for new technology combined with unrealistic expectations for the solutions it brings. He emphasised that new technologies cannot, on their own, save any library. He advises libraries not to make new technologies to become the centre of their missions.

Technolust drives people to acquire new technologies without careful planning, an environmental scan of the current landscape, and a complete road map for training, roll out, buy in and evaluation. People exhibiting technolust are in a rush to add new technologies as soon as they hit the shelves just to boost the coolness factor (Stephens 2004) even if they cannot afford it. Technolust is a form of obsession or addiction to new technologies; it is a compelling desire to get the coolest technology.

Technolust is perceived as one of the desires that have nothing to do with people's real wants and needs or the reality in which they live. It is an extreme form of consumerism fanned by an abundance of "must-get" gadgets flooding the market.

New terms such as techno-shame, techno-hesitation, techno-banality and techno-phobia have also sprung up to describe behaviour contrary to technolust. The terms generally refer to the tendency to keep using the technology one has, as long as it is still useful, before acquiring emerging technologies. Techno-banality is the extreme opposite of technolust. People exhibiting techno-banality have been described as dunce (technologically) and possessing obsolete gadgets. Such people fear to adventure and experiment with emerging technologies and prefer to keep with the tested.

It is not desirable of librarians or library users to exhibit either tendency; a balance between the two extremes is recommended. A similar approach should be applied at the organisational level as well so that libraries do not end up with pieces of technology which they do not need.

FINDINGS AND DISCUSSIONS

Presence and nature of technostress

Twenty-five academic librarians responded to the questionnaire. Of these nineteen (76%) said they have experienced technostress while six (24%) said they had not. 44.4 percent of those who had experienced technostress said that it had increased in the past three years; 22.2 percent said it had remained neutral; 16.7 percent said it had increased greatly; 11.1 percent said it had reduced; while 5.6 percent said it had reduced greatly. Thus, the majority (61.1%) said their levels of technostress had increased while only a minority (16.7%) said that their levels of technostress had reduced. Fig 1 below summarises the results of change on technostress levels:

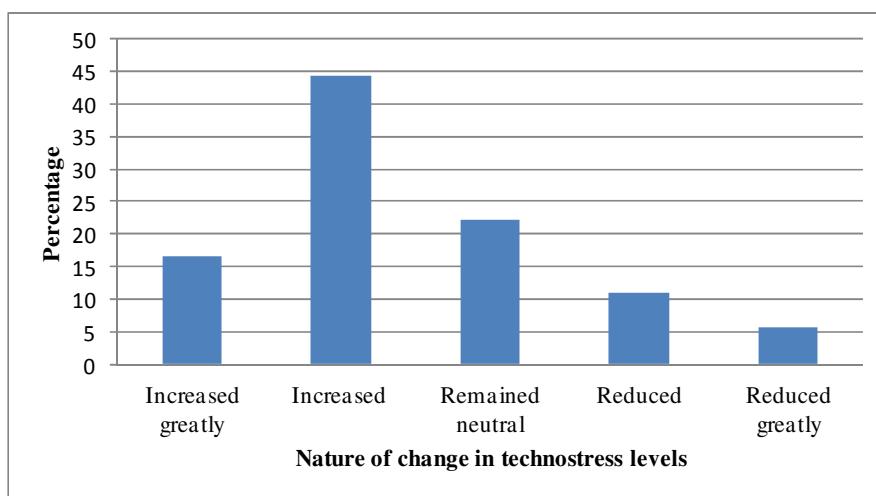


Fig 1 – Change in technostress levels over the past three years.

Seriousness of technostress

The majority (44.4%) of the respondents who had experienced technostress said they found their levels of technostress to be a little serious; 22.2 percent said it was neutral; 16.7 percent said it was serious; 11.1 percent said it was not serious at all; while 5.6 percent said it was very serious. Thus, the majority (66.7%) considered their levels of technostress as serious though in varying degrees.

Causes of technostress

Few access points to some technology systems against many users of the system; performance hitches by some systems; eye-strain; rapid technological change; many profiles

(usernames and passwords) to master; use of obsolete systems; pressure to stay up to date and work efficiently (seamlessly) with the latest technology; pressure to adapt quickly and adopt the latest trends; desire to remain ahead of the market; failure to get expected results from technology; inadequate technological infrastructure; having to learn so many things at one go; lack of support; spam; too much work to be done too soon; inadequate technological skills; heavy workload; inadequate technology standards; and unreliability of technology were identified as some of the major causes of technostress amongst academic librarians in Eastern and Southern Africa.

Ways of coping with or minimising technostress

The respondents proposed the following strategies to help minimise technostress in academic libraries: the libraries should move at the same pace with the development of systems in the market; staffing needs should be considered while implementing technology projects to ensure smooth deployment; keeping a record of passwords; continuous training of librarians to develop skills in the emerging technologies; effective communication; effective change management plans; realistic time scheduling to reduce attempts to accomplish different tasks at once; improving technological infrastructure; providing adequate resources to support technology projects in the libraries; providing ample time to learn and implement the new systems; establishing and using communities of practice to facilitate sharing of ideas and best practices; only attending to the most relevant, personally useful and necessary emails and alerts on the various media and technological gadgets; developing and maintaining comprehensive technology standards.

Technolust

The majority of the respondents (55%) have experienced technolust. The respondents also attributed technolust to peer pressure (“Everybody has it!”); competition to have the best, the latest and the flashiest; new features and abilities of the newer technology hence need to adopt; demand from users or stakeholders; pressure to retain users as some of them withdraw from using the library and look for alternative ways where they can use the new technology; changing needs of the users; and panic. The respondents also said that technolust leads to dissatisfaction or discontent with the library; conflict with decision makers; frustration; bureaucracy; exhaustion; withdrawal; poor service delivery; anxiety; reduced morale; increased costs; and increased workload.

The respondents also suggested that academic institutions should provide more resources for the libraries; decision makers should be more accommodative and prompt; libraries should acquire technologies with long “shelf-lives” and that are futuristic; libraries should invest in staff development; librarians should not bow to peer pressure; librarians should maximise the potential of the tools they currently have; and librarians should be realistic.

CONCLUSION

The presence of technostress and technolust amongst librarians is real. Different people respond to and deal with technostress and technolust in different ways. It is evident from the foregoing that there is no magic bullet to deal with technostress and technolust among librarians. The authors propose the following strategies for academic librarians in Eastern and Southern Africa to enable them to cope with the reality and consequences of technostress and technolust in their personal and professional lives:

Workload reduction

Heavy workload is one of the major causes of technostress and technolust in academic libraries as librarians try to embrace the latest technologies to keep pace with the demands of the library users. Librarians should take mini-vacations throughout the work year; take periodic breaks during work; change routes to and from work; create time to run personal errands such as paying bills or housekeeping; and interact more with colleagues and users. Other ways of reducing workload include approaching problems in a systematic way, setting realistic goals, setting aside time for learning, fostering a culture that values cooperation and is positive about technology and providing adequate equipment, training, and technical support (Kupersmith 2012).

Librarians should also admit what they cannot do and inform library users of the same; apply a sense of humour in their work; develop and sustain a cordial working relationship with the users and colleagues; step away from the areas of stress so as to get time to reflect, rejuvenate and map out a way forward; ask for help when it is necessary; create opportunities to learn; develop and use written “to-do” lists to manage time better; prioritise tasks; and know when and how to say “No” and make it clear that they cannot do everything (Kupersmith 2003). Outsourcing or hiring a dedicated techie for the library may also help reduce the workload.

Training

Training and education is another way of coping with the impact of technostress and technolust. Training develops the capacity of the librarians to understand and appreciate technological trends, manage change effectively, and explore alternatives to frustrated goals. Individualised training is recommended where possible.

Good health

Proper nutrition; exercise; breaking of unhealthy habits such as smoking, drinking or excessive eating; meditation; and relaxation can help the librarians to generate sufficient social, physical and psychological energy to cope with the consequences of technostress and technolust.

Independence, self-sufficiency from technology

Librarians should be encouraged to use technology selectively. They should be helped to understand that not all technologies are useful for their personal or professional needs. Thus, they should be encouraged to use technology which works for them; stay cool when technology is not working; schedule time away from technology to avoid overdependence on technology; boost personal image to forestall peer pressure; and develop capacity to impart the same skills to their clients.

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Digitizing the Legal System: The Process Intervention

by

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ABSTRACT

Singapore is well known to have successfully deployed information and communication technologies since the early 1980s. Its success was much based on its leadership in strategizing, planning and implementing the many facets of the various public and government sectors. This paper analyzes the nation's effort to implement its legal systems. We proposed a framework to demonstrate that the successful implementation of the electronic litigation system through the concerted and coordinated efforts of the leaders operating at different levels. We also highlight the important influence of shared leadership in converting potential value to realized value. The research adopts a qualitative approach where data were collected and analyzed from interviews as well as questionnaires. Based on the empirical analysis, we find that such shared leadership occurs in layers - at different phases - progressively impacts the business value of ICT.

Keywords:

Business value of IT, IT leadership, electronic government, digital court system.

1. INTRODUCTION

Since the late 1980s, the Singapore government has been building capabilities in e-Services starting with the launch of the National IT Plan to leverage on networking technologies like EDI and ISDN (Tan, 1999; Tan & Yong, 2003). In particular, government agencies have initiated and facilitated much business-to-business (B2B) and government-to-business (G2B) projects which have helped to improve the efficiency and productivity of various industries (Teo et al., 1997). Examples include EDIMAN, EDITRANS and TradeNet – the latter was the world's first nationwide IT-based trade documentation system that allows the trading community to perform electronic submission of permit applications to government agencies, and receive the requisite approvals expeditiously (Gwee & Tan, 2002).

Against this backdrop, an initiative that has received worldwide attention is the implementation of the electronic litigation system in Singapore (Accenture, 2003). The city state has a driving ambition to become a financial centre and the availability of high quality legal services is one of the most important pre-requisites (ILSAC, 1998). Work in law firms involves high information and knowledge intensity – and to support the needs of clients - the use of IT is needed to provide a structure for knowledge management as well as to streamline administrative activities. However, the implementation of the electronic litigation system in Singapore has not been totally smooth. For example, even though the Electronic Filing System (EFS) component of the project has been credited with paving the way for the world's first nationwide paperless court system, there was initial strong resistance from the legal profession after the implementation of its first phase (ST, 2003a). Considering the scale of the project, it is clear that much leadership and coordination are required of the various government agencies involved in the implementation. For instance, even though top leadership have the vision that IT could be used effectively, however, this had to be endorsed by concerted and coordinated action on the ground in bringing the vision to fruition. Therein lies the motivation for this study – exploring the influence of leadership in visioning the potential value of IT and its effort in working to realize the value in the legal sector. Over the years, the legal sector has seen the implementation of various technological systems to help increase its effectiveness and operational efficiencies, to improve its accessibility to the public, to reduce costs and to enhance the nation's competitiveness. These government-initiated efforts started with the LawNet project (knowledge repository focus) in the early 1990s and have since evolved into an ambitious vision of implementing a “total and integrated electronic litigation system”.

2. LITERATURE REVIEW

2.1. Business Value of IT: Potential vs. Realized

Davern and Kauffman (2000) suggested two types of business value in deploying IT: potential value and realized value. Potential value is the maximum value that can be gained if IT is implemented strategically and realized value is the measurable value that is achieved after the successful implementation. Realizing the potential value is dependent on effective IT planning and strategizing to overcome “conversion contingencies” – in other words, the extent to which the potential value is realized depends on how well the implementation is carried out in practice. Often, the realized value is much less than the potential value since problems are likely to occur during the implementation and unexpected deviations from the

plan may then become necessary. However, the discussion on the value of IT suggests that effective leadership is critical in major IT implementations. Indeed, leaders involved in such projects can have a direct influence on how well the potential value is realized based on their timely and appropriate actions and responses to contingencies as they arise at three different levels: strategic, tactical and operational.

2.2. Change Leadership

When a major technology is introduced in an organization, controversy can result as the accompanying changes can often be politically sensitive, emotionally charged and publicly visible, thus, requiring leadership to help coordinate and take into account the needs of various parties or factions in the organisation (Klenke, 1993). Although there are several leadership theories, Klenke identified key leadership roles as decision makers, motivators, change agents and strategic leaders while Bass (1985) discussed the different characteristics of transactional versus transformational leadership. However, in technology-driven change, strategic leadership is required to get the organization to fully understand the underlying value proposition, that is, clear recognition of the system's potential value.

At the tactical level, an effective organization would have to be adaptive to make changes to its plans when the circumstances arise. Tushman and O'Reilly III (1996) discussed this importance of ambidexterity in the organization, when managing evolutionary and revolutionary change. Alignment between the strategy, structure, personnel and culture of an organization allows evolutionary changes. However, the success of evolutionary changes can later lead to structural inertia, as organizations develop structures that are resistant to large changes. Such revolutionary changes often require a major shift in the strategy, structure, people and/or culture of the organization. In this context, Gibson and Birkinshaw (2004) described how contextual ambidexterity arises when the leadership display a supportive context, allowing individuals to conduct exploitation-oriented (for alignment) and exploration-oriented (for adaptability) activities to improve their performance and competitiveness in a dynamic environment. To effect IT-based change, specific forms of leadership intervention are necessary since the introduction of a new technology is often an "intrusion" into an organization. Hence, how it is implemented is important in determining its success (Markus & Benjamin, 1996).

Huy (2001) identified four types of change actions, namely, commanding, engineering, teaching and socializing. A commanding form of intervention is useful for changing formal

structures, where the change agents use direct and coercive actions to achieve their goals. When a commander-like style is used, threats and holding people accountable are common methods used to ensure compliance. An engineering style concentrates on changing the work processes and increasing productivity through the process of analyzing, understanding, and redesigning. This form of intervention usually takes time and due diligence, as the change agents need to be engaged with the employees in analyzing and redesigning work processes. The success of such an intervention depends on whether employees will make use of the new work processes on a sustained basis. In a teaching type of intervention, a learning approach is adopted and the agents facilitate the reeducation of the targets to bring about changes in their beliefs through sense making. Here, the idea is that a change in beliefs will bring about a change in behavior. These leaders are also sympathetic in nature so as to generate trust and many are trained as both process consultants and psychoanalysts. A socializing style focuses on improving the social relationships within the organization. It is also felt that a change in behavioral interactions will bring about a change in beliefs and organizational culture. The underlying premise here is that by making the social bonds strong, stability will be achieved, which will be useful when major changes are being made in the organization. In summary, it appears that in order to lead and effect planned change, various stakeholders may have to exercise appropriate leadership in order to jointly bring about the full realization of the potential business value of IT implementations.

2.3. Shared Leadership

Pearce and Conger (2003) suggested that models of shared leadership may better fit the real-world situations in which different individuals are often called upon to provide specific leadership, each making a unique contribution to the process of change in the organization. Building on the notion of shared leadership, we propose a framework to describe how leadership from key stakeholders can facilitate the realization of the value of IT, that is, bring about the transformation from potential value to realized value in a major IT project. We contend that the ideal leadership should be shared (vertically) among the different levels (strategic, tactical and operational), and with each level playing its part in jointly bringing about the IT implementation. Also, this leadership may be further shared (horizontally) among the various groups of people at each level. Overall, this creates a layered impact on the value that is progressively derived from the implementation as illustrated using a conceptual framework shown in Figure 1.

2.4.

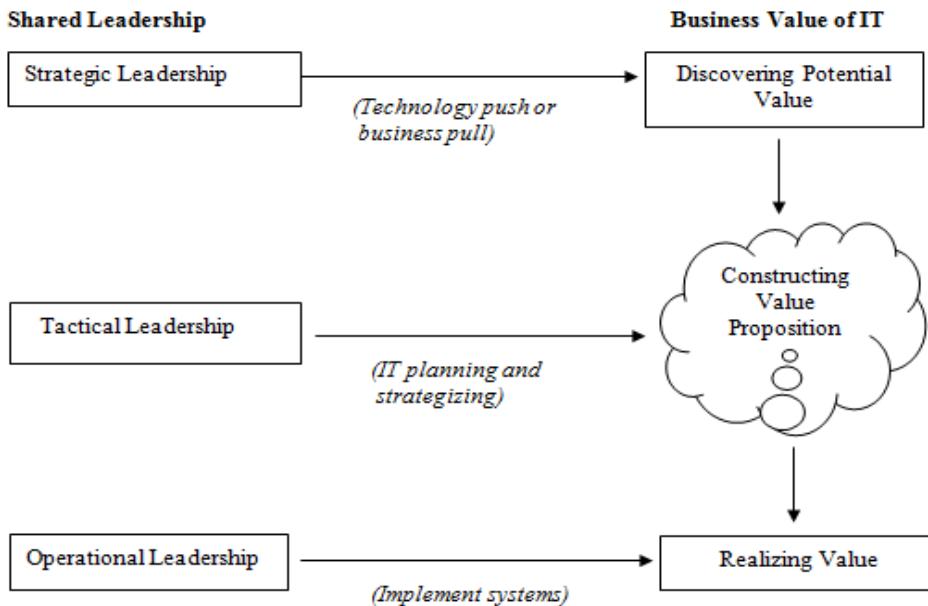


Figure 1: Preliminary Conceptual Framework

2.5. Conceptual Framework

The framework begins with the strategic process of “discovering potential value” on the part of top leadership - either through a technology push or through a business pull. The former occurs when “a technology solution is discovered that can address a previously undiscovered business problem or opportunity” while the latter occurs when “a business problem or opportunity is the first thing to be identified, and only then is the impetus provided for the development of a technology-based solution” (Davern & Kauffman, 2000).

Pursuant to this value discovery, a “constructing value proposition” process is posited to be set in motion. Generally, it involves careful IT planning and strategizing by the leaders to obtain buy-in through advancing a value proposition that the benefits of the project would greatly outweigh the costs involved. Specifically, it involves a process at the tactical level during which the leadership attempts to secure the participation of the stakeholders through persuasion, incentives, seeking mutual understanding, appeals to authority, and obtaining feedback to fine-tune the proposed implementation.

Once implementation begins, the process of “realizing value” is posited to be triggered into motion. Generally, it involves converting potential value into realized value by

leveraging opportunities and overcoming contingencies as they arise during the implementation (Chircu & Kauffman 2000; Davern & Kauffman 2000). The ideal set of eventual outcomes is characterized by the extent to which the system is used in a comprehensive and integrated manner to support work processes, and the degree of interfacing and integration with other applications.

3. RESEARCH METHOD

We view the process from discovering to realizing value as a sequence of events that describes how things change over time (Van De Ven, 1992). Thus, this study is concerned with the analysis of the sequence of events, actions and activities unfolding over time in context (Pettigrew, 1997). In this way, the analysis of the process would allow for investigation of the ways in which people at different levels of the organizations create patterns of interaction. Such analysis would assist in providing a (theoretical) understanding of the trajectory course of the phenomenon under study as it evolves over time and the actions/interactions contributing to its evolution (Garrety & Badham, 2000).

The qualitative research method was deployed to collect data using face-to-face in-depth interviews and onsite observations of work procedures. Data was collected over a period of 18 months and the interviews involved 34 key informants as listed in Table 1. During the data collection phase, relevant documents were accumulated on an ongoing basis and periodic on-site visits were made to observe the systems being supported and/or used. Onsite observation was critical as it helped the researchers understand the integration of the internal and external systems as well as the day-to-day routines of staff using the systems. Further, it provided the researchers the opportunity to interact with the staff of various organizations so as to have a better understanding of the work processes and how technology has affected the employees.

Open-ended semi-structured interview questionnaires were developed so that the data collection efforts became more focused. Appendix A shows the examples of key questions asked and how they largely revolve around the themes. The interviews were useful as the researchers were able to understand employees' attitudes and perceptions towards IT as they elaborated on the benefits and problems faced by them. Interviews were first transcribed on paper, and then analyzed for emerging themes. Certain keywords frequently repeated in the interviews and other documents/notes were coded to generate and construct the main themes, which in turn provided the premise for the eventual findings.

Table 1: List of Key Informants

Singapore Academy of Law (SAL)	Assistant Director Business Development Manager
Supreme Courts	Senior Assistant Registrar
Subordinate Courts	Registrar
Attorney General's Chambers	Deputy Senior State Counsel
Infocomm Development Authority	IS Manager
BiziLaw (software vendor)	Directors (2)
CrimsonLogic (software vendor)	Administrator
Law Firms	Lawyers (13) Secretary BizNet clerk EFS Court clerks (2) EFS Administrators (2) IS Manager Systems Analyst Litigation Support managers (2) Library Manager Knowledge Management Dept employee

Secondary data collection was collected through examination of newsletters, minutes of meetings, strategy documents, internal memos, professional reports, books and newspaper articles. To deal with the huge amount of data collected, analytic strategies were used which included reviewing regularly and developing ideas as the research progressed. Indeed, the observation and verification became iterative processes – “one observes, follows themes and trails, identifies patterns, have those patterns disconfirmed or verified by further data, and the process moves on” (Pettigrew, 1990). Finally, the interim papers (building up to the eventual final report) were given to two persons (the Assistant Director and the Business Development Manager of the Singapore Academy of Law) for their review and comments. Factual inaccuracies were corrected based on the feedback received.

4. RESEARCH FINDINGS

4.1. Case Background

This Singapore judiciary has been credited as being one of the most advanced users of technology (Accenture, 2003) even though it is noted that its state of affairs is less than satisfactory. It was because there were thousands of cases which had clogged up the court system in addition to various inefficiencies within the judiciary itself. One problem was the access to case-related information - such information was not comprehensive or available in a systematic way. As such, lawyers or members of the public had to go to the court personally to find the relevant information, which was time-consuming and tedious. For example, a

search on the status of a company in a winding-up petition could, for instance, would take a few days or even weeks (Thian, 2004).

When Chief Justice Yong Pung How was appointed the head of the Judiciary in 1990, significant efforts were initiated to reorganize the inefficiency of the Judiciary system so much so that in the process of implementing IT, the legal landscape was decidedly transformed (Magnus, 1999). Initially, the most pressing concern was the massive backlog of cases which had accumulated, some from the early 1980s. However, an impediment to the effective tracking of the thousands of cases at that time was the lack of key management information on cases and caseload. Case information was recorded in paper form; indeed, this provided the impetus for an overhaul of how the court system should record, keep and archive information to make it easily accessible. It was the urgent need to develop a case management system that precipitated the use of IT in the Judiciary (Thian, 2004).

It is important to note that the objective of LawNet in 1990 was to provide a single window into all the various laws and legal information so that law firms would no longer need to maintain multiple subscriptions for various electronic legal services. This was accomplished by computerizing a national legal information database – a one-stop centre for various information repositories to provide the legal community electronic access to legal information. The aim is that carrying out legal research would then become more convenient, time-saving and effective, as lawyers would no longer have to spend long hours in the physical library laboriously searching for precedents and authorities.

Beyond the initial repository focus, an integrated electronic litigation system (ELS) comprising various state-of-the-art technologies has been gradually taking shape. The system consists of the Electronic Filing System (EFS) (for electronic filing of court documents, obtaining electronic extracts, electronic service of documents - on other law firms - and access to electronic information services), Electronic Hearings, Technology Courts, Practicing Certificates e-Filing Service, LawNet Litigation Module, Internet Videophone Service, Mobile Information Service, Wireless Internet Hotspot and JusticeOnLine. JusticeOnLine (based on broadband Internet and videoconferencing technologies) was implemented as a multiparty communication platform connecting the courts, law firms and other government agencies involved in the administration of justice (Magnus, 2004).

Among the various legal systems, perhaps the most noteworthy is the EFS which is the world's first nationwide paperless court implementation. Its benefits include time savings and

reductions in the number of physical trips being made to file court documents, the ability to submit cases twenty-four hours a day and the resolution of the difficulties of paper handling that is faced by the judiciary. A good case in point is the antitrust case against Microsoft that was filed in the San Francisco Superior Court some years ago. The judge concerned ordered electronic filing of all documents so that the physical courtroom would not be overwhelmed by case papers and to better manage the huge volume of filings resulting from the complex lawsuit (Holmes, 2001). Over time, enhancements (such as adding Web-based and other capabilities) have been made to the EFS, with all affected public and private organizations jointly involved in the implementation efforts.

However, it should be noted that the relentless search for greater efficiencies was not without cost – between 1999 and 2001, 624 young lawyers left the legal practice citing long working hours and work stress as reasons for their departure (Ho, 2004). Nevertheless, Singapore's effort at reforming its legal sector was being recognized. The Swiss-based IMD World Competitiveness Yearbook ranked Singapore 1st (for legal framework) and 6th (for justice) in 2003, while the Political and Economic Risks Consultancy (PERC) group gave Singapore the top position in Asia for overall integrity and quality of the legal system that same year. In fact, Singapore's score surpassed the score for the United States and Australia, thus signifying the confidence of the high standards of the Singapore's judiciary.

4.2. Discovering Potential Value of IT

Computerization of the judiciary actually began in the late 1980s but it picked up speed only after Chief Justice Yong was appointed in 1990:

"When I was first appointed Chief Justice, it would take roughly five years for a suit begun by writ to be heard, and a further two years before it went before the Court of Appeal... This was unacceptable... I realized that judges would have to become managers of cases, setting the pace and monitoring the timelines. They would have to be administrators as well, learning how to run an efficient judicial system. And because they would require technology to maximize their ability to administer and manage the judicial system, they would have to become technopreneurs as well. The legal profession would have to adapt to the changes in the judicial system by working harder, faster and more efficiently. They too would have to become knowledge workers and technopreneurs..."

Chief Justice Yong Pung How's comments in Subordinates Court Annual Report 2000

In 1991, a high-level Law National Council was formed to oversee the LawNet project and it comprises the Chief Justice, Attorney-General, Dean of the Law Faculty, Minister of Law and President of the Law Society. LawNet was given a further boost as part of the

government's initiative to modernize the legal profession (BT, 1992a). Particularly noteworthy was Chief Justice personally officiating at many launches of LawNet enhancements over the years (e.g., BT 1992a; BT 1992b; ST 1998) while his speeches at the opening of each new legal year would inevitably touch on the importance of IT to the legal profession (e.g., ST 1995b; ST 1999):

"When I was a young practicing lawyer half a century ago, I remember trying to make sense of a mountain of cases, statutes and books which I had located for particularly arduous cases. The only way to view everything in context, to see the relationship between them, was for me to take over a large section of the firm's floor space, lie down on the floor with law reports and text books opened out, in an attempt to achieve what I believe the computer whiz kids of today would call 'hyperlinking'. Thankfully, technology has come to the rescue and today's lawyers will not have to resort to territorial expansionism to carry out legal research that I used to have to do."

In response to the massive backlog of cases, a mainframe-based case management system known as the Civil System was developed and by the mid-1990s, the backlog of cases in the court docket was cleared. This success which the courts had in improving the judiciary reinforced that technology, harnessed with purpose and innovation could be instrumental in building up a first-rate Judiciary beyond LawNet's initial objective of being just a knowledge repository. In other words, it became clear that an efficient and responsive justice system can be facilitated by the strategic deployment of a holistic IT system to help in judicial decision-making, to expedite case handling and to enhance public access to justice (Magnus 2004):

"The Honourable Chief Justice Yong Pung How had a vision of a world class court system. He wanted technology as a tool to leverage that vision – but with the basic tenet that it should never be more than a tool. Litigation is about people."

Deputy Registrar of the Supreme Court (Inter Se 2002)

"Clearing the backlog of cases was only the first step. After the backlog was cleared, the new focus was on the higher goal of how to make our judiciary a world-class organization. What makes for a world-class court? It not only has to dispense justice swiftly and fairly, but it also has to be able to adapt and respond to the changes in its environment..."

Chief Justice Yong Pung How's comments in Subordinate Courts Annual Report 2000

Further, the judiciary moved rapidly from tackling operational issues towards envisioning the courts of the future – with IT as a key component of the strategy (Magnus, 1999). Thus, the vision of a paperless courtroom system was born. It was envisioned that such a system would require the computerization of every single court process, from the filing of court

documents and preparation of cases to the actual trial before the judge. These various initiatives gradually folded under the umbrella of implementing a “total and integrated Electronic Litigation System” revolving around the EFS.

Constructing the Value Proposition

In 1996, the Singapore Academy of Law (SAL) took over the running of LawNet and started levying a subscription fee for LawNet services. Through the subscription, lawyers and others can obtain information on civil suits filed at the courts, Singapore statutes, case laws, bankruptcies and other court matters through their computers (ST, 1995a). Also, the LawNet Service Bureau was set up for lawyers who did not have the technologies to obtain electronic information from their offices (ST, 1995b). While SAL was the coordinating body, key members of the Judiciary were also instrumental in pushing the electronic litigation vision:

“Quite a bit of IT is judiciary driven.... We actually focus on the use of technology to better the administration of justice at all levels... the push by the judiciary helped...”
- Senior assistant registrar

The core technological component of the electronic litigation vision was the EFS that started as a pilot project (Phase 1.0) from 1997 to 1999 with four main services: an electronic filing service, an electronic extract service, an electronic service of documents facility and an electronic information service. On 8 March 1997, Chief Justice officiated at the launch of the pilot phase with the following exhortation to the legal community:

“Of course this new system is not an isolated accident, but the result of a concerted effort, since the start of the 1990s, to realize the full potential of information technology...Our past experiences have accordingly prepared us for what may be described as the judiciary’s most ambitious technological project to date...”

Prior to the launch, practitioners from over 600 law firms were invited to a series of dialogue sessions held by Supreme Court Registry officers. To gain acceptance, regular tips and information about LawNet were provided in newsletters of the Singapore Academy of Law to help the legal sector to be familiar with IT. There were also many training sessions:

“Well, we need to have pretty good training, it is just not the same plain vanilla training that you get, you know, at Informatics [a private IT training school] and what have you. We needed people to be trained in the specific things which we were making available to law firms. So we set up a training center and we provided specialist courses in those aspects of IT.”

- Deputy Senior State Counsel

While the reorganization of the judiciary in the 1990s has been referred to as its “golden years” (Thian 2004), this journey towards a paperless courtroom has not been without problems. First, there were early concerns about the impact on small law firms which prompted the Minister of Law to publicly state in Parliament that small law firms would be “treated no less favorably” than other small enterprises if they apply for financial assistance under the Small Enterprise Computerization Programme (BT 1991). During the EFS pilot, there were complaints from lawyers that they preferred the tried and tested method of sending their clerks to the courts with paper documents. This was because they were concerned that pages might be transmitted only partially, or not filed on time because of some electronic glitch. There were many skeptics then:

“They had to force certain small firms into it; some didn’t even have PCs at that time...”
- Lawyer A

“For small firms at beginning, they were scared whether this thing can carry on or not, but now mostly they know the system can work... Earlier, some see this machine and scared you know, whether they can handle it or not... All the court clerks went down to the courts with one another and assist with the filing – we used to join the queue together and start catching up – how this thing can be done or not, then some of them got scared...”

- Court clerk at a law firm

In fact, a few lawyers and judicial officers pointed out that even some of the judges preferred to print out documents rather than refer to the computer screen during hearings. However, the judges) were seen as trying their best to adjust to the new courtroom dynamics:

“In a trial in a high court, you might get papers that fill up the entire table, now to access the documents on a screen is a strain and it is slow, it is much easier to flip through pages than to go through documents on a screen...”

“You know, on paper, it’s easy for me to flip to a particular page I want, but in electronic format however much you try and build in those navigation, it still lags a little behind in terms of intuitive ease of use and you also need to deal with the fact that different judges have different levels of comfort with technology. So, to expect all the judges to embrace the use of electronic documents in court are a bit unrealistic...”

“The judges themselves, especially the older ones were trying their best to use it, especially since many have come from a generation where IT was still absent, and there was no such thing as a School of Computing...”

The Supreme Court Registrar argued that the resistance to change was expected and this was why the EFS system included disincentives: when implemented fully, it would cost 50 per cent more to file a court document manually:

"Here, we know the value and benefits ... convenience of this new way of working for lawyers. We have to adopt a paternalist approach to encourage lawyers to use the system. The day will come in the not-too-distant future when lawyers say we can't do without EFS... There are over 3000 lawyers now, a large majority of which are young. Those 50 and above are a minority. Their number will dwindle as time goes by. But older ones are the senior partners. They hold the purse strings. Our message to them: You should adapt and change to the new way of working. If you are unwilling, step aside instead of resisting or acting as an obstacle to change... Let them take issue with me. We will throw them into the deep end because we know it is good for them when they haven't learnt how to swim. Eventually, they will be grateful for the rough treatment." (ST 1997a)

To garner support, stringent efforts were made to ensure that all major stakeholders in the legal fraternity were represented in the implementation, as the success of the project was dependent on the (gradual and eventual) acceptance by all the main players (Thian 2004):

"Government puts in place good reasons by giving, providing or being a catalyst for these services to be available to the legal profession ... So the government has been trying to drag the profession kicking and screaming but eventually they will realize the value that IT can play in the law firm"

- Deputy Senior State Counsel

"I think at one time, everyone was complaining, but the push by the Judiciary helped. They have definitely egged the lawyers on to use it..."

- Senior Assistant Registrar

The input from (and buy-in of) these stakeholders was valuable as ultimately, they would be the key users of the system. SAL also organized an IT Law Immersion Program consisting of nine one-day seminars during the early stages of the EFS project which attracted a wide spectrum of participants from the legal profession, government bodies and corporate entities.

4.4. Realizing Value of IT

When Phase 1.2 of EFS went live, mandatory electronic filing of court documents was introduced; court documents could no longer be filed in paper form. However, law firms which were not EFS equipped could use a Service Bureau to assist them to file court documents electronically. Subsequent phases progressively involved more documents to be included within the mandatory scope of the project. Such phased enhancements gained momentum over two years, with the system in Phase 6 enhancement (covering High Court criminal cases, criminal appeals and magistrates' appeals):

"This is the Subordinate Courts' 10th Workplan. You have turned the corner to be a world class judiciary. Although this is an enviable position, it is not enough. We cannot rest on our laurels as the primus inter pares or the best of the best

judiciaries...Over the next three years, we will lead from the future and build upon the foundation of excellence which you have achieved in the past decade.. In order to provide the best possible public service, the Subordinate Courts must continue to modernize judicial administration practices. Advanced information technology efforts should promote greater efficiency, economy and convenience to the public. These include the best case management practices and systems, voice response systems, document imaging systems, records management retrieval systems and speedy access to both local and foreign cases and legal literature..."

- Chief Justice Yong's address to the Subordinate Courts at the 2001 Workplan Seminar

At the opening of 2003 Legal Year, Chief Justice observed that the paperless court system, once “scoffed at as a far-fetched dream” became a reality and since 2002, all classes of civil actions in the Supreme Court had been efficiently filed via the EFS. However, to further improve the system, the Chief Justice appointed a Review Committee comprising representatives from both the Bar and Judiciary, to undertake an in-depth review of its operations. The review found that the EFS had indeed provided the judiciary with a fully electronic registry and was instrumental in encouraging the legal profession to take a big leap in the adoption of IT. However, the resulting system usage had added a significant layer of costs for litigants while several technical issues also needed to be addressed.

“Even EFS, we had some problems - quite a lot of problems in the beginning but it is better now. The other systems are fine, but you might like to look at the Registry of Companies, I can tell you there is chaos in that one... they make you use their website, and it takes hours just to get in and then it hangs... There are lots of rejections [of documents submitted electronically to that website], and you are charged for the rejection [of the submissions] after you filed them. IT doesn't work for older people. It is pathetic, honestly”

- Lawyer D

“Before we had EFS, all the filing was done manually. These gentlemen here [the court clerks] attended to the filing... This means they had to go to the courts and do it manually... They had to go to the respective ministries. They had the experience to know where to go, what to file, see if the files are properly followed up. Then they will get the documents served to the defendants. All that can be done through EFS...Now all this can be done in the office...An advantage is the timing – EFS operates twenty-four hours, manually sometimes we had to rush...For EFS, as long as you file before midnight, it can meet the deadline.”

- Litigation support manager at a law firm

Propelled by the acceptance of the successful EFS enhancements, SAL issued a white paper on “Electronic Litigation in Singapore: A Roadmap for the Implementation of Technology in the Litigation Process” for public feedback. It envisaged a new EFS version as one which should function as an effective and efficient litigation tool that lawyers will utilize,

such as an integrated due diligence checks with various government departments, as a repository of case information, as an electronic data room for case documents, as a conduit for communications between law firms and the Court, as a conduit for law firms inter se, while at the same time, being customizable to suit different practices of the law firms. It also proposed that open technical standards be adopted to allow law firms to customize their internal systems to interoperate with the new EFS while also enabling IT vendors to design complementary compatible solutions. The public feedback was analyzed resulting in a revised version approved by Chief Justice for implementation.

Today, there are more than 700 law firms in Singapore ranging from large ones consisting of hundreds of practicing lawyers with international presence to small ones with only a handful of employees. Almost all firms use computer systems with many having networks linking to access LawNet. A senior state counsel describes the current situation as follows:

"I think it [LawNet, EFS, etc] has made IT indispensable. You wouldn't imagine setting up a law firm without buying a computer, without buying your Internet access. Otherwise, you would be put at a great disadvantage... and imagine the competitive advantage the other guy would have if you don't make sure you have access to the same research tools..."

More important, there is also an emerging consensus among the legal professionals that the implementation of the electronic litigation vision does have a positive impact on the individual firm's efficiency, the industry's productivity and the nation's competitiveness:

"EFS is an amazing advance, it's a lot quicker than it used to be, it saves a lot of money and you don't need people to go around and serve documents to other people. Information is quicker, previously will have to write, fix calls, now it could be done with EFS..."

"Things are a lot faster than they used to be. [But] technology is costing law firms - the recurrent expenditure is higher than in the past. Even [for] sole proprietorships, you need not have a secretary, but to survive, you need to have these [technology] tools."

4.5. The Process Interventions

Clearly, the Chief Justice was instrumental in recognizing the potential value of IT to revamp the judiciary, articulating that vision and exercising his prodding influence throughout much of the process. While he was primarily responsible for instituting the change, other institutional players also played important roles in bringing this vision to fruition. For example, the strategizing, planning and fine-tuning were taken up by SAL working in concert with the Attorney-General's Chambers, the Supreme Courts, the

Subordinate Courts, IDA and key industry practitioners. The collaborative and ambidextrous effort was achieved through the formation of committees, sub-committees and workgroups (with both public and private sector participation), each with oversight responsibility for specific components of the project. For instance, the high-level Law National Council formed to oversee the project includes the president of the Law Society, in addition to institutional leaders. Specifically, the EFS pilot saw the involvement of the legal profession from the start that involved many law firms (both large and small). Further, the EFS review committee included representatives from the Bar and the Judiciary while the subsequent review implementation committee consisted of industry practitioners organized into workgroups:

“We are quite fortunate in that we are given recognition for it, I mean the judiciary as a whole, because you know Singapore, we always work like a Singapore Inc..The Judiciary always act in one voice, you know what I mean, so even when you read a report, the report won’t say, [name of a person] says this, because [we are] all part of the Judiciary...So what we do is that, actually, when we were working on Justice Online - we involved the people from Supreme Court and AG’s Chambers...We started the working but in the end, it involved everybody...In the end, it was more of a tripartite thing... Supreme Court was there, was involved also, AG’s Chambers and Subordinate Courts...”

- Registrar

To achieve the desired operational outcomes, appropriate change intervention actions were taken, as the project progressed. Huy’s (2001) four intervention action types were all found in the case analysis: commanding, engineering, teaching and socializing. However, there was an additional intervention action that was also deployed – for the purpose of this paper; we call it “affirmative intervention”. To recap, commanding intervention is useful for changing formal structures, where the change agents use direct and coercive actions to achieve their goals. For example, the electronic filing of court documents was made mandatory with the launch of Phase 1.2. Subsequent phases involved more documents coming under the mandatory scope:

“Alright, some people might say that, but you look at it, it’s a question of time before the lawyers realize the value of it... But of course, to make it mandatory, I would say it was useful in that it accelerated the whole process...”

- Registrar

Engineering intervention concentrates on changing work processes and increasing productivity through analyzing, understanding, and redesigning business flows. For example, the courts’ business workflow changed dramatically with the implementation of EFS while even more changes are likely as stated in the recent “Electronic Litigation System” roadmap:

“In most sectors, the successful implementation of IT systems has typically been preceded by an exercise in re-engineering the affected work processes. This allows the work processes to

be rationalized and re-designed if necessary to harness the benefits of IT more fully. The Committee is of the view that a similar exercise related to the rules governing the litigation process may be necessary in order to realize efficiencies in the litigation process..."

In a teaching type of intervention, change agents facilitate the re-education to bring about changes in their beliefs thus bringing about changes in behaviour. For example, SAL provides seminars, training and scholarships for lawyers. They also organized exhibitions and IT law immersion programs to increase IT awareness and usage. The set up of the LawNet Service Bureau to allow small firms (without IT capability) to use the bureau's services for filing and accessing the electronic information was important to the overall success.

Socializing intervention focuses on improving the social relationships between organizations which included conversations, interpersonal communications and through the agents behaving as role models. Many of the socializing activities took place during the meetings of committees, sub-committees and workgroups. In addition, the judges were clearly trying their best to adjust to the electronic courtroom proceedings, so as to be a role model to the legal profession.

Finally, affirmative intervention has been argued to be needed to address the possibility of widening information inequality in society at large, and it involves proactive and purposeful government efforts to give priority to the information have-nots (Garson 2000). Such intervention was also evident in the context of our study - small law firms could obtain financial assistance under the Small Enterprise Computerization Programme while service bureaus were also set up in the Supreme and Subordinate Courts to enable small non-computerized firms to do electronic filing for a reasonable assistance fee.

5. CONCLUSION

In many countries, when incorporating IT in the judiciaries, the process has been fragmented and often restricted to a single department with minimal communication between different organizations (Oskamp et al. 2004). In Singapore, however, the integrated and shared leadership at the various levels, the strong executive involvement of the government agencies and the practitioners' inputs and insights throughout the process have helped Singapore to avoid the problems faced by other judiciaries.

Indeed, the study found that the successful implementation of the electronic litigation vision was due to both institutional and industry stakeholders exercising shared leadership. It is also an example of how a major IT initiative has been carried out by a group of players at various levels, making an integrated effort to bring about the necessary changes while

percolating down the different implementation levels: strategic, tactical and operational. Extrapolating the results of this study, layers of leadership can usually be identified within organizations - this means that it may be important that such leaders at the different levels be given the necessary power and facility to exercise their different roles for IT implementations. Indeed, the process is likely to occur such that initially a leader at the strategic level takes the initiative and promotes the visionary change, then leaders at the tactical level work ambidextrously to advance the vision and bring about change, which then continues to the operational level where the system gets implemented and gradually evolves into the desired product (through a portfolio of complementary change intervention actions).

We suggest that practitioners give due cognizance to network externalities during the implementation processes. Positive externalities are based on the fact that as the number of users increase, the value to other users increases. However, practitioners need to be mindful of the effects of negative externalities. In our study, the initial strong resistance and the adverse publicity generated during the early stages was converted into gradual acceptance due to effective follow up by the different layers of leaders working in concert with each other. Small law firms have many pragmatic considerations regarding affordability and the usefulness of the system. While financial considerations are important, perceived benefits of the system appear to be critical. In this regard, affirmative intervention (in addition to other change intervention actions) may be important to address the issue of network externalities that may arise in similar industry-wide implementations. The study also found that commanding intervention appears to be important in galvanizing the industry into joint competitive action. However, there are limits to commanding intervention. For example, while commanding intervention can force compliance to intermediate deadlines, it cannot ensure the long-term success of the system. Instead, ongoing success is more dependent on slower, empathetic approaches such as engineering, teaching and socializing interventions.

Overall, the net result is a layered impact on the business value of IT, as the potential value is progressively and inexorably converted into realized value. We therefore propose the revised framework in Figure 2.

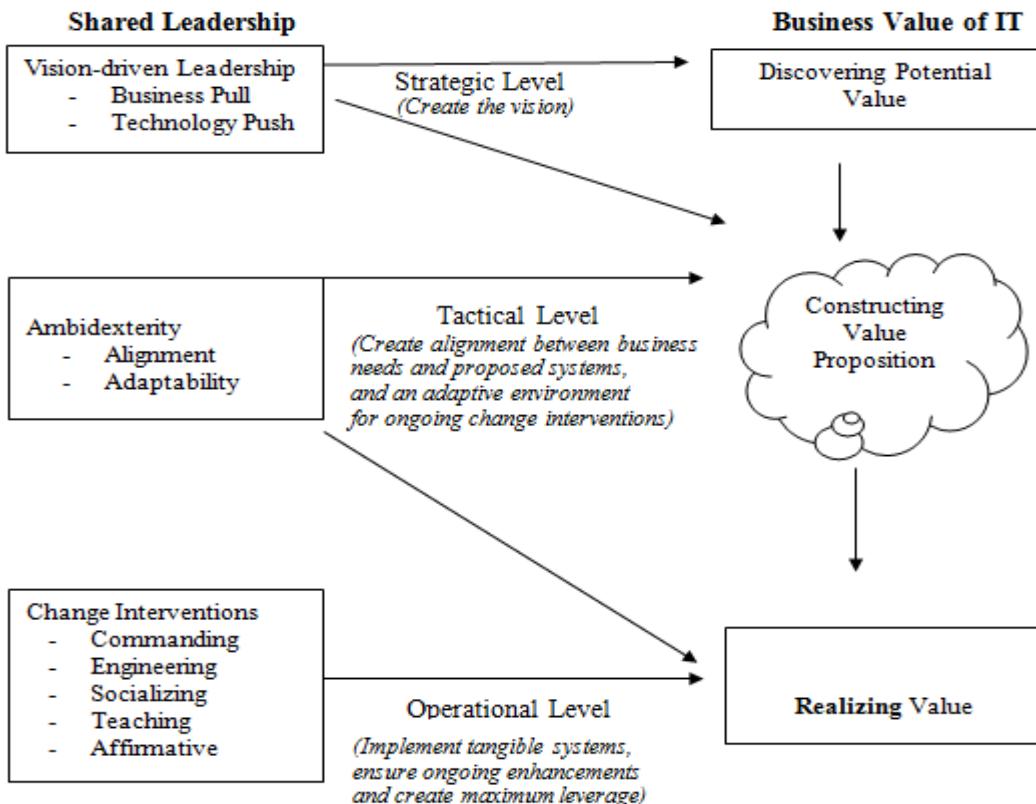


Figure 2: Revised Conceptual Framework

A limitation of this study is that we were unable to study the interactive course of events in a full longitudinal manner from the initial implementation of LawNet in the early 1990s to the advanced usage of the electronic litigation system of today. Another limitation is that the layered impact framework provided may not be applicable to other countries. The reason is that in a small country like Singapore, the government is able to exercise better control as well as providing better support to bring about such initiatives. However, interested researchers may thus wish to explore these same concepts in other contexts and settings.

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LONG ABSTRACT

Pressures of Intellectual Property on Emerging Markets' Dependency

By

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“Emerging markets” in today’s markets are behaving worse than the markets they are emerged from. The market performance require the markets to develop with the change and follow the upward trends. The inter and intra relationships between the major players are important but the independent performance of businesses, especially major drivers of the market index, is significant by following more traditional approaches instead utilizing the strategies adopted by the small businesses. The change in the structures, management teams and products are not responsive to accustomed productivity and development during steady markets. The consumer satisfaction index, consumer price index, manufacturing price index, living standards, employment practices, housing market and business intelligence index are many of the most significant factors that interfere in all markets and effect the performance of the industries. Due to the national and international conditions of the markets, the balance sheets, income statements, and cash flow statements of businesses are projecting very slow economy though some of the analyst and experts also predict upward changes in the environment with the change in the political systems. Regardless, emerging market’s growth is dependent upon the success of global economy. Furthermore, to address the immediate concerns the global community create standardization which widens the gap between the emerging and mature markets; and yet increases the conflict in the environment. The consequential concentration and saturation create a control-tunnel, invites new government policies and practices and slow down the market performance.

The research postulates that intellectual property, intellectual capitalization and business’s knowhow (intelligence) play a major role in strengthening the uncertain conditions. The focus of the paper is to study the role of the intellectual property and to analyze the effects on global markets.

Develop a business model to understand the intellectual capital as a major element and create logical relationships with the market factors to evaluate the effects. The intent is to develop a framework by identifying the items' objectivity and sensitivity to the market environment. In addition, the assumption is made that investment of intellectual property is a key to success and requires systems that are more responsive to the environment and act as a "A Market Sensor". Thus, the study voices the concerns related to the underperformance of global markets, mature or immature, agrees with the researchers, academia and practitioners to investigate and understand the reasons and find strategic solutions to address the concerns. Specifically, intellectual property is a know-how of the intelligent markets and a source of capitalization where success and failure is dependent on the transitional change. The explicit and implicit know-how remains in the data and human reservoirs as intelligent resources of the businesses, processes and knowledge worker. Mature markets develop innovative practices to integrate with the know-how of emerged markets to learn and create learning environments. Hypothetically, in a distributed intelligent environment, the global market has higher chance of growth; the mature market anticipates greater probability of success; and transitional or emerged markets experience greater probability of success. However, if the intelligent environment is centralized, the global market has low probability of success; the mature market has somewhat greater chance of success; and the transitional or emerged markets has less probability of growth. Moreover, incompatible infra-structures formulate intellectual property that increases unexpected volatility and limit the growth rate.

The empirical study adopts inductive factor analysis approach to develop the measurements. The recommendation are based on logical simulation mapping to confirm the sensitivity of factors. The paper makes contribution in the area of management, intelligent systems and simulations techniques.

Research Paper

How to Engage Students with Diverse Computing Backgrounds in the Learning Process?

by

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ABSTRACT

An experimental study was conducted using two sections of an undergraduate computer course at the University of Bahrain to investigate the problem of engaging students with different computing backgrounds in the learning process. Three approaches were used to engage students: teacher-centered, student-centered and blended. The latter two approaches proved to be effective with engaging students. They also showed an improvement in students' performance and teamwork skills. The blended approach proved superior in increasing student confidence level in their learning.

KEYWORDS:

Student Learning, Student-Centered, Teacher-Centered, Blended Learning

INTRODUCTION

Today's classrooms are filled with diverse learners who differ in their cognitive abilities, background knowledge and learning preferences. Such diversity has posed challenges to teachers to effectively address all students' learning needs.

Faced with such diversity, many researchers suggested the move from a teacher-centered to a student-centered approach. Altan and Tromby (2001) offer student-centered learning as a model for countering classroom challenges because of its viability for meeting diverse needs. McCombs (1997) argues that the student-centered approach assists in clarifying what is needed to create positive learning contexts to increase the likelihood that more students will experience success.

Tomlinson (1999), Brown (2003), Fadul (2004) and many others, argue that teacher-centered approach is inadequate to meet diverse students' needs. In the teacher-centered approach, teachers put more emphasis on the transmission of knowledge rather than on developing students' learning skills. The effort to get to know the students and how they process information is secondary. While in the student-centered approach, the knowledge is constructed by students and the lecturer is only a facilitator of learning. The role of the teacher would be to know students capabilities and create an environment where students can make learning connections. In this way, students become more active participants in the learning process and take greater responsibility for their own learning. Tomlinson (2000) argues that teacher narratives and the emphasis on learner characteristics make the student-centered approach a viable alternative for matching teaching practices with learner needs.

Despite the trend of moving from a teacher-centered approach to student-centered approach, there are still many researchers who believe that the teacher-centered approach is effective. Biggs (1999) argues that this approach is appropriate especially when the teacher is the one who comes from a position of expertise. Xiaohui (2006) emphasized that rather than abandoning teacher-centered approaches, the instructor needs to make modifications to traditional teaching methods according to new ideas and methods. A blended approach combining elements of both a teacher-centered and student-centered approach has been proposed to this effect.

Graham (2005) argues that it is better to move to a blended approach where the instructor enriches the lecture and classroom environment using a combination of face-to-face instruction with some new approaches. The issue of which approach is best will be explored in this research in the context of teaching computing to students with different level of preparedness in a developing country context.

RESEARCH BACKGROUND AND PROBLEM

As part of its ICT foundation courses, The University of Bahrain offers many courses in computing. These courses aim to build student proficiency in computer applications.

Courses last one-semester and carry four credit points. The Computer and Business Information System course, which will be setting for this research, has three-hour lectures in the classroom and one-hour practice in the computer laboratory per week. Classroom lectures are delivered through slide presentations by means of modern multimedia devices. In the

laboratory, students are guided to learn popular productivity tools such as spreadsheets and database management.

One of the co-authors has been teaching this course for several years using a teacher-centered approach. This approach was perceived to be necessary because more than 15 sections per semester were offered with at least 25 students per section. Indeed, the numbers of sections and the need to standardize teaching delivery across the sections made it necessary to adopt a teacher-centered approach.

Students who register in this course come from different school backgrounds where computing is taught in many different ways. Graduates of government schools are taught computing in Arabic whereas graduates from private school are taught in English very early on. The computer curriculum is also very much different between the two systems. Private schools have generally more computing resources than public schools and afford students better practical training. Such diversity of student computing backgrounds poses challenges to instructors to make class time worthwhile for all learners.

In many instances, the diversity of students' computing backgrounds is manageable. However, when the distribution of the class is such that there are two distinct groups of students with radically disparate levels of computing knowledge, the instructor faces an insurmountable task to manage this difficult situation and to provide value added learning across the classroom.

Focusing on just one level of students' background can alienate parts of the class. Hence, if a course is tailored to meet the needs of students with a more advanced computing background, much of the class will be left behind and will likely fail the course. Conversely, if a class is tailored to meet the needs of student with no or little computing knowledge, then more knowledgeable students will lose interest. The question is then how to engage students of different computing backgrounds in a joint learning process? This will be the major objective of this research.

Answering this question will enable the satisfaction of requirements of both low performing as well as high achieving students in computer courses and subsequently introducing changes to the current teaching practice that is predominantly teacher-centered.

RESEARCH METHODOLOGY AND PLANNING

In preparation for designing a solution that will engage students with diverse computing backgrounds in the learning process, this research will investigate a teacher-centered vs. student-centered approach and student-centered vs. blended approach.

The sample of the study included two sections of *Computer and Business Information Systems* with 24 students enrolled in each section. At the beginning of the study, students were briefed about the objective of the research. They were verbally informed of the purpose of the research and were given a Consent and Authorization form to sign. Furthermore, the students were assured of the confidentiality of the information they would provide. Students were also reassured that this research would not enter in any way into the final assessment for the course.

The students were then asked to sit for a pre-test to ascertain the differences in computer backgrounds that existed between all participants. The pre-test would reflect the students' backgrounds prior to any instruction and the required improvement, if any, in their computing knowledge and skills after using the different approaches.

The pre-test consisted of 10 questions related to communications and network topics. The students were required to provide general answers to the questions based on their background. This test aimed to measure their communications and network knowledge. Based on their scores in the pre-test, students were placed into three groups: low (total mark < 5), moderate (total mark = 5) and high (total mark > 5). Table 1 illustrates the results of the pre-test for both sections.

Table 1: Pre-test scores for computing backgrounds

	Number of Low-Score Students	Number of Moderate-Score Students	Number of High-Score Students
Section One	10	6	8
Section Two	12	4	8

As expected, the results of the pre-test showed that there exists three different levels of student backgrounds. Low-score and high-score students were the primary focus of this research.

As stated earlier, three approaches (teacher-centered, student-centered and blended) were used with the intention to engage students with diverse computing background in the learning process. In a first cycle, a teacher-centered approach was used within one section and a student-centered approach within the other section. Then students were given a quiz to

compare the two approaches based on student scores. In cycle two, a swap was done of the teaching methods between the two sections in order to investigate if the level of students had affected the results of cycle one. In a third cycle, a blended teaching approach was introduced within one section and a student-centered approach in the other section. Doing so allowed a direct comparison between the three teaching approaches using the same sections. However the learning and assessment objects were obviously changed through remained within the same topic.

In designing the lesson plan, presentation slides were used for the teacher-centered approach. For the student-centered approach, a case study was developed to push students to discover and learn the topic independently. This aligns with Trigwell's *et al.* (1999) suggestion that in the student-centered approach, teachers adopt a student-focused strategy to help the learners change their world view or concept of the phenomena they are studying.

For student-centered approach, students were assigned to six groups of four members each. A peer learning method, in which learners help each other through group work, was used. This aligns with King's (1997) suggestion that in a student-centered approach, a teaching program needs to include materials and strategies that are interesting, motivated and requires the learners to be involved not only in individual tasks but also in cooperative tasks. High-scoring students were coupled within groups with students who had low scores in the pre-test.

Directly after going through each approach, students were asked to sit for a post-test and to complete a questionnaire. The post-test aimed to measure students' performance after going through the teaching approach whereas the questionnaire aimed to elicit students learning skills, developed skills, feelings and attitudes toward the teaching approach. The questionnaire was specifically developed for purposes of this research.

RESULTS AND DISCUSSION

Teacher-Centered Vs. Student-Centered Approach

Both tests for teacher-centered and student-centered were marked by awarding one mark for the correct answer and zero for the wrong one. Table 2 and Table 3 illustrate the results of the t Test conducted to compare the results of the two tests. The paired-sample t test analysis indicates that for the 24 subjects, the mean score on student-centered test ($M=7.875$) was significantly greater than the mean score of teacher-centered test ($M=6.208$) at $p < .05$. In other words the difference between the scores of both tests is statistically significant.

Table 2: Post-test mean score analysis for teacher-centered vs. student-centered

	Mean	SD	No.
Teacher-Centered Approach: Post-Test	6.208	1.350657	24
Student-Centered Approach: Post-Test	7.875	1.034723	24

Table 3: t-test analysis for teacher-centered vs. student-centered

	t-calculated	df	t-critical
Teacher-Centered and Student-Centered Approach: Post-Test	-4.79883	46	1.9475

The results show that the student-centered approach is more effective than the teacher-centered approach in improving the students' overall performance. The questionnaire also showed that students, with the student-centered approach, developed better teamwork skills in addition to learning skills. There was a change in the class environment as well as students with different computing backgrounds were engaged in learning process.

To control for rival explanations resulting from differences in the level of students and the topic, a swap of the teaching approach was done between the two sections.

Table 4 and Table 5 illustrate the results of the t Test conducted to compare the results of the two tests. The paired-sample t test analysis indicates that for the 24 subjects, the mean score on student-centered test ($M=8$) was significantly greater than the mean score of teacher-centered test ($M=6$) at $p < .05$. In other words the difference between the scores of both tests is statistically significant.

Table 4: Post-test mean score analysis for student-centered vs. teacher-centered approaches

	Mean	SD	No.
Teacher-Centered Approach: Post-Test	6	1.44463	24
Student-Centered Approach: Post-Test	8	1.021508	24

Table 5: t-test analysis for student-centered vs. teacher-centered approaches

	t-calculated	df	t-critical
Teacher-Centered and Student-Centered Approach: Post-Test	5.537749	46	1.9475

Other than students performing better in the post test when subjected to a student-centered approach rather than a teacher-centered approach, improvement in student academic

performance, when comparing the post-test to the pre-test, was significantly higher with the student-centered approach than with the teacher-centered approach (Table 6 and Table 7).

The low-score student group across the two sections, as identified in table 1, further improved its score with the student-centered approach than with the teacher-centered approach. Likewise, high-score students increased their overall performance with the student-centered approach. Communication skills increased for all along with their academic performance. By working in groups, students learned to take more responsibility for their own learning. This is in line with Tomlinson (1999), Brown (2003) and Fadul (2004) findings who argued that students become more active participants in the learning process with a student-centered approach and take greater responsibility for their own learning.

Table 6: Pre-test/post-test comparison for low-score and high-score students for section 1

	Section One		
	Pre-Test Average	Teacher-Centered Post-Test Average	Student-Centered Post-Test Average
Low-Score Student Average	2.7	4.6	7.0
High-Score Student Average	6.0	7.0	9.0

Table 7: Pre-test/post-test comparison for low-score and high-score students for section 2

	Section Two		
	Pre-Test Average	Teacher-Centered Post-Test Average	Student-Centered Post-Test Average
Low-Score Student Average	3.1	5.3	7.4
High-Score Student Average	6.25	7.5	9.0

Based on the questionnaire analysis, most students indicated that, with the teacher-centered approach, a significant portion of class time was spent copying information whereas, with the student-centered approach, they felt that critical thinking was encouraged and that the method enabled them to actively get involved in class activities and discussions. In addition to learning skills, most students responded that the student-centered approach allowed them to develop teamwork skills such as communication skills and interpersonal skills.

Although student performance and learning skills increased with the student-centered approach, many students expressed that they were not very confident that their peers provided them with the correct information during group work. Example of such comments include:

“Although today’s class is enjoyable, I still believe that the teacher can give us more than our peers.”, “I have learned from my peers but am not sure what I have learned is correct and enough, I think I need my teacher’s help because the subject is too technical.”, “I like to discuss my thoughts with my peers but I don’t trust their thoughts.”, “Although I do not feel shy to ask within the group but still I believe that my teacher provides us with more accurate information.”. This gives an indication than an approach blending pure student-centered methods with teacher-driven methods would be a good compromise.

Student-Centered Vs. Blended Approach

On this premise, a new experimental design was introduced having the instructor intervene to deliver the foundational technical information and then allow the students to construct detailed information. This aligns with Biggs’ (1999) and Graham’s (2005) in that teacher intervention is necessary especially when the teacher is the one who comes from a position of expertise. This new set up allowed for the comparison of student-centered approach, which was already proven to increase student performance, with a blended approach, which includes elements of both a student-centered and teacher-centered approaches.

Table 8 and 9 illustrate the results of the t Test conducted to compare the results of the two tests. The paired-sample t test analysis indicates that for the 24 subjects, the mean score on blended test ($M=9.2$) was significantly greater than the mean score of student-centered test ($M=8.5$) at $p < .05$. In other words the difference between the scores of both tests is statistically significant.

Table 8: Post-test mean score analysis for blended vs. student-centered approach

	Mean	SD	No.
Blended Approach :Post-Test	9.2	.931533	24
Student-Centered Approach: Post-Test	8.5	1.021508	24

Table 9: t-test analysis for blended vs. student-centered approach

	t-calculated	df	t-critical
Blended vs. Student-Centered Approach: Post-Test	2.510074	46	1.9475

Moreover, the questionnaire analysis showed that, in comparison to the student-centered approach, and other than the improvement in their learning, the blended approach allowed students to cooperate and develop teamwork skills. In addition, students responded that they

gained more confidence through the blended approach. Some of the comments in this regard: “I feel I am good at computers”, “Computing is challenging and I like to learn more.”, “I am not shy anymore and I believe that I can bravely discuss my beliefs and thoughts with my peers.”

The results show that the blended approach not only improved the test scores of all students as well as their communication skills, but it also increased student desire to learn computing, improve in computing, and increase their confidence in their computer abilities. This implies that the student engagement, learning skills and teamwork skills improved using the blended approach.

IMPLICATIONS AND RECOMMENDATIONS

Many studies investigated ways to engage different student levels in the learning process; most of which agreed that student-centered approaches engage diverse learners (McCombs, 1997; Tomlinson, 1999; Brown, 2003; Fadul, 2004). The findings of this research align with earlier studies. Students with different computing backgrounds were engaged in the learning process through a student-centered approach. Not only has their engagement improved, but also their overall performance has increased. It also promoted student independent learning, thinking and teamwork skills.

Furthermore, this research found that a blended approach is even further effective not only in engaging diverse learners but also by increasing the level of confidence of students in what they learn. Compared to a student-centered approach, blended learning shows an improvement in student performance, teamwork skills and confidence in their computer abilities.

The above results should be confirmed through more rigorous experimental designs with different learning contexts, a larger sample, and more strict experimental procedures. Only then, we will be able to ascertain the above findings.

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A comprehensive framework for software as a service adoption

by

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ABSTRACT

Software as a Service (SaaS) as one of service models of cloud computing offers without a doubt a lot of advantages for enterprises. But there are also disadvantages and risks, which should be taken into account, when an organization is considering migration of an application to the cloud. Therefore, comprehensive framework for SaaS cloud migration is needed. Costs are the key factors, which influence the decision making; therefore Total Cost of Ownership (TCO) is included in our framework. Also other criteria (benefits, risks,...) affect the final decision. Thus, the framework based on multi-criteria method is introduced in this paper.

Keywords:

Software as a service, SaaS, decision making, cloud service adoption, Total Cost of Ownership

INTRODUCTION

Software as a Service (SaaS) is the capability provided to the consumer by the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser or a program interface. The consumer does not manage or control the underlying cloud infrastructure (network, servers, etc.). The consumer can't manage even individual application capabilities, with the possible exception of limited user specific application configuration settings [56]. SaaS helps organizations to avoid capital expenditure and because of the subscription payment model, operational costs are arisen.

The aim of the transition to the cloud may be for example lower costs, increased effectiveness of business processes, improvement of system availability and reliability, ability to scale IT resources etc. On the other hand, decision to migrate to cloud or not is not an easy task. All types of benefits, risks and costs should be considered before decision is made. This decision process involves multiple, often conflicting economic, technical and strategic criteria. Therefore there is a need for guidelines and decision support tools for enterprises, which are considering cloud migration. There are already research reports concerning about what type of workload to move the cloud and when [2,3,4,5]. These different approaches are shortly described in the following related work section. Although, we miss complex solutions, which would take decision maker (DM) trough the whole process of decision making – from workload definition to TCO calculation and other criteria consideration. Hence, we propose a new, more complex approach going into this direction.

In this paper, we present a framework to facilitate the process of decision-making specifically with respect to SaaS cloud adoption. The paper is structured as follows. We are reflecting related works in the next section. Then, the proposed framework is described, including description of all steps of the framework in related subsections. Finally, conclusion and future work is given in the last section.

RELATED WORK

There are several approaches which support decision making during cloud computing adoption. Some approaches are general, providing only a kind of overview of all possible alternatives, or sequence of steps to be completed in the transition to the cloud. Other approaches take into account only costs, and do not take into account any benefits that arise from the transition. Sophisticated solutions see cloud computing adoption as more complex

problem and thus they try to solve it as a decision problem by using a variety of multi-criteria decision making methods.

One of the basic approaches by IBM [57] provides a general approach to this issue - explains basic alternative options provided by cloud computing (SaaS, PaaS, IaaS as well as private, public or hybrid cloud). However, it does not provide an answer if company is ready for cloud adoption, or which solution is the best one for particular organization.

Microsoft's framework [58] provides an analysis of particular software application into two segments and then assess whether the application is or is not appropriate for the transition to cloud computing. It focuses on SaaS solutions, but does not take into account the transition costs and potential benefits that cloud solutions deliver.

The solution based on multi-criteria decision method is proposed by researchers from India [59]. The Analytic Hierarchy Process technique is used as a multi-criteria method. In this approach, authors include benefits and risks into account. On the other hand, not complex costs structure is included and cost calculation is not addressed.

The most comprehensive approach offer scientists from IBM Research [60]. Their solution is also based on multi-criteria decision methods and tries to answer the question, which service model and deployment model of cloud computing to implement and which provider to choose (this option is only outlined). It does not reflect only the costs but also positive aspects of cloud computing adoption. The outcome of this approach is most appropriate alternative based on chosen multi-criteria method. This approach, however, does not analyze organization's suitability for particular cloud solution in the context of entire organization and do not answer the question whether the organization is ready to adopt or not. Also, costs and other economic indicators are listed in the model only as some of the criteria, which are estimated in advance, but do not address their actual calculation.

THE FRAMEWORK FOR SAAS ADOPTION

The goal of our framework is to help decision makers to determine best alternative of cloud software as a service for their organization. To make as good decision as possible, we need to make decision in the context of specific workload. Without specific workload defined, decision framework would be too abstract. Thus, for our framework we assume that the IT manager knows which workload could be transferred to the cloud. Our comprehensive framework leads IT managers step by step from workload definition up to the proposal for the most appropriate alternative. The goal is to help IT managers to evaluate if the workload

is appropriate for the adoption to cloud and if yes, also to propose, which alternative is the best one. One of the most important factors which influence decision making is costs; therefore a key step of the process is the calculation of Total Cost of Ownership (TCO).

Proposed SaaS adoption framework consists of the following steps (as Fig. 1 shows): 1) Workload definition, 2) Definition of Alternatives, 3) TCO Calculation, 4) Definition of criteria, 5) Selection of the best alternative. We describe each of the steps in greater details below.

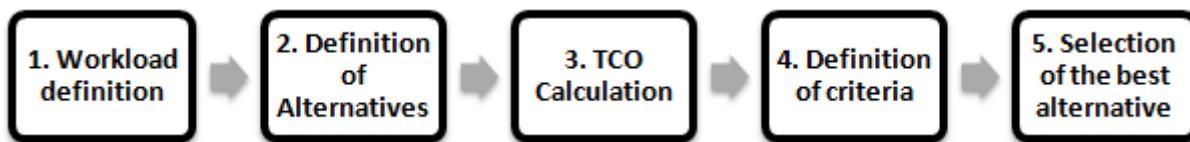


Fig. 1. SaaS adoption framework

1. Workload definition

Workload is defined (according to [61]), as the kind of (IT-based) work that an organization needs to accomplish. Workloads have different characteristics, which make them run most efficiently on different types of hardware and software. There are different requirements for different types of workloads, like some demand fast transactions (e.g. ATMs), others intense calculations (e.g. predictive analytics). Another definition [62] says that workloads represent collections of key IT system components and the relationships among them (e.g. web servers and application servers, databases...). In our framework, as mentioned above, we assume that decision maker knows the workload under consideration.

According to cloud service model, we can divide workloads into three main groups - software as a service, platform as a service and infrastructure as a service workloads. For the purposes of our model, software as a service workloads are important. Software as a service workload type includes applications which are used by users through a web browser, such as e-mail, ERP applications etc. We have identified most used SaaS workloads based on the literature analysis, mainly based on [60,61,62]. The resulted SaaS workloads are shown in Table 1.

Table 3. Examples of SaaS Workload

Workload type based on cloud services models	Example	References
Software as a service (SaaS)	E-mail	[63], [61],
	ERP applications	[64]

Customer relationship management (CRM)
Desktop
Data mining, text mining and other analytics
Audio/Video/Web conferencing
Graphics intensive applications
Productivity applications
Web applications
Business intelligence and data warehouse

Definition of proper software as a service workload from workload taxonomy is first step of the whole decision-making process. Defined workload is important input to the second step of our process – Definition of alternatives.

2. Definition of alternatives

Alternatives are the different options among which a decision maker can choose. These alternatives need to be explicitly specified in the beginning of the decision process. At least two alternatives should be defined for particular workload. It is recommended that one of these alternatives should be also on-premise solution (or existing solution), so it's possible to compare cloud alternatives and non cloud solution and make the right decision when considering cloud adoption possibility for given workload.

When cloud computing provision of the workload is under consideration, there is almost never just one solution. We can therefore define a set $S = \{a_1, a_2, \dots, a_m\}; m \geq 2$ of finite number of available alternatives a_i (provided e.g. by different cloud computing vendors). All alternatives need next to be compared with respect to a set of criteria, which will be defined in 5th step of our decision-making process.

3. TCO calculation

Costs are one of the most important factors affecting the decision on the adoption of any IT solution. To calculate the cost of each alternative in our framework, the Total Cost of Ownership (TCO) method is used.

TCO expresses the total cost of implementation and operation of particular workload (e.g. direct costs on hardware and software, operation and maintenance costs, administration costs, users training, costs of inactivity due to system patches, updates, etc.). In the context of cloud

computing we are calculating TCO for each cloud service model differently. Calculation of TCO of software as a service was introduced by many cloud vendors, but the most comprehensive approach is described in [63], [64]. An example of TCO for SaaS type of workload is shown in Table 3. For TCO calculation, it is very important to make the calculation with respect to ongoing costs also (if possible at least 5 years) to make more precise analysis.

Table 4. TCO for SaaS type of workload includes the following parts:

	Initial Cost	Ongoing Costs
Capital Expenses		
Hardware		
Software or License costs		
Support and Maintenance		
Upgrades		
Facilities/Datacenter Expenses		
Design and Engineering		
Integration/Implementation		
IT and Helpdesk Staffing		
End User Training		
Scheduled Maintenance		
Unscheduled Maintenance and Outage Recovery		
Monitoring and Security		
Migration cost		
Legal/Purchasing and General Administration		

For each alternative, TCO is calculated. After that, we can simply compare alternatives to determine which alternative is most appropriate from a cost perspective (the lower the total cost, the better). The disadvantage of this method is that other criteria are not taken into account. Therefore, we are using results of the TCO method within the next step just as one of the criteria used for taking the final decision.

Note that our framework can easily be extended also with the calculation of other important economic indicators such as e.g. Return of Investment (ROI) by including it as one of the criteria in the following step of our methodology.

4. Definition of criteria

In this step, we identify all relevant criteria and their values in order to take the final decision about SaaS (or on-premise) adoption with respect to particular alternatives defined in step 3. We have created a hierarchy of criteria for software as a service type of workload. Let our set of criteria for SaaS workload type has n different criteria. Criteria hierarchy was created based on literature review, mainly [60,61,65,59] and criteria for SaaS type of workload are depicted on Fig.2.

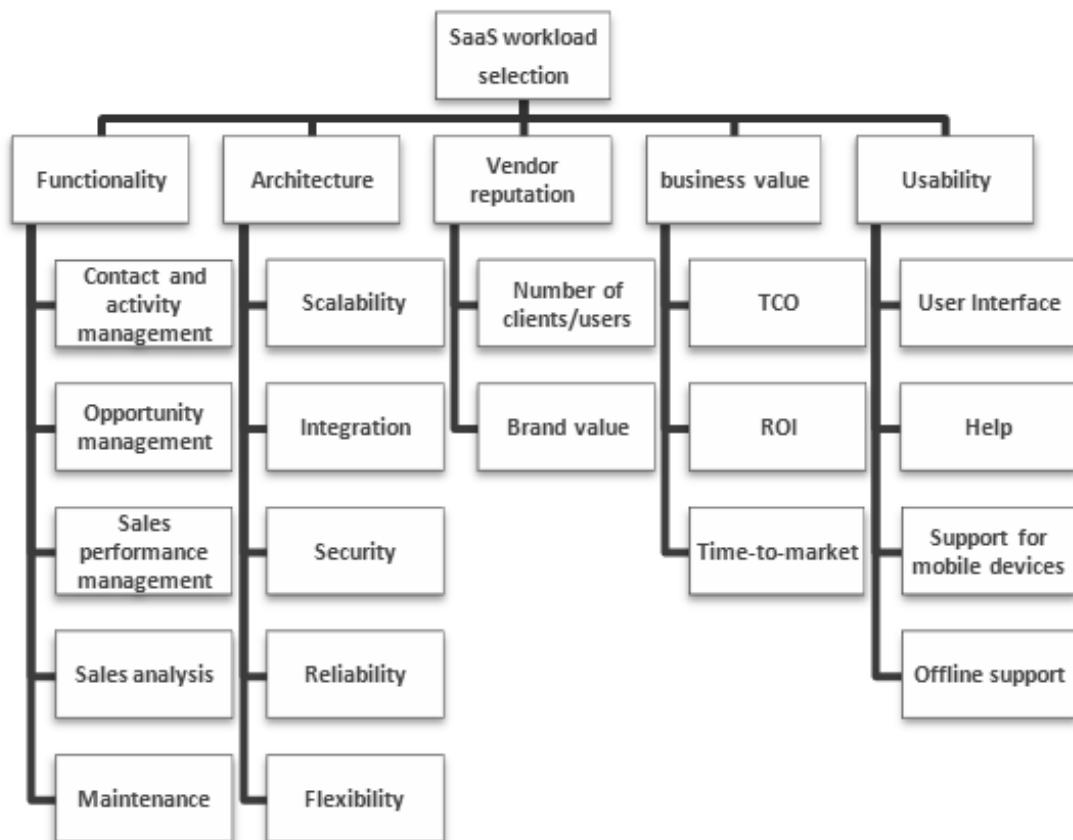


Fig. 2. Criteria hierarchy for SaaS type of workload.

Once we have selected a set C of n criteria c_j ($j=1..n$) for particular workload and particular organization, the value of each criterion needs to be defined for each alternative solution a_i (in our case m alternatives form the set S defined above in step 2). A multi-criteria decision problem can be then formally represented as a matrix, where each row corresponds to one

alternative and each column to one criterion, i.e. our matrix has size $m \times n$. Moreover, weight for each criterion is defined, i.e. $W = \{w_1, w_2, \dots, w_n\}$.

Delphi method [66] is recommended to gain experts' evaluation of each criterion. Delphi method is a structured communication technique, developed as a systematic and interactive forecasting method which relies on a group of experts. As a rule, it involved a team of experts, who make estimates independently of each other and the facilitator summarizes the materials, which are then distributed to experts for next round etc. Standardized questionnaires are sent by electronic mail. The procedure can be repeated until there is reached an agreement between independent experts.

Then, each alternative a_i is rated by DM according to all criteria c_j from C . The rating of alternative a_i with respect to criterion c_j while w_j is the weight of criterion c_j is stated as a real number x_{ij} . Each criterion can be either of benefit type (i.e. the higher value, the better, e.g. ROI) or of the cost type (i.e. the lower value, the better, e.g. TCO). Next, to gain comparable scales, a simple normalization technique is used. For benefit types of criteria, $r_{ij} = x_{ij} / x_{max}$ is used, for cost types of criteria $r_{ij} = x_{min} / x_{ij}$ is applied. After normalization, a multi-criteria method, which is described in next step, is applied in order to get the best alternative decision.

5. Selection of the best alternative

There are several decision rules and algorithms, which can be applied when looking for the best alternative. In our framework, we used Simple additive weighting (SAW) decision rule [66], which is one of the most widely used methods. SAW basically calculated the weighted sum of criteria values for each particular alternative. I.e. the value V_i of each alternative a_i is calculated as follows:

$$V_i = \sum_{j=1}^n w_j r_{ij}, i = 1, \dots, m$$

where V_i is the value function of alternative a_i ; w_j is the importance (weight) of j^{th} criterion and r_{ij} is the normalized rating of the i^{th} alternative for the j^{th} criterion. After calculating the value for each alternative the one with the highest value is recommended as the best one.

CONCLUSION AND FUTURE WORK

Software as a service is changing the way that software is being bought and sold today. "Buy and use" is not the only way how to obtain software for organization anymore. Cloud is becoming increasingly interesting for providers who bring new, better and more sophisticated

solutions. The problem is, however, which solution is the best for particular organization and if it is worth to adopt the cloud solution in particular workload. Right decision to facilitate cloud adoption is therefore crucial.

We present a comprehensive framework for software as a service adoption in this paper. Proposed methodology, consisting of 5 steps helps decision makers to select the best alternative for their organization. As far as we know, this is the first decision-making framework focused on SaaS, which takes also TCO into account.

In future, we plan to include research of suitability in cooperation with experts. Since not each organization is ready for cloud, we think readiness assessment for cloud is needed as a first step in decision process.

We see high potential of this framework in particular for small and medium enterprises as well as organizations of all types which are using various IT services in their work. It is also planned to implement the framework as web-based decision support system.

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Research Paper

Encouraging Students to Engage in Discussion Boards: A Case Study in the University of Bahrain

by

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ABSTRACT

Discussion boards have been widely used in education to engage students in learning. However, this is usually impeded by students' disengagement and disinterest. This research investigates three approaches to motivate higher education students at the University of Bahrain to use Blackboard's discussion boards as a tool to facilitate their discussions and collaboration with their peers: (a) ungraded discussion, (b) graded discussion and (c) synchronous graded discussion at a specific time allocated by the instructor. The last two approaches proved to be effective for motivating students to engage in discussions. They also showed improvement in the quality of students' posts on the discussion board. However, grading discussions and allowing students to engage in discussions whenever they can is a better motivator for asynchronous discussions.

KEYWORDS:

Discussion, Collaboration, Blackboard, Virtual Learning Environments

INTRODUCTION

The use of Information and Communication Technologies (ICT) in education has always been viewed as a driver to the progression of developing countries. Emphasizing on developing the collaboration and communication skills of the generations in these countries is essential as these skills are important for preparing the generations for the "Information Age" and later as professionals to effectively interact with others across cultures and languages (Wittwer, 2001; Hawkins, 2002; Ascroft and Watts, 2005). However, employing communication and collaboration technologies to assist pedagogy in developing countries is challenging as the educational systems in these countries can still be considered traditional with students listening and taking notes while the teacher is instructing. In addition, these

attempts are usually challenged with the reluctance of using such technologies especially that these are considered as foreign objects in the pedagogy.

The Ministry of Education in the Kingdom of Bahrain has introduced ICT through King Hamad's Schools of Future project which was implemented in 2005 in most of the schools in the country. One of the main goals of the project is to connect all the schools in Bahrain with the Internet. In addition, all schools have been equipped with ICT to provide educators and students with the latest technology to help in building a knowledge-based economy. In line with the country's focus on employing ICT in education, the University of Bahrain established a center (E-learning Center) that is specialized in providing e-learning services and supporting faculty members in the university to employ ICT in pedagogy. Virtual Learning Environments (e.g. Blackboard and Moodle) is one of the services provided by the center and its usage has increased over the past years. Faculty members in the university use VLE's to provide students access to learning material, updated announcements and discussion boards. Using discussion boards in education is usually obstructed with the problem of students' disengagement and disinterest in the discussion boards. This paper aims to investigate ways to motivate higher education students at the University of Bahrain to use discussion boards in their learning.

Communication and Learning

Communication has always been considered a major factor in students' learning. Researchers argue that communication is a central process in education as it helps people to negotiate their differences, understand each others' experiences and establish shared meaning (e.g. Pask, 1976; Scott, 2001; Sharples, 2005). Pask, Scott and others studied communication and its effect on learning across three decades and developed the conversation theory which posits that learning occurs through conversations about a subject matter which serve to make knowledge explicit. In addition, Picciano (2002) argues that the ability to ask a question, to share an opinion with a fellow student, or to disagree with the point of view in a reading assignment are all fundamental learning activities.

To foster the benefits of communication and collaboration both in and off campus for the benefit of students' learning, many universities have considered the use of virtual learning environments (VLE). Blackboard is one example. Blackboard's discussion boards can enhance student-to-student and student-to-instructor communication (Curtis and Lawson, 2001). It can also encourage and extend learning activities beyond the traditional classroom

time and space (Xie et al., 2006). Researchers argue that online interactions encourage wider student participation and produces more in depth and reasoned discussion than traditional face-to-face discussions (Citera, 1988; Karayan and Crowe, 1997; Smith and Hardaker, 2000).

However, using discussion boards to assist students' learning is usually accompanied with a problem of lack of students' engagement and reluctance to use the discussion boards (Hiltz et al., 2000; Oliver and Shaw, 2003; Clouder, 2006). In these cases, students need to be motivated to engage in discussions via discussion boards. Researchers argue that students can be motivated to use discussion boards when given incentives such as grades (Deci and Ryan, 1985; Warren and Rada, 1998; Bender, 2003). Others argue that allocating a specific time in students' schedules for discussions will enhance students' engagement in discussions boards and thus their motivation (Singh, 2004).

STATEMENT OF THE PROBLEM

The study aims to investigate ways to encourage students to use Blackboard to engage in discussions with peers. The need for this research arose from the researcher's past experience with utilising Blackboard as a tool for facilitating students' communication and discussions. The students did not use Blackboard the way the researcher was hoping for. They noted that the main reason for not using the discussion boards was their unfamiliarity with it as it was never used for any of their other courses. They also argued that it was a new way to engage in discussions as they were used to face-to-face discussions.

Reflecting on this experience, the researcher came to recognise many factors that might have affected the students' use of the application to engage in discussions. First, and as Pilkington et al. (2000), Giordano and Trufant (2002) and Salmon (2000) argue, the lack of training or expertise might have impeded the use of the application. This can be resolved by providing students with an introductory session discussing Blackboard and its features, mainly the discussion board (Lewis and Treves, 1997; Muirhead, 2002; Oliver and Shaw, 2003; Clouder, 2006).

In addition, the lack of motivation might have factored in the use of the discussion boards. This can be improved by explaining to students the benefits of using the discussion boards as Akerkind and Trevitt (1999) argue. Moreover, allocating grades as an incentive for those who engage in discussions can motivate students (Deci and Ryan, 1985; Warren and Rada, 1998; Bender, 2003). The quality of students' participation should also be counted and not just their

participation quantity (Bender, 2003). Furthermore, allocating a specific time for the discussions to take place can motivate students to engage in discussions (Singh, 2004). Thus, in this research, three approaches were used to motivate students to engage in discussion boards: (a) posting an ungraded exercise for students to discuss in their free time, (b) posting a graded exercise for students to discuss in their free time and (c) posting a graded exercise for students to discuss in a specific time assigned by the researcher. The researcher then compares these approaches in terms of students' engagement and the quality of their posts.

RESEARCH BACKGROUND, PLANNING AND METHODOLOGY

The sample of the study included 16 undergraduate students enrolled in an Information Systems (IS) course (Physical System Design and Implementation). The course is a compulsory course taken by all IS students in their third year which aims at developing students' knowledge and abilities in designing and implementing information systems. Students registered for this course were enrolled in a B.Sc. program in Business Information Systems.

In this course, a group project, case studies and exercises are considered major factors that help students to understand and practice the topics discussed in the classroom. Therefore, after discussing each chapter, students were provided with an exercise or a case study to be discussed within a group on Blackboard's discussion boards. These discussion boards are private and only the group members could access and view the posts. Thus, during the first lecture, students were asked to form groups of 3-4 members. Students within each group were expected to work together for the rest of the semester. Berge (1995) argues that small group discussions can stimulate learners' participation and interaction in discussion boards. Allowing students to work within the same group has both advantages and disadvantages. It can be a good thing as it can improve the students' sense of responsibility to a group (Warren and Rada, 1998) and therefore enables learners to gain from the potential benefits of online interactions. But at the same time might hinder students from these benefits in case the student was uncomfortable within the group. Stabilizing the groups that students work within also helps with clarifying the change in students' behaviour in the different approaches used to motivate their discussions engagement.

The first step in this research was to provide students with an introductory session to explore Blackboard. This was done to enable students to engage effectively in the discussion board once. Lewis and Treves (1997), Muirhead (2002), Oliver and Shaw (2003) and Clouder

(2006) stress on the importance of introducing students to the basics of logging on, posting messages, and threading prior to the use of discussion boards which can also work as a motivator for students to engage in discussions. Students were also made aware of the benefits that they can gain from discussing issues with colleagues and the instructor, which can be a motivator for engagement in discussions as Akerkind and Trevitt (1999) argued.

At the beginning of the study, students who were enrolled in the course were provided with verbal and written information about the study and were asked to take part in the study. Those willing to participate were asked to sign the consent and authorisation form which also ensured their anonymity, privacy, confidentiality, and their right to withdraw from the study at any time or to not complete any part of the study. The students were then asked to complete a questionnaire that comprised questions regarding their familiarity, past experiences, perceptions and attitudes towards using the discussion boards in Blackboard. The questionnaire helped in planning the study.

In this study, three approaches were used through making some changes to the study design with the intention to encourage students to use the discussion boards in Blackboard. First, students were asked to discuss an exercise that was posted on their group's discussion board on Blackboard in their free time. Students were given a week to discuss the exercise in their own time and were reminded that no grade was allocated for this activity. Great emphasis was put on the quality of students' contributions to the discussions. Students were clear that their contributions are expected to be useful and helpful in terms of solving the exercise. Second, an alteration was made to see how allocating a grade for the activity and stressing on the quality of their posts would motivate students to engage in discussions. Third, instead of asking students to discuss the exercise within their groups in their free time, they were required to have a discussion session during the lecture time. For this, the class was shifted to the computer lab instead of the usual lecture hall. Students were notified that the activity would be graded. During this discussion session, students were observed by the instructor who was in the lab reading their posts and posting responses and commenting on their posts. In the last approach, there was a change in the environment where the discussion took place.

After applying each of the three approaches, students were asked to complete a questionnaire to provide information on whether and how their engagement in discussions have been altered and they were motivated by the change imposed. These alterations were also viewed through the discussion boards as students' discussions can be tracked and viewed. Thus, the discussion boards in Blackboard were used, firstly, to provide evidence on students'

participation in the discussion boards and thus calculating the total number of students engaged. An increase in the number of participants was interpreted as a positive influence of the factor enforced and vice versa. Secondly, this provided evidence on any changes that occurred in students' participation (i.e. engaged or did not engage in discussions) in response to the change enforced. Thirdly, this calculated the total number of posts in each approach where an increase in students' posts was interpreted as a positive influence of the factor enforced, and vice versa. Lastly, the aim was to assess the quality of students' posts in each cycle.

RESULTS AND DISCUSSION

Ungraded Discussion

The questionnaires and exploring the number of people engaged in discussions on Blackboard showed that not all students were motivated to use the discussion boards even when providing students with training on how to use the discussion boards, discussing the benefits that they could gain and giving them the choice to discuss the exercise in their own time with no grade allocation. The questionnaire showed that only 8 students out of a total of 16* students used Blackboard to discuss the exercise. This was validated by the discussion board in Blackboard. In addition, 6 students out of 16 students stated in the questionnaire that they logged into Blackboard and checked the discussion board but chose not to start discussions or to reply to the available posts. They argued that they were reluctant to use the discussion board because it is a new tool and therefore they were not confident in using it for discussions. In addition, students stressed that they did not have time to engage in discussions because they were busy with other graded coursework. They argued that discussing the exercise (which was not graded) on Blackboard requires time and since the activity would not be evaluated, they chose to focus on the other evaluated coursework. This aligns with Morris et al. (1999), Totter et al. (2006) and Xie et al. (2006) argument that students' motivation to participate in online discussion boards decreases as a result of being overwhelmed by the increasing amount of course work. In the questionnaire, students mentioned that allocating a specific time or a grade for the activity would motivate them to engage in discussions.

* Appendix 14 provides a summary of the total number of students engaged in discussions and the total number of posts per group in all cycles.

On the other hand, the students who have contributed to the discussions argued that using Blackboard for discussing exercises is a new experience that was interesting and they were motivated to use the technology for discussions for the first time. This aligns with Deci and Ryan's (1985) Self Determination Theory which stresses that students choose to engage in a task because it is interesting or enjoyable. The students also commented that they could benefit from the discussion boards to have access to their colleagues' views on exercises and topics which will help them look at these from different perspectives. However, students commented that because their other group members did not contribute to the discussion, they were discouraged and left alone having no one to discuss issues with. This aligns with Xie et al.'s. (2006) argument that students' motivation to use discussion boards declines as a result of the lack of peers responses to their postings.

Reviewing students posts on Blackboard showed that the total number of posts were 18 for the 8 students who used the discussion boards. Most of these posts were about either a student providing the solution for the exercise or a student commenting that he/she agreed with the solution provided. Students were not really involved in discussions with the other group members; rather, they used the discussion boards to post their answers. In addition, students did not challenge each other's solutions, although some were not entirely correct.

One interesting observation on the discussion boards was that although students were asked to discuss the exercise with their group members on Blackboard, most of them solved the exercise in their own time and then posted the answer as an attachment. So if anyone wishes to view the solution, he/she has to download the attachment. Other students mentioned that they will meet face-to-face to solve the exercise and then post the answer on the discussion board. When asked, these students clarified that they were not clear about what was expected from them mainly because using Blackboard as a tool for discussion and solving exercises was new for them.

Thus, giving students the freedom to engage in discussions in their own time and not allocating a grade for discussions did not show to be effective enough to encourage students to engage in discussions. This result was due to a number of factors. First, the lack of time because of the load from other courses. This was also a factor that Morris et al. (1999), Totter et al. (2006), Murihead (2002) and Xie et al. (2006) , argued to influence students engagement in online discussions which is mainly a result of the un-compulsory nature of participation. Second, the lack of experience in using Blackboard's discussion boards.

Although students were provided with training to use the discussion boards, they remained reluctant to use them.

These results showed that (a) allocating a grade for the discussion (Deci and Ryan, 1985; Warren and Rada, 1998; Bender, 2003) and (b) allocating a specific timing for the discussion (Singh, 2004) can motivate students to engage in discussions.

Graded Discussion

When a grade was allocated for engaging in discussions on Blackboard, the questionnaire showed that most students have engaged in discussions. The students argued that allocating a grade for the discussion was a great motivator.

The discussion boards in Blackboard showed that the number of students engaged in discussions and the total number of posts has significantly increased in comparison to these when the discussion was ungraded. A total of 13 students out of 16 contributed to the discussion boards with a total of 59 posts. Table 1 shows the total number of posts and engaged students in discussions.

Examining students' posts on Blackboard helped with identifying some of the students who did not contribute to the discussions when the activity was ungraded but did contribute when a grade was allocated for the discussion. These students clarified that the main reason for their engagement in discussions was grading and evaluating their posts.

Examining students' posts on Blackboard also showed an improvement in the way students used the discussion boards. Students started to enquire about, comment on and analyze each other's posts which they did not do when the discussion was ungraded. They also enquired about some topics which could help them solve the exercise.

These results show that there has been an improvement in the number of students engaged in discussions, the quantity and the quality of these discussions. Students showed greater interest in solving the exercise which is a result of the fact that the exercise was graded. Students also enquired many times of how their responses will be graded and if they are going to be graded as individuals or as a group. Moreover, students commented that the activity enabled them to interact more with their peers, look at issues from other people's perspectives, and help each other in problem solving.

Synchronous Graded Discussion

In the first round of questionnaires that collected students' perceptions about ungraded discussions during their free time, students mentioned that allocating a specific time for the discussion to take place will motivate them to be online and have discussions with their peers at the same time (synchronous). This would also overcome the two main causes of students' dis-engagement in the discussion boards: (a) the lack of time and (b) getting no response from colleagues. Therefore, all students were accompanied to a computer lab to engage in a graded discussion session on Blackboard. Although discussion boards are mainly helpful for asynchronous discussions, having all the students discuss an exercise at the same time would open up opportunities to allow some of the reluctant students to experience discussions in groups and recognize the benefits that they can gain as well as developing their sense of community.

The results showed a dramatic increase in the number as well as the quality of posts on the discussion board in relation to the results of the previous two approaches. A total of 14 (2 absentees) students out of 16 engaged in discussions with a total of 165 posts. Table 1 shows a comparison of the number of students and posts in each of the three approaches.

Table 1. A comparison between the three approaches used to motivate students Blackboard Discussions

Cycle	Total number of students engaged in discussions	Total number of posts
Ungraded Discussion	8	18
Graded Discussion	13	59
Synchronous Graded Discussion	14	165

Students clarified in the questionnaire that they liked this method because having the discussion during the lecture time will ensure that they will be able to collaborate with their colleges who are available in the class. This helped with overcoming the problem of getting no responses from their group members which students encountered in the first two approaches. Students also clarified that having the discussion in a specific time such as the

lecture time would ensure their dedication for the activity and overcome the problem of the lack of time needed to engage in the activity. In addition, students commented that there were more discussions during this exercise than it was in the previous two exercises because they were able to directly interact with and get instant response from their colleagues.

When asked about the method that they preferred and motivated them the most for discussions, students were divided exactly in half. 50% of the students liked the activity to be ungraded and with no specific time allocation, while the other 50% preferred it to be graded and allocate a specific time for discussions.

Examining students' posts on Blackboard showed that before discussing the exercise, students outlined how are they going to tackle the exercise by setting points to be followed sequentially which was not done in the previous two approaches. In addition, students' posts were shorter and students did not provide the whole answer for the exercise in one post which they did in the first two approaches. Instead, students finished discussions on one issue before moving to the next. Students also provided hyperlinks to websites that provide more details and help in solving the exercise. In addition, students' discussions showed that they critically thought about the problem and their colleagues' answers because they were able to ask questions and get instant answers.

These results show that the students were highly motivated to use the discussion boards because all colleagues were available online which allowed instant communication and having a dedicated time for the activity to take place. This was reflected in the significant change in the total number and the quality of posts in this approach in comparison to the previous two approaches.

Not many researchers used preset time to motivate students to engage in discussion boards. This could be due to the fact that using discussion boards is mainly aimed for asynchronous discussions and presetting time would jeopardize one of the main benefits of discussion boards which is engaging in discussion at any time that is convenient for students. However, having such activities from time to time can ensure higher engagement in discussions. Xie et al. (2006) argues that students' engagement in discussion boards dwindles over time because they lose interest in the activities especially when they get busy with other course obligations and this type of activities can help empower students' interest and motivation. Thus, it is useful as a way of changing the lecture environment which students become bored of and at the same time inserting the fun factor in students' learning.

CONCLUSIONS AND RECOMMENDATIONS

Many studies investigated approaches for motivating students to engage in discussion boards, most of which agreed that giving incentives such as grades, rewards and recognition increases the motivation of students (Deci and Ryan, 1985; Warren and Rada, 1998; Bender, 2003). The findings of this action research align with these findings. Students' engagement in discussions increased when allocating a grade for the discussions. Not only their engagement has changed, but also the quality of their posts has improved as students did not consider the quantity of posts but also their quality, similar to the argument of Bender (2003).

This research also found that allocating a specific time for students to engage in discussions is a powerful motivator as this method overcomes many of the problems that students face in asynchronous discussions such as the limited response from peers and the lack of time because of other course obligations. In addition, this method showed to be fun and enjoyable for students as it enables them to get instant interaction with colleagues. This method also showed an improvement in the quality of students' responses mainly because they could question each other's posts and get responses at the same time.

In conclusion, no single method should be worshiped for motivating students to engage in discussions. Instead, a teacher has to make a decision on what method is best for a given situation. In addition, using a single method to motivate students to engage in discussions will become a routine and students will be de-motivated and de-interested over time.

Moreover, the instructor's engagement in discussions can motivate students to engage in discussions (Bender, 2003; Oliver and Shaw, 2003). In addition, asking students to use discussion boards as a medium for discussions to prepare a group project can be a powerful motivator (Bender, 2003). These issues can be examined in future research.

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Research paper

Monitoring the Career Paths of the University Graduates as the Quality Instrument in Education

by

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ABSTRACT

The carrier path researches among the graduates have become common a practice in the developed countries. Their fundamental aim is to adapt the educational content to requirements of the labour market. The article addresses the issues of survey methodology as the measure minded and aimed at obtaining the information about the graduates career paths. Apart from many logistics difficulties, the main obstacle is to the get an effective conduct of graduates while dealing with their low motivation to get involved into researches. The article proposes an innovative solution to increase the graduates' responsiveness.

Keywords: Carrier Path Researches, Data Collection Method, Responsiveness, Representativeness, Questionnaire

Introduction

In the modern educational system, the priority areas such as the high quality of education or an adjusting the educational offers as to conform them to the job market, are continuously improved. An adaptation of learning and labour demands is essential. In the Polish reality the trends and supplies in the job market had not been taken into the consideration on the educational curriculum for many years. The educational system in Poland still changes, that is why Polish schools need to assume the constant process of

evaluation. Whereas educational experience of Western Europe provides many valuable tips on a study area, gathering data techniques, or methods of its usage.

An important context for the issue of the carrier paths of the graduates is an unemployment. In Europe, the scale of deactivation among people under 30's reaches unacceptable rates. That is one of the reasons of dissatisfaction and social protests. Unemployment rate of young people in all EU countries is still higher than the overall value of this indicator (22.3% in the EU compared to 9.8%)⁸⁴. In Poland, the youth unemployment rate in 2011 was 27.8%, which is nearly three times more than the harmonized unemployment rate in general. However, it should be noted that although the situation of young people in the labor market remains difficult, the youth unemployment rate in Poland in 2011 was lower than in Spain (49.6%), Slovakia (35.1%), Portugal (30 , 7%), Italy (30.1%) and Ireland (29.3%)⁸⁵ . In the view of the foregoing, successive waves of mass protests are not isolated. Movements like "*Indignados Revolution*" began in Madrid May 15, 2011 are an indicator of dissatisfaction with the overall labor market situation. Both the low wages, limited access to jobs and prospects for the future are for many young people indicators that cause bitterness, and frustration which can take various forms and scale.

The European governments have to face the challenge of bottom – up reforming which change the unprofitable economic rates into the stable ones. One of the primary need is to identify problem areas in the higher education system.

The last decade was a period of significant change in higher education systems, which have carried from country to country and internationally under the influence of phenomena such as rapid growth in student numbers, the relative decline in public investment, together with an insufficient level of private funding, the growing importance of research and innovation in knowledge-based global economy, and wider competition between the universities⁸⁶.

The integration of the courses with employers needs is reflected in numerous initiatives supported by the Ministry of Education or the Ministry of Social Policy. However it should be emphasized, that all attempts as to adapt education to the demands for certain employees are only parts of the whole process that in the long term has to improve the

⁸⁴ Eurostat newsrelease euroindicators 5/2012 - 6 January 2012.

⁸⁵ Eurostat and the Ministry of Labour and Social Policy of Poland, cf.: Response to the interpellation nr 891/2012.

⁸⁶Report: *Badanie ewaluacyjne ex-ante dotyczące oceny zapotrzebowania gospodarki na absolwentów szkół wyższych kierunków matematycznych, przyrodniczych i technicznych*, IBC GROUP, 2012.03.06.

situation of youth in labor markets. At this point the reference to the ongoing trends in the higher education system in Poland should be made. The implementation of the following recommendations is a long lasting process and requires continuous evaluation. These include in particular⁸⁷:

- ✓ increasing transparency of the process of education by using such tools as: defining curricula through the description of learning outcomes and the possibility of comparing qualifications through the National Qualifications Framework, the introduction of new (internal and external) quality procedures at the universities;
- ✓ Study programs based on specific learning outcomes relevant to employers (proposed supplement to the graduates diploma indicating their achievements and competencies);
- ✓ A clear and the more understandable definition of I and II level studies in for students, employers and academies;
- ✓ The wider curricular autonomy of universities;
- ✓ Increasing the quality of education carried out within the students' trainings;
- ✓ Inclusion of the development of new technologies in the educational process;
- ✓ Creating opportunities for professional certificates during the time of studies;
- ✓ Tackling against the graduates unemployment caused by the adoption of too many candidates into some study courses;
- ✓ Modernization of the machine / hardware base at the universities⁸⁸.

An implementation of these actions should be done through constant referring to the realities of the labor market. Although the main trends in the economy are known and change rapidly, the specifics of the demand in regional labour markets requires constant monitoring in order to meet the demand of the relative autonomy of universities continuously modify education and improve the quality of education was primarily understood as prepare the student for the demands of the labour market.

The graduation from specific higher studies does not specify the occupation performed for life today. The role of the modern educational system is also to form of certain

⁸⁷ Expertise: „Ocena sytuacji w szkolnictwie wyższym w Polsce w zakresie obowiązujących programów kształcenia w stosunku do potrzeb rynku pracy”, G. Światowy, pages 22 and next, www.nauka.gov.pl/2012.03.03.

⁸⁸ Ibid.

attitudes, which in particular include the ability to efficient adaptation to labor market trends. This is reflected in the expectations of experienced employers who increasingly insist on a high intellectual ability and adaptation of newly employed workers. Theoretical knowledge is only an additional asset to graduate faster adaptation to the specific company and the nature of work performed in steps. The results of students and graduates⁸⁹ in five Central European countries, conducted by *Deloitte* and Human Capital Development Department School of Economics in Warsaw indicate a concern for students and the need for curricular change in higher education, in order to adapt them to the labor market. Expectations of students and the challenges before them the labor market in the confrontation with the offer of teaching in higher education, demonstrate the weakness of the system. Respondents asked about the overall assessment of how the higher education system is preparing to carry out future professional responsibilities expressed in the majority of negative feedback (56% of the students in Central Europe)⁹⁰.

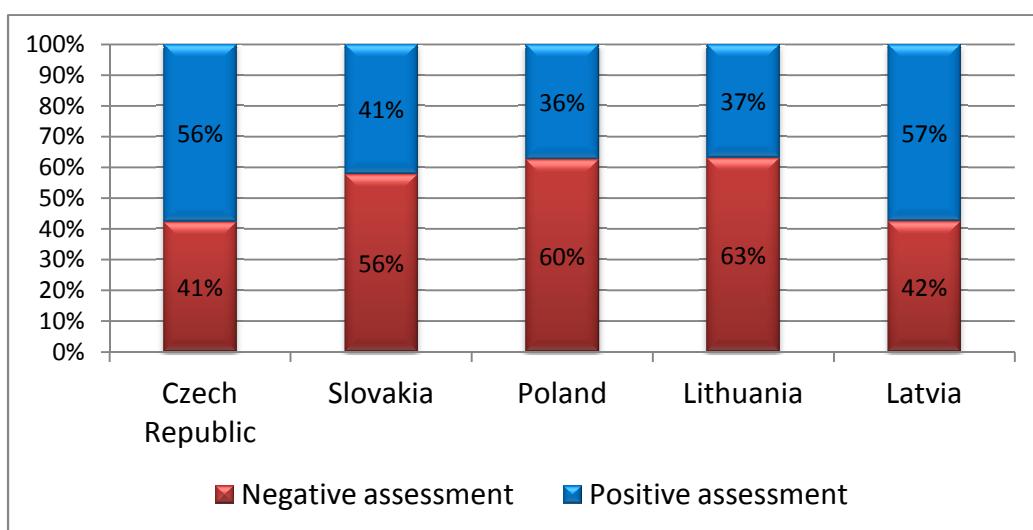


Chart 1. Rating of prepare students for higher education for future professional responsibilities.

Source: Deloitte and Human Capital Development Department School of Economics in Warsaw' Report "Pierwsze kroki na rynku pracy Międzynarodowe badanie studentów i absolwentów".

⁸⁹ Deloitte and Human Capital Development Department School of Economics in Warsaw' Report "Pierwsze kroki na rynku pracy Międzynarodowe badanie studentów i absolwentów". A survey by online interview held from 27 January to 27 February 2011. The study involved a total of 3618 students and graduates from five countries: Czech Republic, Slovak Republic, Poland, Lithuania and Latvia; Warsaw; April 2011.

⁹⁰ Ibid; Page 7.

These data show up one of the reasons supporting the necessity of the changes in the existing approach and determine the direction of the modern universities⁹¹. Concerns of students related to their professional skills also confirmed by the entrepreneurs themselves. Thus, it is important to both ongoing monitoring of experiences of graduates, as well as the expectations articulated by the employers.

The Polish Higher Education towards the obligation of the graduates carrier paths monitoring

The Act which regulates Higher Education in Poland is the Article 13a of the *Higher Education Act* dated 27 July 2005 with further changes (*Dz. U. No. ... 164*, item 1365 as amended), which states that "*The University monitors the careers of its graduates to adapt courses and training programs to labor market needs, especially after three and five years from the date of completion of the studies*". Therefore, universities are required to monitor the career paths of the university graduates. Significantly, the legislature did not specify the methodology of such studies, indicating only the period in which graduates should be treated as the subjects of monitoring. According to many critics of this amendment to the lack of top-down set of methodological standards may be the source of confusion or even manipulation in the competitive educational market. Without a doubt, the data obtained by the professional graduates' career paths researches will be used as a marketing material in the struggle for the student - both in the public and the private education. In the short time the appearance of ranking, constructed on the basis of data from reports the universities, can be predicted. As the practice in USA shows today, there are rankings of the effectiveness of training, defined as the social and professional success of graduates, performed by the analysts of educational or labor market or journalists. Attached to them, the rankings have got minor importance. One of the reasons for that is the fact that the studies at the carrier paths of graduates in Poland were carried out according to an unified methodology. In addition, because of the lack of the regulations defining the frequency of measurement, further confusion arises while trying to do the comparative analysis of the results. Similarly, Central Statistical Office

⁹¹ One can also appeal to other studies in which students in Poland extremely negatively assessed their preparation for professional work. In studies of the *Homo Homini Institute* of August 2011 almost 90% of graduates claimed that polytechnics, universities and academies did not adequately prepare them to professional carriers.

researches in this area are not cyclical. Current statistics carried out by the Labour Offices in Poland or different workplaces reporting on graduates' admissions and exemptions are also not in-depth source of information about the careers paths of the Polish graduates.

As a result of statutory changes previously mentioned, 460 public and private universities in Poland⁹² are preparing to monitor the carrier paths of their students. Some colleges, which cyclically have already been studying the carrier paths of their graduates, still modify the methodology of researches referring to the practice of the western-European countries. Even though the studies on creating the unified research system (model) at the carrier paths of the graduates are in progress, it does not seem to happen soon that the generally applicable standards in the higher education will be established⁹³. It is connected with the diversity of specializations and different specificity of the schools. Nevertheless, the university teams designing a procedure for such researches have to deal with a number of organizational and methodological issues. The questions related to the necessity of developing test procedures consist mainly of the following areas⁹⁴:

- ✓ Protection and processing of personal data of graduates;
- ✓ Frequency of testing (regardless of the minima specified in the Act);
- ✓ Methods of reaching out to the respondents;
- ✓ Content, order and form of questions in the questionnaire;
- ✓ Responsiveness (the returning questionnaire rate, which indirectly determines the representativeness of researches among graduates);
- ✓ Way of presenting and sharing results from the researches.

⁹² <http://www.nauka.gov.pl/szkolnictwo-wyzsze/dane-statystyczne-o-szkolnictwie-wyzszym>, 03.03.2012.

⁹³ Examples of such activities are contests for innovative projects announced by the National Centre for Research and Development. For example, the Human Capital Operational Programme, Priority IV, "Higher education and science," *Strengthening and developing the potential of university teaching and increasing the number of graduates in critical knowledge-based economy - Theme 3: Monitoring of the carrier paths of graduates in order to improve the quality of education and to adapt the educational offer to labor market and economic requirements.*

⁹⁴ The probe is made by the author among the representatives of public and private schools during an informational meeting organized by the National Center for Research and Development; Competitions for Innovative Projects - Action 4.1.1, January-February 2012.

Consent to participate in the researches and the aspect of protection of personal data

Scientists are unanimous about the fact that research involving humans should always be preceded by the respondents agreeing on the basis of presented to them information⁹⁵. This consent is particularly important for researches in which respondents are exposed to risk of the loss of personal values⁹⁶. The respondents must be informed about number of issues related to the researches purpose and specificity, as to be able to express their willingness to participate in the study. An extent of such information should include:

- Presenting the aim of the study; clarify of what kind of decisions will be based on material obtained;
- Identifying the research establishment that covers the costs of research;
- Pointing out the methods of using and making the results available (including the publication of data);
- Presenting the people and institutions that will carry out the researches;
- Characterizing the methods by which the individuals were selected for the researches and their role in the studies;
- The anonymity and confidentiality degrees and the type of discomfort and inconvenience related to the participation in the research;
- The ways of storing the research data and the ways of protecting against disclosure of the personal data;
- Statement whether the participation in the researches is voluntary or obligatory⁹⁷.

In case of the graduates carrier paths monitoring, the issues placed above can be addressed particularly during the signing of a form and during the information meetings at Universities, organized by the Careers Offices or by the academic staff. These actions fulfill the demands of ethics in the social researches (respondent must be informed), but also have a pragmatic dimension, because they increase the success rate to reach out the respondent.

⁹⁵ Ch. Frankfort-Nachmias, D. Nachmias, „*Metody badawcze w naukach społecznych*,” wyd. Zysk i Ska, Poznań 2001, p.95

⁹⁶ Ibid.

⁹⁷ J. Kowal, *Niektóre etyczne, metodologiczne i pragmatyczne aspekty badań statystycznych*, [w:] *Etyczne i psychospołeczne aspekty badań rynkowych*, J. Kowal, K. Węgłowska-Rzepa (red.), wyd. WSZ Edukacja, Wrocław 2002, page 145.

Graduates who have full knowledge of the researches issues and aims will be more motivated to provide detailed information.

At the planning stage of the researches it is important to fulfill the legal requirements relating to the protection of personal data. According to the educational mission of the Higher Education institutions, the processing of the personal data in order to raise educational standards do not affect the legal principle⁹⁸. The standard requirements for security of the personal data are defined in the *Act on Personal Data Protection* in the articles 36-39a and in the Regulation of the *Minister of Internal Affairs and Administration* dated at 29 April 2004 on personal data processing documentation and technical and organizational conditions which should be fulfilled by devices and computer systems used to process them (*Dz. U. No. 100, item 1024*)⁹⁹.

It should be also noted that in accordance with applicable law, the controller who creates the collection of personal data is obliged to submit the list to the General Inspector of Personal Data Protection (GIPDP). The legislature in Article 43, paragraph. 1, item 4 shows the exemption because "*from the registration requirements of the data set are exempt data controllers (...) are processed in connection with the employment or providing services on the basis of civil contracts and the people associated with them, or learning.*" Thus, the personal data of students do not require notification. However formally, the list of students required to conduct in the researches is the collection of personal data and requires special protection. This includes contact details and unprocessed survey results, which could be in any way identified or assigned to a specific respondent.

The graduates whose personal data were collected have got special law protection, as such:

- ✓ Request to supply, to update, or correct the personal information; temporary or permanent suspend or erase data, if they are incomplete, outdated, untrue or collected in violation of the law or are no longer required for the purpose for which it was collected;

⁹⁸ art. 23 ust. 1 pkt. 5 Ustawy o ochronie danych osobowych

⁹⁹ H. Franaszek, *Aspekty prawne wynikające z Ustawy o ochronie danych osobowych*. [in:] *Pierwsze kroki na rynku pracy – analiza losów zawodowych absolwentów Politechniki Krakowskiej, narzędzie badawcze, metodologia i wyniki badania pilotażowego, rocznik absolwentów 2006*, J. Żyra (red.), Raport z badań wykonanych przez Biuro Karier i Instytut Ekonomii, Socjologii i Filozofii Politechniki Krakowskiej, 2006, page 17 and next. See also. Ustawa z dnia 29.10.2010 r. o zmianie ustawy o ochronie danych osobowych i niektórych innych ustaw, Dziennik Ustaw nr 229, poz. 1497

- ✓ Write a request to stop the processing of the data due to the particular situation of someone who is in the set. This applies to the cases mentioned in the *Article 23, paragraph 1, item 4 and 5 of the Act*;
- ✓ Object to data processing, in the cases specified in *Article 23, paragraph 21, item 4 and 5 of the Act*, when the controller is going to process them for marketing purposes or to transfer the personal data to another data controller¹⁰⁰.

Aspect of data protection is an important part of the researches at the carrier paths of the graduates. The data itself and obtained results should be protected with due care. The fact that any unauthorized use of the information collected, in addition to the obvious legal implications, it could permanently hinder or even prevent any further researches conducted by the particular university. It is important to involve people with specific ICT skills and knowledge to avoid the unforeseen events, especially with methods of computerized data collection.

Responsiveness and the Usage of Data Collection Method

One of the biggest organizational problem with the social researches is the rate of returning of the questionnaires. Practice shows that this also applies to the monitoring of the career paths of the university graduates, both in Poland and abroad. Regardless of the method used to collect data, this question is crucial for the degree of representativeness and the possibility to generalize the results to the population of graduates¹⁰¹. A particularly low rate of return may hinder analysis of the results for each subgroup selected on the basis of criteria of the organizational or social characteristics - demographic graduates (the study degree, specialization, the age category, location, etc.). Therefore, in order to meet demand of maximizing the representativeness, these researches should have character of so-called *Total Studies*. For obvious reasons, access to every graduate is not possible. The reason for this

¹⁰⁰ Ibid. page 19.

¹⁰¹ The financial aspect is the issue that goes beyond the scope of this paper. It should be mentioned that the average market prices in Western Europe, proposed by the research institutions at the universities, oscillate between 3 and 7 €, (including VAT tax), for each respondent. In Poland, the offers sent to the public and private universities are in the range of from 6 to 10 PLN (including VAT tax), for each respondent, which is about 1,30 €.

may be the fact that not all of them agreed to participate in the study (decelerating stage - signing a declaration to participate in the study). Some elements of the graduates population is also unavailable - you can not make contact with a graduate of random reasons¹⁰². So called *Missing Data* can contribute to a reduction of representativeness, which is particularly common problem in the traditional mail researches.

The most effective strategy in terms of rate of returning the questionnaires is certainly the simultaneous use of the all possible methods during the researches. (*Fig. 1*). The disadvantage of this approach would be the complexity of procedures, the time-consuming and excessive costs.

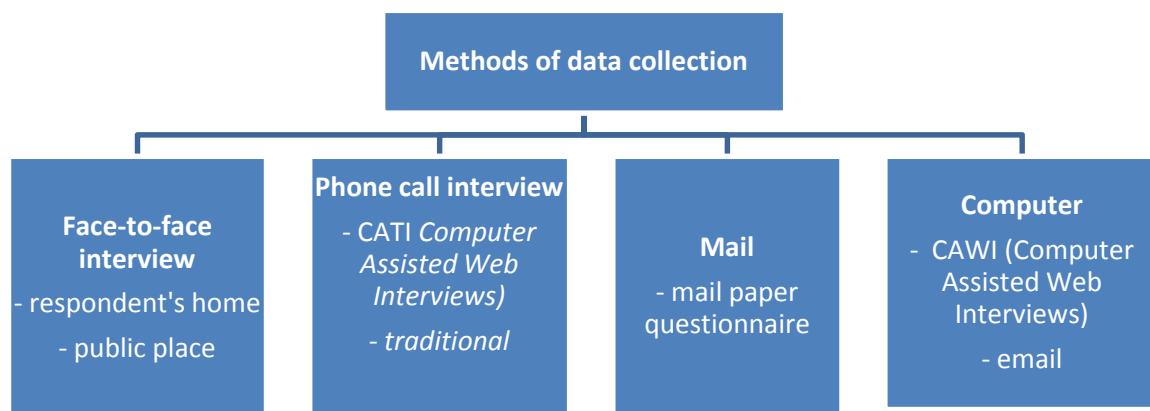


Figure 1. Methods of data collection in the survey research.

Source: own calculations.

Face-to-face interview is usually associated with the high costs and relatively long data collection. The main advantage of face-to-face interviews is the ability to control the situation in which the questionnaire is completed. However in the monitoring of the career paths of the university graduates this method can only be ancillary, complementary. In the current practice involving the monitoring of the graduates carrier paths are phone call, mail or computer interviews as the most frequently used methods to reach out the respondents. Of the above-mentioned method, the traditional mail is usually characterized by the lowest responsiveness. Due to the relatively low costs, relatively high levels of returns, the

¹⁰² For obvious reasons, rate responsiveness is also related to the period of study - the longer the time after graduation, the survey return rate is lower.

possibility of the study at the geographically dispersed population and it's fastness, the CAWI¹⁰³ (Computer Assisted Web Interviews) method is gaining in popularity.

The survey area has developed a range of treatments which are aimed at increasing the responsiveness. Depending on the chosen method of data collection, the effectiveness of motivating respondents to participate in the researches differs. It is also confirmed by analysis of the returning rates which were achieved in the studies of the monitoring of the career paths of the university graduates among European Union countries. Concurrent use of available methods to reach out to the respondents produces the best results, as evidenced by eighty percent effectiveness research conducted by the Higher Education Statistical Agency in the UK (HESA). Indicators of the returning rate presented below should also be included in the context of financial resources and the organizational facilities. Because this information is not widely available it is impossible to do meta-analysis of the effectiveness of selected procedures of the data acquisition.

COUNTRY	Responsive ness*	Paper Questionnaire	On-line Questionnaire	Phone call research	Face-to-Face Interview
Great Britain HESA	80%	✓	✓	✓	
Italy	80%		✓	✓	
Poland	75%		✓		
Finland	60%	✓	✓		
Germany INCHER	50%	✓	✓		
Germany HIS	30%	✓			
Austria	25%		✓		
Great Britain HFR	20%				✓
France	20%			✓	

* Approximate ratios, calculated from graduates who have signed a declaration to participate in the research.

Table 1. An example of responsiveness and the method of data collection in selected European countries.

¹⁰³Apart from the advantages, one should be aware of the dangers posed to capture the data via the Internet. Therefore, schools often use secure access to an interactive questionnaire using a single password, so that an unauthorized person was unable to attend the measurement. Over a one-time password protection prevents multiple complete a questionnaire by the same person.

Source: own study based on: .almalaurea.it, www.his.de, www.incher.uni-kassel.de/2012.03.09 and on the book: „Monitorowanie losów zawodowych absolwentów szkół wyższych – rozwiązania stosowane w wybranych krajach europejskich”, Sedlak&Sedlak, Kraków, 29.12.2010.

As it was mentioned above, the monitoring of the career paths of the university graduates should be aimed to cover the entire population of students. Depending on the planned level of detailed analysis of the results, the researcher must establish a minimum number of completed interviews. It is proper, if the calculations take place in real time during the data collection so as to provide an essential opportunity to report about the various subgroups of graduates (faculty, major etc.)¹⁰⁴. Table 2 presents the required minimum number of graduates participating in the study for the assumed confidence level of 0.95. Please note that the analysis of multi-variable, the quantities may not be sufficient for an assumed below the limit of statistical error (maximum error - 0.03).

Population of the graduates e.g. year of study, department	The minimum size test for level confidence interval 0.95 (Error max. 0.03)	Population of the graduates e.g. year of study, department	The minimum size test for level confidence interval 0.95 (Error max. 0.03)
100	91	650	404
150	132	700	423
200	168	750	440
250	203	800	457
300	234	850	473
350	264	900	488
400	291	950	503
450	317	1000	516
500	340	1050	529
550	363	1100	542
600	384	1150	554

Table 2. Population size and the size of the realized sample.

Source: own calculations.

¹⁰⁴ Tool used to monitor the return is called *Plot Llevel Returns*; Earl Babbie describes the procedure to monitor returns in the following way: *A day in which they were sent questionnaires, the graph is called the first day. Each day thereafter applied to the graph the number of questionnaires sent back. It is best to combine the two graphs. One shows the number of questionnaires sent out every day - increasing and then decreasing. The second shows the number or percent cumulatively. This is a clue for investigators how the data collection. If you plan to list-like, the graph is an indication as to when to send such reminders (the date of the next prompt should also be marked on the chart)*, See. E. Babbie, *Badania społeczne w praktyce*, PWN, Warszaw 2003, page 286.

These calculations are indicative, based only on the basic knowledge of the sampling theory. The minimum sample size is one of many issues to be resolved at the planning stage of the researches. For example, the important question of a methodological nature is whether persons not participating in the studies differ in a systematic manner and specified parameters in relation from those actively participating in them (for example, it is difficult to reach out to the work migrants or people who do not take the dialogue with researcher - frustrated by failure at the labour market etc.).

To sum up this thread, it should be emphasized that the level of returning rate is one of the indicators of representativeness. When the level is high, the likelihood of sampling bias associated with it is smaller than when the level is low. Similarly, the low level of returns is a warning signal, because people who did not participate in the researches may differ from the respondents, not only in this sense¹⁰⁵.

In the literature that addresses the issue of the questionnaire returning rate a number of indicate factors are listed. The following actions concern in particular the mail questionnaires and computer methods:

- ✓ *Letter of inform* - a letter or postcard informing of the proposed study and inviting them to participate;
- ✓ *Explanation of choice* - explain how to create tests and the coverage of the respondents (description of the purpose of research);
- ✓ *Envelope* (for postal surveys) - empirically confirmed is more likely to return questionnaires in the case of personally addressed letter, which is not paid a lump sum;
- ✓ *Advertising* - for graduate study may be information meetings, leaflets, discussions with teaching staff;
- ✓ *Ensuring the confidentiality of the data* - involves informing the respondents about who will process the data (only researchers) and that the publication of results will not allow the identification of individuals involved in the study;
- ✓ *Reminder* - in case of postal surveys, which generally have a low return, a final reminder, clearly increase the rate, the effectiveness of reminders recorded also in the case of a method CAWI (Computer Assisted Web Interviews);

¹⁰⁵ E. Babbie, *Badania społeczne w praktyce*, PWN Warszawa, page 228.

- ✓ *Questionnaire Appearance* - There have been many experiments to the appearance of postal questionnaires, font type, color paper. These experiments show that the most effective appears to be relatively conservative, non-irritating appearance¹⁰⁶. This rule also applies to online surveys. Here may be an important way of dividing content questionnaire (the screen with a progress bar).

Apart from the technical and organizational ways to motivate respondents to participate actively in research, the literature lists a number of psychological mechanisms that may determine the ultimate level of the questionnaire returns. Their knowledge and skillful use determines the success of the researches. These are in particular techniques based on the principles of social life such as reciprocity, consistency, social proof of the validity and power of authority.

The Rule of Reciprocity is the principle of timeless and trans-cultural. Refers to reciprocate the behavior of interaction partners. Fair reciprocating which builds up social relations can also be used in the manipulation and deliberate shaping the attitudes of other people¹⁰⁷. In European practice relating to monitoring the carrier paths of the graduates such treatments as small gifts or bonuses are applied¹⁰⁸. *The Rule of Consequent* on the other hand, refers to a strong people need to perceive themselves as consistent and compatible with that in what they were already engaged to. This mechanism is associated with a desire to be perceived by others as a unit of predictable and consistent in their attitudes. So when the interviewers rely on a previously signed declaration of participation in the researches, for the respondents it is just difficult situation in which they are not able to refuse because of the high psychological costs (dissonance). Responsiveness' researchers also point to the effectiveness of recourse to the general social norms and behaviors. This principle is called by socio - psychologists *Social Proof of the Correctness* and refers to the relationship between the respondent and the researcher. Referring to the scale of involvement of other respondents (those who have already filled out) the researcher may expect a higher

¹⁰⁶ A.N. Oppenheim, *Kwestionariusze, Wywiady, pomiary postaw*, Zysk i Ska, Poznań 2004, page. 125 and next.

¹⁰⁷ J. Jarco, *Manipulowanie w komunikacji*, [in:] *Public Relations na tle problemów zarządzania*, Z. Knecht (red.), WSZ Edukacja, Wrocław 2001, pages 51-52.

¹⁰⁸ A well known solution is also motivating the respondents to provide the possibility of receiving the main prize intended for randomly selected graduates participating in the study. The prize that can be post-graduate studies, language courses or other attractive educational services offered by the institution. There have been no studies carried out to what extent these actions increase the return of questionnaires and help to increase the motivation of the respondents. See: *Monitorowanie losów zawodowych absolwentów szkół wyższych – rozwiązania stosowane w wybranych krajach europejskich*, Sedlak&Sedlak, Kraków, 29.12.2010.

questionnaires returning rate. In the case of a person from a particular academic community, the refusal to participate in the study is difficult to communicate. In an indirect way, this principle refers to the conformism of psychological information, and the universality of this mechanism is one of the very well-documented empirical facts.

The Power of Authority can be understood in the context of the graduates and the university as an authority. Studies at the socio - psychology suggests that most people are less likely to challenge the validity of requests made by the authority and are also more likely to reflexive fulfillment of it. Psychologists attribute the performance impact not only on the mechanism of the elimination of liability, but also on the cognitive factors, so-called *heuristics*, that is generated in the course of experience patterns of thinking. This leads to a narrowing of perception, to simplify the process of thinking and omissions in the analysis of many aspects of the considered situation, that is, to lack of reflection. Then the behavior is directed automatically such as, for instance, "*if a professor who is a wise man, believes that this survey is needed, so it probably is*"¹⁰⁹.

An innovative idea which may elevate responsiveness and which is being currently tested, is a software solution with the working title "*feedback*"¹¹⁰. This idea can be used in the computerized method of data collection CAWI (Computer Assisted Web Interviews). The essence of this approach relates to the well-known and successfully used in Internet marketing *e-gift formula*. The layer of the socio-psychological mechanism is based on the need for the comparison with other graduates from the same graduate year.

Before completing the questionnaire graduates are aware of the possibility of getting a partial research report which will be automatically sent to them. The content of this summary report are selected features of a single graduate student, presented graphically on the background of the averaged results relating to all graduates. The only requirement for receiving the results return (in addition to complete the questionnaire on-line) is clicking on an electronic consent. In the mid-term report delivered by e-mail graduates may find different variables such as: wages, job-search time, language skills evaluation, current job satisfaction, or many other dimensions describing the respondent. The content presented statements

¹⁰⁹ M. Kałaska, M. Komorowski, *Psychologiczne i socjologiczne uwarunkowania responsywności w badaniach kwestionariuszowych*, [in:] *Pierwsze kroki na rynku pracy – analiza losów zawodowych absolwentów...*, page 28 and next.

¹¹⁰ P. Jarco *Know-how: Wyższa Szkoła Zarządzania Edukacja we Wrocławiu*, The publishing of the data collected with the use of solution requires attribution.

characteristics of the subjects is unlimited, in practice it depends on the questionnaire author's imagination. Below there is a visualization sample of the result which can be send to the graduates after their completing of the questionnaires.

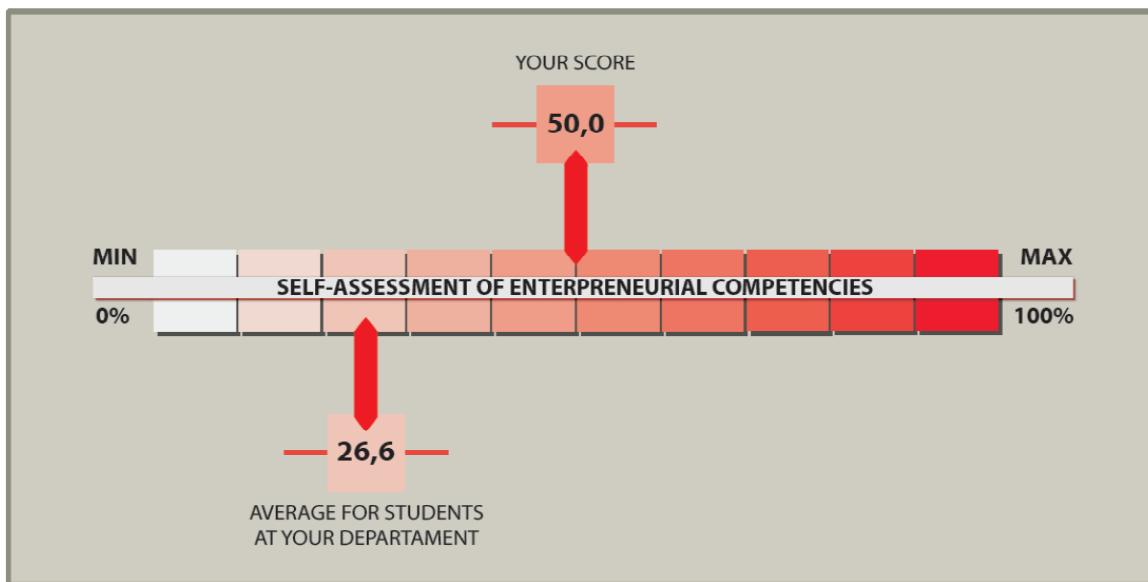


Figure 2. Example result sent automatically to the graduate via e-mail

Source: own calculations

In the social structure the desire to comparison between people is well established on the basis of psychological research. An important component of successful online projects such as *Facebook* or “*Nasza Klasa*” (Polish equivalent) was and is the need to relate their own life to the immediate circle of the society. Psychological attractiveness of this mechanism is confirmed in many aspects of social and economic life. Rankings and ratings are a sign of modernity, supporting the ongoing process of building their own identity (whole groups and individuals). On the other hand, they also cause many negative phenomena such as low self-esteem or depression. Personality psychologists indicating the functional importance of social comparison, emphasizing the role of the so-called. *Downward Comparisons*, namely the tendency of people to compare with people who find themselves in a similar (but more unfavorable) to our own situation. Such comparisons usually provide relief, helping to improve the well-being. *Upward Comparisons* are typical for non-defensively oriented, geared to a greater extent on the development and self-improvement. Such comparisons facilitate the programming of its own activity and stimulate the incentive

to act¹¹¹. Using the universality of the psychological mechanism described can be expected to increase responsiveness and higher identify alumni of the university research initiative¹¹².

Contents Range Of Questionnaires

Basic issues which are related to construction of the questionnaires are: the content, structure, format and order of questions. It should be noted that the researcher at the stage of designing the questionnaire, specifying the content of the questions and their level of detail, should keep in mind the limited perception of the respondents. Excessive details may indeed lead to the low questionnaire returning rate and the general reluctance of the respondents. Both the factual questions and subjective experiences (attitudes, opinions, satisfaction) should take into account the time dimension - graduates may not remember certain facts about which they express (e.g., types of employment contracts contained in the last 5 years of their professional work, etc.)¹¹³.

Previous research practices used in Poland and Europe, allow to specify of a set of repeated operationalised themes with questions and statements in the questionnaires. These are the most common¹¹⁴:

- ✓ Personal data (sex, year of birth, marital status, residence, number of children, social environment, etc.);
- ✓ Themes of study, level of satisfaction with the completed study, the overall assessment of the selection of faculty and the university, training, work undertaken during the study, assess the usefulness of skills acquired during the study, evaluation of the program to match labor market requirements, stays abroad during their studies, their the purpose and duration;

¹¹¹ The question arises at this point whether the report of the return should be sent to the respondent until after the edition of the survey that may be generated immediately after filling out a questionnaire. The first solution makes it possible to reference the results of a single respondent for the whole sample. However, a delay of "reward" which is to satisfy the curiosity of the respondent can negatively affect the responsiveness and reduce the effectiveness of this solution.

¹¹² The question in the questionnaire: Overall, how would you rate your own entrepreneurial skills? (scale 1 - 5, where 1 = very low, 5 = very high). In this case, the respondent pointed to the midpoint of the scale - 3 (50%).

¹¹³ J. Strelau (red.), *Psychologia. Podręcznik akademicki*, part 2, GWP, Gdańsk 2000, pages 571-252. See also: *Reference group of positive* (Robert Merton), *Comparative reference groups* (George Hyman), [in:] P. Sztompka, *Socjologia, analiza społeczeństwa*, Znak, Kraków 2002, page 217.

¹¹⁴ See: *Monitorowanie losów zawodowych absolwentów szkół...*

- ✓ Subjective assessment of their psycho-social competencies acquired during training (social skills, entrepreneurial, management, language skills, communication, self-presentation, resourcefulness of life, dispositional optimism, location control, ability to effectively cope with life's problems, levels of stress on the background work);
- ✓ Further plans for education, further education and gaining qualifications (undertaken and / or completed additional courses of study, their motivation to take and / or completion, further practical teaching profession, for example application - the law, specialization - medicine, compulsory professional practice, assessment of further training in angle range of programs, duration, etc.);
- ✓ The history of exploration work (exploration time, terrain and forms of research, experience with recruitment processes, possible reasons for rejection of candidates by employers, subjective evaluation of a graduate of the reasons for rejection of his application);
- ✓ Work experience (current job and main duties, employment taken after graduation - time, type of employment contract, profession, place of employment; way to get the first and current job, a form of work - full or part-time, subsidized jobs, own business , information about the first employer - location, industry, type of operator, the name of his position, major responsibilities associated with working at the position), the height of the first and current salary, additional components of the current salary¹¹⁵.

An important methodological issue to be resolved at the design stage of the questionnaires is also the order in which questions should be arranged. It was noted that the nature of the answers given by respondents may influence the order of questions. The recommended order of the questions relates to whether the interviewer conducts an interview or questionnaire to be completed independently by the respondent. As a rule, in which case the best that the questionnaire began with a most interesting set of questions¹¹⁶. It is advisable

¹¹⁵ Although differences in self-diagnosed selected characteristics (respondent relative to the sample) did not have a special value for the main objective of research, may be a prerequisite for the presentation of graduates by e-mail offers postgraduate studies, training courses (personalized newsletter). The relatively high efficiency of targeted marketing in this case is strengthened by "objective" condition - the result of proving the respondent's potential deficits in selected areas.

¹¹⁶ An interesting solution to minimize the problem of lack of data (memory wailing respondent) is applied in France. In a study carried out by CEREQ (Centre for Study and Research on qualifications, the annual budget 11.7 million - 2010). respondent receives a telephone interview before the professional calendar, (fr. *Calendrier professionnel*) in which the respondent in a systematic manner can recall a place of employment and forms of employment contracts of the period. This speeds up the telephone interview process and increases the accuracy

not to use questions about the facts (Imprint) at the beginning of a questionnaire. But in the case of the monitoring of the carrier paths (in particular, conducted via the Internet) to verify the respondent's data is an indispensable necessity (year of graduation, direction). Nevertheless, the logic of survey questions, which goes into the hands of the graduate should be part of the so-called principle *migration from general to specific*. This strategy is called the funnel, as opposed to *an inverted funnel*, where the principle of a narrower question ahead of a general question. Where possible, researchers should also try to make the procedure of filling up the questionnaire not only boring or frustrating. Social studies offer many opportunities to demonstrate their ingenuity, and the same contact with a research tool can and should be of interest to the respondent. To draw attention to this aspect of the test and will enhance the accuracy of the impact of the data collected. Special field to meet the demand to give the attractiveness of a questionnaire asking for subjective opinions about the psychological and social resources of people surveyed (e.g., number of owned friends, family situation and psychological characteristics are important for the effectiveness of the labour market). In a letter to the respondent, or in a letter announcing the survey the researcher should indicate the research activity in such a way as to arouse curiosity.

Summary

Summing up the subject matter it is impossible to ignore the broader context of the qualitative changes which are observed in the higher education nowadays. New statutory requirements and ministerial recommendations are often taken with suspicion or surprise in academics. In their in essence they aim to improve the socio-economic reality of the country. The formatting of high-grade knowledge and the graduates resources developing, which are manifested in the form of modern skills, social skills, resourcefulness and entrepreneurial attitudes, is unquestionably a key goal for building a vibrant economy and prosperous society. However, one can get an impression, shared by many others, that the problem of quality of higher education in the context of the fight against unemployment is over fetishized. There are some objective barriers to the nature of the system, which are equally

of the data collected. See: Ch. Alpaga, B. Duplouy, S. Jugnot, P. Rouaud, F. Ryk, Enquête «*Génération 2004*» *Méthodologie et bilan 1ère interrogation - printemps 2007*, Céreq, Mai 2010.

important.. The migrations of well educated graduates who gained valuable skills and are the best proof. An educational offer that the Polish government have for those who want to start their labour carrier is not very attractive. The unfulfilled aspirations of young people are related to the low standard of life in relation to that which can be achieved in other European countries. The sustained improvement in the labor market requires a number of long-term governmental investments. Other regulations and statutory requirements as to quality education, for which they do not follow financial expenditures, are imperfect measures, indicating only the propaganda and often thoughtless copying of solutions used in the rich western economies.

In a sense, the obligation imposed by law, with regard to monitoring of the graduates carrier paths is another manifestation of the right direction to implement changes without the financial commitment of the Polish government. It should be noted that the study at the monitoring of the graduates carrier paths in Western Europe is largely financed by external funds. Polish legislator did not indicate the sources of funding. Not for the first time in Poland arbitrarily introduced regulations provide additional financial and organizational burden for those entities which these changes relate. Funding research projects nationwide in countries such as Austria, France and Germany is the responsibility of the Ministry for Science and Higher Education. Even if they do not fund researches in total, they cover a large part of them. In the UK and Finland funds for research projects come from the budgets of universities (incomparably higher in comparison to the Polish reality). In Italy, the finance professional to monitor the fate of the graduates come from three sources: 40% of the expenses borne by colleges and universities participating in the centrally managed research projects and 25% of the cost is borne by the Ministry of Education, Higher Education and Scientific Research. Other funds are collected from employers and private institutions¹¹⁷.

However, looking at the positive aspects of current legislative changes it is worth to note that even though the lack of imposed research methodology creates many problems, it is also a challenge for Universities to organize the sociological and marketing valuable data collections. Apart from improving the quality of education and adapting the educational offer to the requirements of labor market institutions, during the researches it is possible to obtain information that otherwise would not be possible to get. The constant contact with the

¹¹⁷ See: *Monitorowanie losów zawodowych absolwentów szkół...*, page 6.

university graduates seems to be strategically valuable perspective, not only in the aspect of the monitoring the graduates carrier paths. In the Polish reality of higher education such activities are carried out inadequately. Communications made in the course of research (especially by a computer CAWI) provides extensive opportunities to build relationships, share the experience and initiate the various forms of cooperation of all stakeholders: the universities, the graduates and the business world.

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Reverse logistics as a solution to growing waste

by

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ABSTRACT

The paper deals with the reverse logistics problems in the context of retrieval of worn out industrial products and materials. Increasing importance of the reverse logistics for economical and ecological problems resulting from the necessity of saving material and energy resources has been emphasized. The particular features of the reverse logistics have been characterized. Rationale for introducing reverse logistics into logistics networks of industrial processes have been described as well as difficulties in planning of the product recovery operations. Guidelines for designing of products which allow for retrieval and facilitate reverse material flows have been formulated. Factors that should be taken into account in design in order to improve management of the used products have been discussed.

Keywords: Mass production, reverse logistics, waste, reuse, recycling, design

1. INTRODUCTION

In recent decades, the world population growth, combined with the technological changes associated with our living standards, has created a greater consumptions of our resources, resulting in potential shortages, which, in turn, has stimulated shifts toward establishing other means for accomplishing objectives. Concurrently, the amount of waste has increased significantly. From the logistics point of view, the solid waste is of particular interest.

Solid waste is any garbage or refuse (e.g., paper, wood, clot, metals, plastics, etc.) that cannot be decomposed and will result in a health hazard. Roadside dumps, piles of industrial debris, junk car yards, and so on, are good examples of solid waste. Improper solid waste disposal may be a significant problem in view of the fact that flies, rats, and other disease carrying products are attracted to areas where there are solid wastes. In addition, there may be a significant impact on air pollution if windy conditions prevail or on water pollution if the solid waste is located near a lake, river, or stream.

Adverse effects of the production rapid increase driven by greed for profit become more and more damaging. Natural resources of raw materials and energy are closed to be exhausted

and ability of biosphere to absorbing the industrial production side effects has already been exceeded. Expansion of industry to developing countries nothing changes in the longer prospects.

The limited resources of our planet are not only reason of the situation; the market absorption is also limited. Increasing production capability when clashes with decreasing market absorption gives rise to the trade perturbation and creates economic conflicts. In the countries and the societies which can not use benefits of modern technology rapidly increases feeling of the discrimination.

Modern technology has been based on the paradigm that the human needs for the material products should be satisfied with excess. This, however, led to the conflict with the natural, social, and human resources. The famous report of the Roman Club turned our attention to the exhaustion of natural recourses, whereas the social and human threats have been indentified only not long ago. It is depicted in Table 1.

Table 1. Threats caused by excessive production

Sources		Limitations	Threats
Natural		Materials Energy Environmental sensitivity	Lack of materials resources Lack of energy sources Detimental changes of environment
Human	Social	Capability of market absorption Transport capacity	Economic stresses Jams of transport service
	Individual	Consent to turning human functions to cybernetic systems	Over-useful products Man will have to obey artificial intelligent systems

If we do not change the basis of the manufacturing industry expansion then we will have to fight against the consequences instead of the causes. It will end in failure. If we, however intend to remove causes, we must base production development on the entirely opposite principles, i.e. a different paradigm [10]. The commonly accepted *Mass Production Paradigm* (MPP) which calls for ‘better, more, cheaper, at top speed’ should be abandoned and replaced by *Economical Production Paradigm* (EPP) [12].

The new paradigm requires the separation of the producer income from the increased use of materials and energy. Further, it requires reduction of amount of manufactured goods till rational size. It also calls for restriction of operating devices quantity to the amount not disturbing natural, social and personal equilibrium. Thus, production and usage should consume minimum amount of materials and energy and do not produce any waste. In order to provide producers with satisfactory profit at much reduced material needs the new types of products are to be designed [2,9].

In order to accomplish above postulates it is necessary:

- (i) to develop and apply knowledge of current and future social needs;
- (ii) To satisfy the needs more by means of the qualitative than by the quantitative measures of possession;
- (iii) to make producing industry responsible for the whole life cycle of the product;
- (iv) to make change of the ways of users needs satisfaction.

Figure 1 shows diagrams two product life cycles: the open and the closed one. The open cycle can not been accepted because it causes pollution of the environment by used product waste.

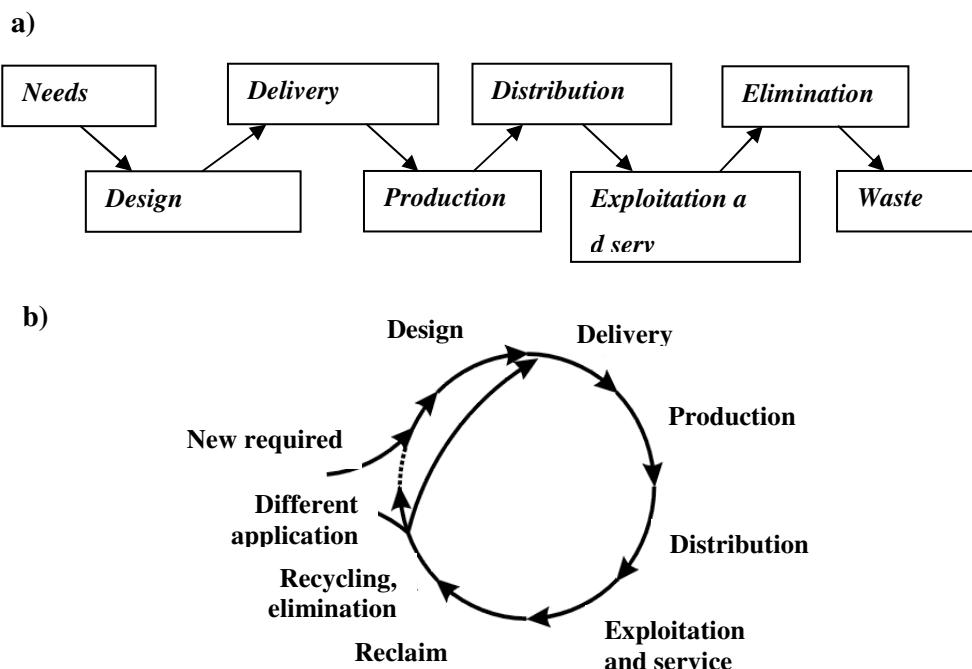


Fig. 1. Models of the product life cycle: a) open b) closed

Ideal would be the closed cycle that does not generate any waste. The law of mass conservation states that – in theory – it is possible. In reality, however, full retrieval of materials, even if feasible, would not be economical.

Most of modern products represents intermediate phase. Importance of recycling and material salvage is continually increasing. Other opportunities for the the material cycle closure are in reclaiming partially used parts, utilization of elements which are take out of service for other products, and the like. In thermodynamic processes, according to second law of thermodynamics, realization of the ideally closed cycle is not possible. Therefore, in order to avoid the energy crisis, there is necessity of efficient exploitation of the solar energy, indirectly or in the form of natural energy sources.

With the increasing concern for the environment, and the possibility of environmental degradation, more attention must be given to the phaseout and recycling stage. It must be addressed along with the design and development of the prime mission-related components of the system, the design for producibility, and the design for supportability. In other words, an appropriate level of emphasis should be placed initially on the design for disposability or recycling/reuse, and later on developing the appropriate logistics infrastructure for the subsequent processing of items to be discarded.

Thus, any physical system should be designed for recycling, reuse and disposability. From a supportability perspective the accomplishment of such an objective should result in minimum requirement for follow-on logistics resources (i.e. spares/repair parts, test equipment, software, personnel, facilities, data, etc.). The plan covers the retirement and phaseout of equipment, the disassembly and reclamation of material items as appropriate, and the ultimate disposal of residual material. In some cases the phaseout process could be rather extensive, including the requirements for logistics support. The logistics plan should identify the requirements for transportation and handling, the support equipment necessary for material processing personnel, facilities and the data necessary for the processing of items out of the inventory. The use of commercial and standard elements is preferred.

2. SPECIFIC FEATURES OF REVERSE LOGISTICS

General objective of the reverse logistics chain is retrieval material objects or disposed them without any violation of environmental requirements. Usually it involves packing and delivering an object to the point of collection for regeneration or recycling. Collecting used products from market is more like procurement than purchasing. Nature of the reverse flow is very unstable because quantity of the returned products/elements as well as their conditions are difficult to predict.

There are three prime factors to take into account in the logistics reverse design:

- (i) logistics network structure,
- (ii) planning of material flow, and
- (iii) sorting and determining the routes of returned elements.

Most of the logistics systems are not adjusted to operate reverse flow of products. These can not be transported, stored or manipulated in the same way as new products. Cost of reverse distribution may be much greater than this of the direct one. However, efficiency of product retrieving can be very beneficial [13].

Importance of reverse logistics for modern industry and ecology is enormous it takes, however, little place in the literature [1,3]. System retirement, phaseout, and the recycling or disposal of material no longer required in the operational inventory are not satisfactorily covered. It is common to address the design and development as well as the operation of a system but phaseout and subsequent disposition of the system (and its components) are not adequately considered until it is time for having to do something about it.

2.1. Industrial processes related to reverse logistics

After equipment has been in operational use for a period of time, various individual components begin to wear out. Some components (i.e., mechanical linkages, gears) wear out sooner than others. When this occurs the need for maintenance increases.

- Repair, modernization, renovation

Repairable spares that are, for one reason or another, condemned and nonrepairable parts, when removed from the system and replaced, are generally shipped to the depot or the supplier facility for disposition. These items are inspected, disassembled where possible, and can be salvaged, reclaimed or recycled. The residue will be disposed of in an expedient and economical manner conforming to environmental and ecological requirements.

Although reasonable predicting of failures for many products is possible yet right decision of returning a product is difficult because it often depends on individual point of view. Forecasting of frequency and types of failures is usually based on historical data, which not necessarily will turn out in the future.

If a product is under repair, the user often expects to get its substitution. Therefore, the producer should possess sufficient repairing capability and the reserve of spare parts in order to provide quick return of the product at a low cost.

Modernization means improvement of the product or of its part in order to decrease frequency of defects or to enhance functionality. Modernization alike repair can be performed at the user or at producer.

Renovation of the product which has been withdrawn from the operation consists in recovering it to the condition in which it can again perform its original functions. Powerful potential for renovation is in electronic industry which sells millions pieces of products.

Not many manufacturers design products for renovated elements or units [4]. Products should be customized to modernization and renovation in design stage. To do this, however, designers have to know real cost of the product life cycle.

- Retrieval of elements

In some cases it may be not worthwhile to renovate complete device whereas some parts still keep their value. Cars can be a good example: usable elements and those suitable to renovation are disassembled from old cars and then used for substitution of defected parts in cars under operation.

- Disposability and recycling:

It pertains to the degree to which an item can be recycled for some other use or disposed of without causing any degradation to the environment; i.e. the generation of solid waste, toxic substances (air pollution, noise pollution, radiation, and so on). Should this area not be addressed in the design, the requirements for logistics may turn out to be rather expensive and costly in order to comply with the environmental requirements currently being imposed. For example, a large incineration facility may be required for material decomposition. This, in turn, may include large amounts of capital investment which requires maintenance and could be very costly to support.

In many products there are units and parts not worth to be repaired, which are not suitable for any further use. The worn out product as a whole may have no value but a part of its material can have a worth. Examples are copper wires, aluminium tins or steel structures. Polymers are less convenient for retrieval because of high cost of processing, and in view of the fact that they lose properties in the recycling process – mainly for a tendency to tearing of the polymer chains. Recycling of materials is particularly important for products which have short life cycle and are manufactured in bulk.

The European Union encourages the member states to reduce polymer production yet enormous quantity polymer products still calls for more effective recycling processes.

2.2. Factors that make recycling difficult.

Product retrieval process has particular character that should be taken into consideration in design of reverse logistics. A number of reasons has been indicated in literature of the subject [5, 14, 15]. Familiarity with these difficulties during design stage make possible reducing their impact and owing to that facilitate recycling and repair processes.

- Irregularity in time of returned items quantity

Occurrence of used products depends on amount of earlier sale, on their expected life, and on rate of functionality loss during operation. This phenomenon makes reverse flow coordination of materials and their processing difficult.

Attention should be paid to the relative ageing of the products. If a product becomes out of date then much its quantity is withdrawn in a short time. Quick modernization of obsolete products may be unrealistic, so only real solution can be reuse or at least recycling. In case the product life time is short then prediction of its reparability, life and so on is of minor significance.

Again, anticipated time of the product obsolescence should be considered in design process. The quantity of retiring products versus time should be estimated during design in order to adjust appropriately technology of spare parts production. Valuable parts should be easily adapted for recovery. Use of lead, mercury, and other heavy metals should be avoided, unless the infrastructure for their collection is well developed. Advances of sensorics and intelligent devices increase reliability of predicting of wear and tear level and defects contributing to more precise evaluation of time and quantity of returned items.

- Balancing of customer demands with returned products

For companies dealing with retrieval of used products supplying of these is important. Quality and quantity of used products which can be obtained at a certain interval are generally not known because many companies do not check them as well as time of their returning. Quality control of used parts before returning them is necessary to evaluate material- and laborconsuming required to recover their functionality.

In order to avoid excessive storage of used products and to balance returns with customer demands companies should have an appropriate strategy. Strategies push and pull in relation

to production and stocks for new and renovated elements are discussed in [6] and [7]. It was proved that choice of the rational strategy depends on the cost relationships between the stocks of new and renovated parts. It was suggested that during the product life cycle managers should update decision rules of effective management and control of the stocks. Producers should balance reserves of returned products and reclaimed parts with current demands of the customers, unless the stockpiles can increase uncontroled, which give rise to discarding of the used products [7].

In order to balance the returns with customer demands producers have to combine forecasting of traditional demand with orders of used products. These products can be acquired from various sources: users, agents and servicemen.

Proper product design and understanding its lifecycle can contribute to mitigate problems of adjusting volume of returns to orders.

- Disassembly

In order to determine the need for new parts department of supply should get information from disassembly. Products that are returned have to be disassembled before being restored.

Disassembly is the first operation in preparing elements for regeneration. The process is often difficult because still rarely the products are designed for dismantling. Disassembling of such products can take a long time, parts may be suffered damage, which results in useless waste. There is difficult to predict how much of materials will be recovered. This makes difficult planning and controlling manufacturing operations.

Companies are interested in minimization of cost while process of disassembling requires some expenditures. Usual approach to retrieval problems consists in comparing of disassembly cost with profit due to recovered material. A simpler approach relays on the expert evaluation if a given part is worth to reuse [4]. This gives a possibility to reduce expenses for disassembling of the product that has minor value for the reuse.

All products should be designed with a view of disassembling and further use [12]. To make it possible designers should know effectiveness of the disassembling. Instructions with respect to this can be find in [8].

- Uncertainty as to quantity and quality of recovered parts

Amount of parts which are suitable to reuse directly or after a repair is difficult to be anticipated because before the product has been disassembled, cleaned, and inspected, it is

impossible to evaluate its parts usability. Without this evaluation the planning and control of any reserve and purchasing become problematic.

Producers should anticipate amount of parts that will be renovated to be able to plan how many new ones have to be produced in order to replace the parts that can not be regenerated.

Currently producers do not regularly report data about renovation. Products may include parts of known reclaim characteristics but might as well have a number of parts without any such data. According to producers that deal with renovation of parts, dominant problems in fulfilling customer orders consist in lack of available parts, long order realization times, and high cost of original parts. Development of electronic data bases is still contributing to improving of renovation forecasting and decreasing of material requirements uncertainty. In possession of the relevant data the designer should specify upper limit of the renovation cycles after which the part material will be recycled.

Rationalization of orders is indispensable for the material flow control, inventory management, and efficient use of personnel and infrastructure. It is of particular importance for producers attempting to offer a broad range of assortment of renovated products.

- Requirements for dealing with regenerated parts

If customer wants to get back the same part which was under repair, the producer is responsible for coordination of disassembling, repair and regeneration of the part being reassembled. In order to ensure returning the same items to the customer the parts have to be numbered, labelled and traced. This results in additional load of informatic system

If the repaired assembly consists of many various elements, the planning of the stock, production, process control and management of materials is not easy task. Accomplishment of the schedule of the unit reassembling may also be delayed because of some postponing in delivery of one part only.

The development of the industry renovating parts and units of various products is additionally slowed down by a lack of cooperation between producers and firms that use regenerated products. Besides, designers rarely design products for using the renovated parts [4]. Despite of these difficulties, continuously growing importance of material recovery gives rise to development of the reverse logistics chains, although it still falls behind the needs.

- Uncertainty of the routing and working time of operations

Uncertainty of the work routing is a consequence of unpredictability of renovated parts condition. Work and time that are necessary to restore full capability of various elements can differ one from another. Some treatments are always carrying out, for example the cleaning, other, however, depend on the part age and condition. As a result, reserve planning, production control, and materials management are significantly more difficult than for ordinary production.

In order to make the plan of load for the working stations producers have to estimate condition of the parts designated to regeneration. Bottlenecks may appear in different places because elements of the same type can be – after dismantling - in various states. In the consequence of this the routes of the elements may be different.

Files of parts working routes contain lists of the all feasible operations but not all parts need the same ones. Only for some used parts the renovating operations will be identical with those for the new parts; others will require different machining. This phenomenon is considered to be the most influential decision factor for operation scheduling and choice of production lot [13].

For the purpose of planning there is a need to evaluate necessity of a given operation. The product inspection before its dismantling can help to get relevant information.

The uncertainty can be also reduced by appropriate design. For example, during designing it is possible to suggest, on the basis of economical analysis, if a part, when worn out, should be regenerated or recycled. Also, design the product for a defined number of renovation cycles makes easier to predict of operation types and working times.

- Conditions of transportation

Real reverse distribution processes have to respect the local regulations. Dangerous and toxic materials may not be permitted for transportation through channels of the reverse logistics. For example, in some regulations dispatching of used electronic products is considered hazardous (because of lead contents), while the new electronic products can be sent without restriction. Transport of radioactive wastes is allowed under severe restrictions only. Generally known are regulations limiting export of wastes (for avoid of illegal removal) and directives for obtaining of special permission and particular caution for transportation of used products.

Weight and size of the product have an impact not only upon the choice of transport means and its cost but also on facility of the dispatch preparation and on easiness of handling the product during the recovery process.

3. GUIDELINES FOR REVERSE LOGISTICS DESIGN

In the design of systems, all phases of the life cycle must be addressed, including the phase of retirement and material disposal. When the system and its components are removed from the inventory, either because of obsolescence they are not suitable for the purposes of maintenance or when the items are removed in order to accomplish repair, those items must be of such a property that they can be disposed of without causing any negative impacts on the environment. More specifically, a prime objective is to design components that they can be reused in other similar applications. If there are no opportunities for reuse, then the component should be designed that it could be decomposed, with the residual elements being recycled and converted into materials that can be remanufactured for other purposes. Further, the recycling process itself should not create any detrimental effects on the environment.

Assuming that the requirements for item removals/replacements have been identified, one should evaluate each of these items following the process illustrated in Figure 2. Can the item be reused as an entity for any other application? If not, has it been designed in such a way that it can be easily decomposed, and can any of its parts be used? If an item cannot be reused as is, can it be recycled and modified for use? Further, if recycling and reuse are not feasible, can the material in question be disposed of without causing a negative impact on the environment? Finally, is the process economically feasible? Cost of reverse logistics is a part of Life – Cycle Cost of the logistics system.. It includes the cost due to the obsolescence or wearout and subsequent recycling, disposal and reclamation.

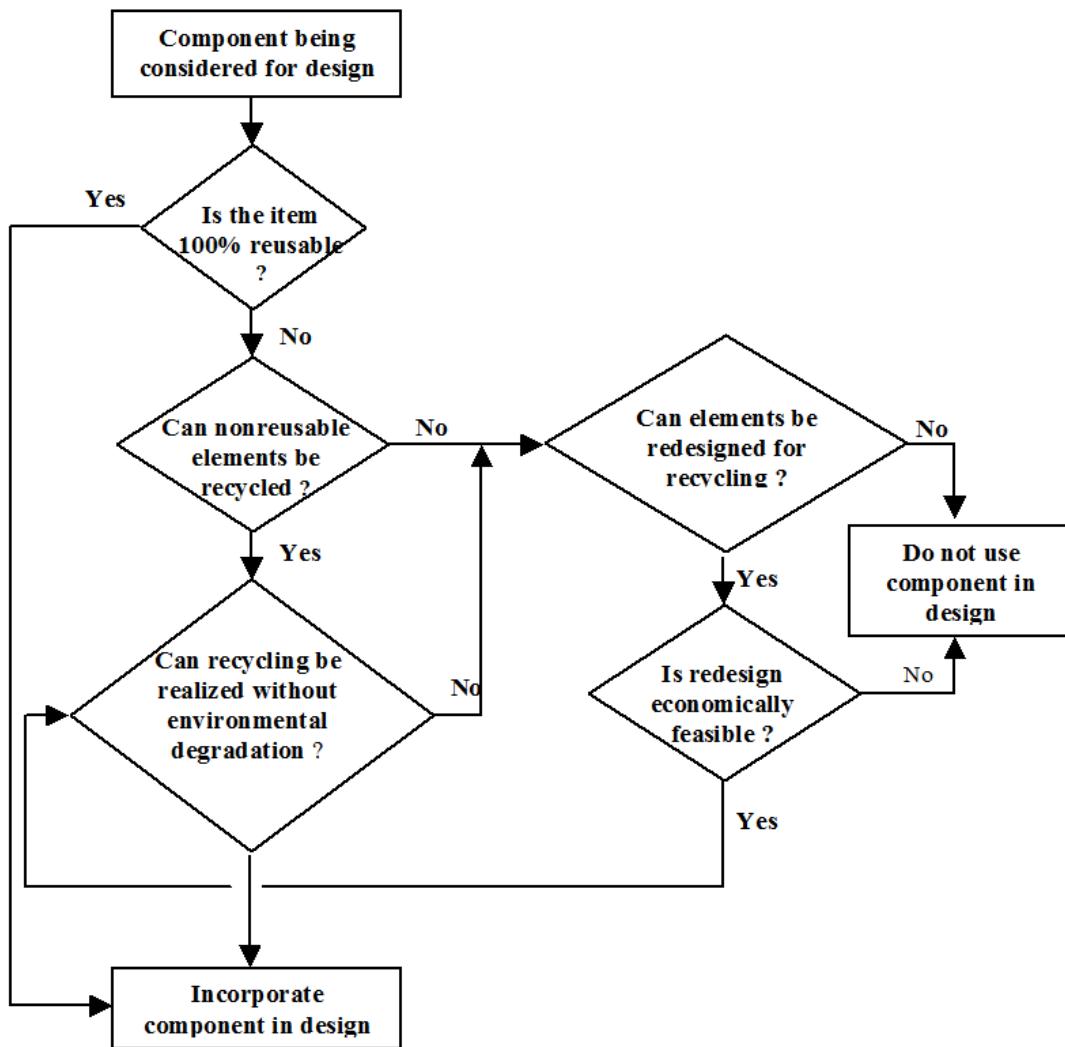


Fig.2. Evaluation of a component in respect of reverse process (according to [1])

Thus, in the development of systems and in the selection of components, the designer needs to be sure that the materials selected can be reused if possible, will not cause any toxicity problems, and can be decomposed without adding to the solid-waste inventory that currently exists in many areas. Care must also be taken to ensure that the product characteristics do not generate the need for a nonreusable container or packing materials for transportation that will cause problems.

Figure 3 conveys a decision-making logic approach that will be helpful in the design and development of systems.

The checklist for disposability goes as follows [1]:

1. Has the equipment been designed for disposability (e.g., selection of materials, packaging)?
2. Have procedures been prepared to cover system/equipment/component disposal?
3. Can the components or materials used in system/equipment design be recycled for use in other products?
4. If component/material recycling is not feasible, can decomposition be accomplished?
5. Can recycling or decomposition be accomplished using existing logistic support resources?
6. Are recycling and decomposition methods and results consistent with environmental, ecological, safety, political, and social requirements?
7. Is the method(s) used for recycling or decomposition economically feasible?

To sum up, the design for system retirement, phaseout, and material recycling and disposal should be responsive to the following questions:

1. What items of equipment, software, materials, data, elements of support, and so on, are likely to be phased out of the inventory, and when is this expected to occur?
2. What should be done to these items (i.e. disposition)?
3. Where should this be accomplished and by whom?
4. To what extent can items being removed from the inventory be decomposed and recycled for reuse?
5. Are the methods used for decomposition, recycling, and material disposal consistent with ecological and environmental requirements?
6. What logistics support requirements are necessary to accomplish the requirement, phaseout, material recycling, and disposal functions?
7. What metrics should be applied to this area activity (i.e. turnaround times, recycle rates, process times, economic, and effectiveness factors, etc.)?

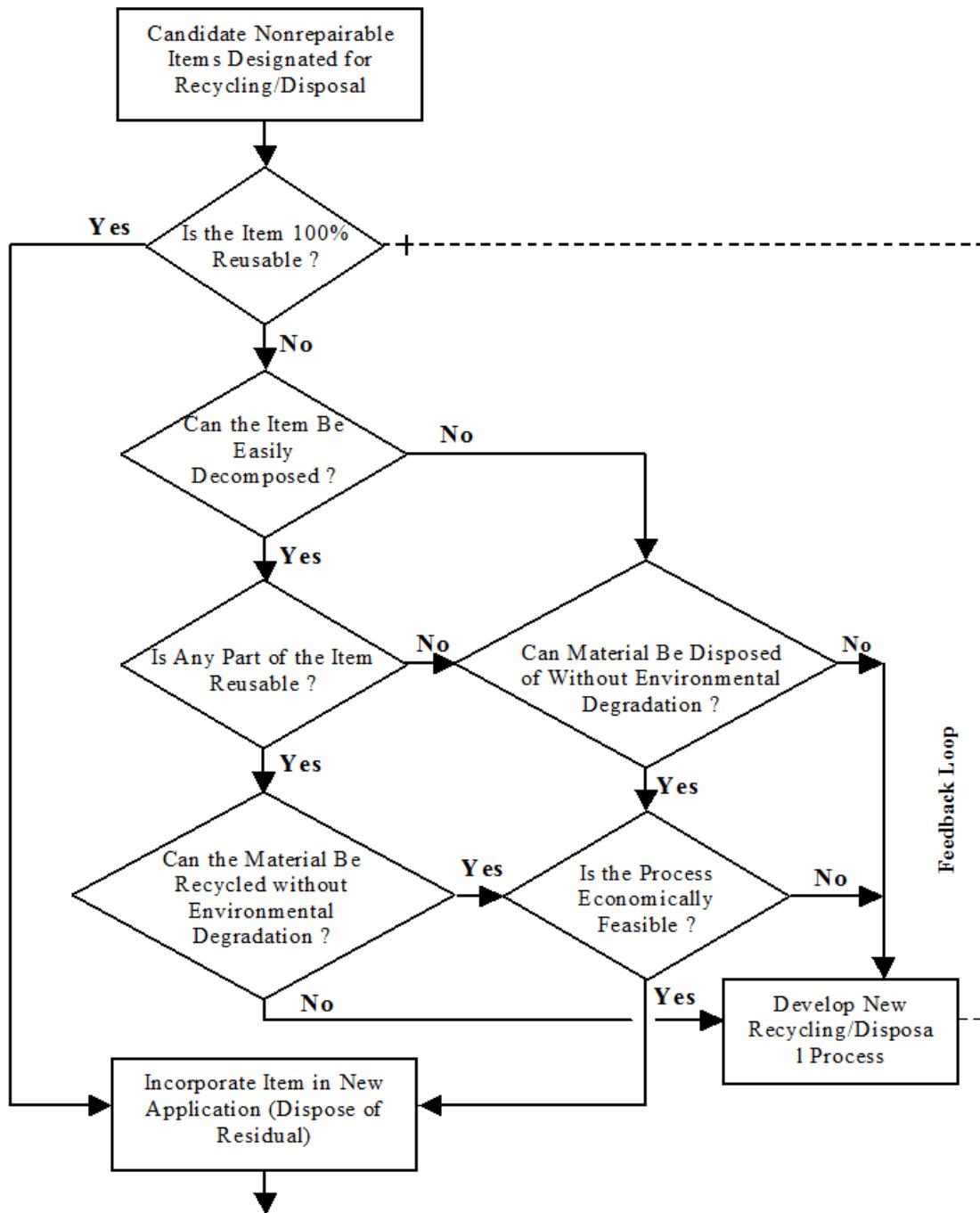


Fig. 3. Evaluation of an element for recycling or disposal (according to [1])

3.1 General Principles for the Design of Products for the Reverse Processes

Consideration of recovery matters leads to the following postulates for designing new products:

1. *Adaptation of products to remote repairs or improvements.* With the products which are tailored to remote operations, can the producer offer improvement, guaranty and servicing at low cost. Owing to this a longer life time of the product can be achieved, what is

appreciated by the user. Development application software and sensoric technology increases capability of remote actions.

2. *Predicting of reliability.* Product reliability should be determined in product design and during prototype investigation. The designers and producers seldom analyse and estimate the frequency of defects. It makes difficulty in prediction of the product replacement rate as well as estimation of time when the product will become outdated, which is related to the marketing and sale plans. Taking in design advantage of information of defects frequency allows better product recovery planning. It is also of advantage for agents taking part in the flow of recovered products.

3. *To design the product in such a way that it would be easier to predict more precisely its likely lifetime.* By means of little design changes it is possible – especially in electronic devices – to record time and operating conditions. It enables one to record service life of the product or its part.

4. *Modular design of expensive parts that should be retrieved.* Modularity contributes to the product value. Modular design should ensure easy replacement of the product elements that have short lifetime. It happens that the complex product loses usability but some of its parts still preserve utility. In such a case modular design offers possibility of retrieval valuable parts or materials.

5. *Avoiding of use of bothersome materials.* Detrimental substances in the product can cause particular demands of transport, manipulation and elimination. It can be difficult to dispose of some products for the sake of contents of undesirable materials. Such situation can rise the product life cycle cost. Thus, it is necessary, if possible, to avoid application of this kind of materials.

6. *Design of products for only one owner.* The idea of one owner means as a rule that the producer itself is the product owner. The product user has the right of using, but he/she does not own the product. The producer as the owner can easily carry out all operations aimed at right product exploitation and long cycle of life, and can plan post-life processes. The product which has only one owner during its life cycle can be easily adapted for recovery processes. These features can also be embodied to the product in design.

It is required that creation of product features related to reverse logistics and recovery processes become integral part of the design process. Usually, these features disclose themselves only after the product use. It should be emphasized that design of products that

meet the reverse logistics demands is preconditioned by developing computer systems with automatic calculation algorithms, simulation programs and engineering data bases.

4. CONCLUSIONS

Pursuit of profit by means of increase material- and energy consuming production causes still growing adverse effects. This way of industrial development comes into conflict with the natural, social, and human resources. Thus, there is a need for change the current paradigm for another one that will not generate the detrimental side effects.

This new paradigm breaks the linkage of economic prosperity with the quantitative measures whereas focuses on the qualitative attributes. It should ensure the economic development in spite of limited utilization of natural resources owing to innovative economic mechanisms that will promote manufacturing of products of the new kind. In order to diminish dependency of the economic growth on increasing material and energy demands the three compatible means are proposed:

- saddle the manufacturing industry with the responsibility for the whole product life cycle, in particular for attempting to close the material cycle,
- attempting to change the traditional approach to satisfying the users' needs and involve the users to cooperation in processes of the reverse logistics,
- implementation understanding of the future social needs in order to fulfil the needs not by means of the product quantity but rather by the quality of usage.

In the industry that is subordinated to the mass production paradigm much attention is focused on the direct flow of the products, i.e. on the flow from the producer to the user. At the present time there is a need for intensive expand the reverse flow chains.

There is a number of factors that hinder the retrieval and recycling of products:

- Irregularity of quantity and time of returned products,
- Difficulty in balancing demand of new products with returning ones,
- Problems with dismantling of condemned products,
- Uncertainty as to materials quality of the returned products,
- Specific demands for the reverse logistic chains,
- Difficulty with satisfying of requirements for regenerated parts,

- Renovation processes are difficult to prediction,
- Stochastic character of transport routes of parts selected for repair and recycling.

Influence of these factors can be lessen or even eliminated by proper product design. It will result in better coordination of processes of repair, modernization, regeneration, and recycling.

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Strategy of development of innovative clusters in Silesia regional economy

by

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Abstract:

In the study Author investigate the principal factors for regional innovative clusters on the base of large scales technology companies from Silesian region. Author determine that the priority task of strategic planning of regional innovative system is search and balance between objective, design, process and environmental characteristic of clusters as a whole and its organization participants. Also, in the article are presented the results of science and technological policy of Polish regional. It is know, that Silesian area scientist carry out fundamental and applied researches on major directions of modern science, scientific schools of a world level were create. It has researched the strategy of development of innovative activity Silesian region.

Keywords

Science, Technology, Policy, Innovation, Infrastructure, Intellectual Property, Cluster,

Main text.

At the present time the Silesian Region is a large centre of science in Poland and Central West Europe having advanced research base and high quality scientific staff. Wroclaw scientists carry out fundamental and applied researches on major directions of modern science, scientific schools of a world level were created¹¹⁸. Specially: University of Technology, Business of Incubators, etc. The science and technology infrastructure of Poland includes more than 450 institutions of academic, university and industry researches. About 30 000 persons are engaged in the research sphere¹¹⁹.

¹¹⁸ See: Dolnośląska Platforma Promocji Przedsiębiorczości Akademickiej, *Innowacje w sektorze TECHNO*, Wyd. Wydawnictwo Europa, Wrocław 2011,

¹¹⁹ See: European Cluster Observatory: www.clusterobservatory.eu,

The priorities of development science and technology of the Silesian Region are aimed in view of priorities of economic and social development of Poland and provide creation and development of advanced technologies ensuring manufacture of import – substituting, competitive production in Poland, pursuing fundamental researches on critical scientific directions in the context of advanced trends of development of the European science¹²⁰.

A principle has been developed¹²¹, known from the world experience, of management of scientific and technical and innovative activity. The system, accepted in Silesian Region, of state support to fundamental and applied researches as state orders, as well as a system of grants on pursuing innovative development works assumes orientation on final scientific and technological results, stimulation of competition if intellectual production, as well as mining the responsibility of the participants of scientific and technical and innovative activity for results of work and targeted use of the public funds.

The support is rendered, including financial and material resources, of not certain establishments of science and organizational structures, but concrete programs and projects, passed state expert evaluation. Such state support is in the form of stimulation of science, technology and innovations by economic methods, active use of market mechanisms of regulation relation in scientific and technical sphere, creation of condition for development competitiveness and entrepreneurship in scientific and innovative sphere¹²². In Silesian region scientific and technical alliances for financing applied scientific and technological development have been created within the framework of priority directions of economic and social development of the EU countries allowing to carry out these development works combining the use of budget resources, as well as share means of branches and regions, enterprises and organizations interest in result of development works for solution of problems set forth by them.

The Silesian region policy,

In Silesian region mechanism of realization of scientific and technical and innovative activity based on program – targeted principle and ensuring a high degree of sustainability on the

¹²⁰ See: Sölvell Ö., Lindqvist G., Ketels C., *The Cluster Initiative Greenbook*, August 2003, Stockholm 2003.

¹²¹ M. E. Porter, *The Cluster and Competition: New Agenda for Companies, Government and Institutions*, MA: Harvard Business Review Books, 1998,

¹²² See: European Commission, Innbarometer on cluster's role in facilitating innovation in Europe. Analytical Report., Eurobarometer 2006, and European Commission, Innovation Clusters in Europe, A statistical analysis and overview of current policy support, DG Enterprise and Industry Report, 2007, also OECD, Globalizations and Regional Economies, OECD Reviews of Regional Innovation, 2007,

chain “fundamental investigation applied researches – innovation projects” has been created and realized¹²³. The realization of powerful structural, investment and innovative policy in the simultaneous use of methods and stimulus of market economy is one of major priorities of state scientific and technical policy, realized in the Silesian region.

Silesian region for the period of its independence has concluded about 300 interoperations agreements on cooperation in the fields of science and technology. Development of international scientific and technical links is stipulated on one hand, by necessity of support of scientific research carried out in the EU country, and technological development works, creation of favourable conditions for bringing of Silesian region to the world scientific and technical community for coincidence with global integration process; on the other hand – securing national interest, first of intellectual property, rights and interests of the scientists abroad¹²⁴.

The active and full access of Silesian region to the EU exchange of high technologies, is integration in EU countries economic system is an effective tool of achievement of the major national purposes¹²⁵. At the beginning 21st century globalization of scientific, technical and innovative activity becomes extremely important and priority one in the foreign economic policy of our state.

The strategy of development of Silesian region on Polish area is focused on following priorities¹²⁶:

- liberalization in economic life, state and public construction in Poland,
- future spiritual updating of the society,
- sustainable, permanent growth of welfare of people,
- strengthening social protection of population,
- structural transformations in economy,
- provision of stability, international and civil consent in the society, territorial integrity of the EU zone,

¹²³ See: the material of the II meeting in Wrocław 2011 of *Innovative in sector TECHNO*, Dolnośląska Platforma promocji Przedsiębiorczości Akademickiej, Wyd. Wydawnictwo Europa, Wrocław 2011,

¹²⁴ See: material Swen Stręk: *Wrocławskie Centrum Badań EIT + Sp. z o.o.*, [In:] Dolnośląska Platforma promocji Przedsiębiorczości Akademickiej, Wyd. Wydawnictwo Europa, Wrocław 2011, pp. 4,

¹²⁵ See: The European Cluster Memorandum, Promoting European Innovation through Clusters: An Agenda for Policy Action, January 2008,

¹²⁶ See: Towards world-class clusters in the European Union: Implementing the broad-based innovation strategy, COM(2008) 652, Brussels 2008,

The Silesian region is in favourable position in Polish market space as its basic competitive advantage is the high potential of natural resources. Additional investment incomes from realization of available resource it is possible to direct on development innovative clusters, such as a science, introduction of scientific achievements and preparation of qualified personnel¹²⁷. On the one hand raw orientation of the Silesian region economy allows to provide its competitiveness in EU space in the conditions of deficit of power resources, and on the other hand, exhausting the given kind of resources and extensive pumping out of stocks of an open source (innovative company of science and technical) and/or open innovation (internet assets) company of EU can provide economic well-being of nations only in short term prospect. As to the remote prospects here on the foreground there should be a capability of economy of Silesian region to became one of prime vendors of innovative decisions.

To modern economic systems of Silesian region there is a lack of innovative activity of its subjects, a fragmentariness and unsystematic character of management at big clusters. For realization of innovative activity it is necessary the cluster approach in a management. The most successful clusters are formed there where “break” in the field of techniques and the production technology with the subsequent exit on new “market niches” is performed or expected. Thereupon, uniform strategy of the country should be based on use of cluster approach for forming and adjustment if the national innovative programs on the basis of poles of innovative growth in profile for regional economy cluster including in technology complex, and also to implement system associability resources and mechanisms of stimulation of innovations of a pas macro – micro level that initiates the given research, determines its urgency.

The main research problems to be discussed consists in the theoretical justification and development of methodical approaches to forming of strategic development economic clusters for large technology complex in the conditions of forming of national innovative system¹²⁸. Realization of the given purpose assumes the decision about the following issues:

¹²⁷ See: Hołub-Iwan J., Małachowska M., *Rozwój klastrów w Polsce*, Szczecin 2008, and INNO-Policy Trendchart: <http://www.proinno-europe.eu>, also in European Innovation Scoreboard. <http://www.proinno-europe.eu>.

¹²⁸ See: Maastricht Economic and Social Research and training centre on Innovation and Technology, European Regional Innovation Scoreboard 2006, and Trendchart Innovation Policy in Europe 2006: <http://www.proinno-europe.eu>, also: *Towards world-class clusters in the European Union*, op. cit. COM(2008) 652, Brussels 2008.

Cluster policy in Europe. Europe Innova Cluster Mapping Project, Oxford Research AS, 2008,

1. research of theoretical bases of essence and the maintenance of forming the Silesian cluster economy taking into account experience of the foreign countries EU,
2. to refine concept “innovative economic cluster” in a context of objective economic processes and innovative technological breaks in development of an technology complex,
3. to justify and to systematize stages of forming innovative economic cluster in technology complex as catalyst of modern Polish economy of innovative type,
4. research processes of integration of the enterprises of technology industry with the research organization in innovative activity,
5. to precise problems of forming innovative economic cluster on the basis of the enterprises of technology industry,
6. to justify strategy of innovative economic development technology clusters,
7. to justify necessity of forming innovative cluster culture as result of self – organizing of social interrelations with essential support from the state,
8. let us make here some conclusions for the above research. The modern theory of economic one of prime vendors of innovative decisions.

The points of view existing in the economic literature for cluster can be divided into concept conditionally on two groups¹²⁹: authors who pay much attention geographical component of cluster and in the second, which considers geographical component as insignificant. That is the concept of cluster is considered as regionally limited forms of economic activity in the related sectors, is usual adhered to those or other scientific institutions and closely cooperating with each other for strengthening of collective competitiveness. Or the concept of cluster is determined as vertical production chains, networks which are formed round head firms and are connected through mutual relations the buyer – supplier, the supplier – buyer, general channels of purchases or distributions.

Conclusion,

One of the most actual directions of the state support innovative clusters across the nation is development of the optimum legislation in the given industry, stimulating healthy competition development between the industry enterprises. The state support in regional scale (Silesian or

¹²⁹ See: Wennberg, K. & Lindqvist, G., *How do entrepreneurs in clusters contribute to economic growth?*, SSE/EFI Working Paper Series in Business Administration, No 2008:3, Stockholm School of Economics, Stockholm 2008,

the other in Poland), in author opinion, should occur by creation corresponding institutes playing a role of intermediaries between the generation of knowledge and large corporations, and forming necessary factors.

Forming of environmental strategy of cluster – process new enough for Silesian region economic theory and practice. As a method of an institutionalizing of innovative culture, i.e. transformation of its development into the organised, ordered process with certain structure of relation, behaviour rules, responsibility of participants, author offer the creation and support of development of corporate universities on the basis of large technology companies as canters of formation, occupational retraining and advanced training of employees of the companies – participants of regional production network.

To take above to consideration author forming for the future success in clusters cooperation the head “Tactical Plan to intellectual property (IP) “ for **Academy to Business (A2B)**”:

- realistic assessment of the projects - thorough describing the idea, the drafting business of plans, detailed analysing products in terms of the current and future state of the market,
- choice of the baulk with doing it alone one's own, but establishing the business of the partner, are important: common goal which are a good of the company, a mutual confidence and a good agreement,
- exploiting abilities of academic colleges, choice of helpful lectures from at university, undergoing practice, trainings, using the help of academic business incubators and technology transfer centres,
- determining the target group of customers, proper marketing and talking to the customer with language of his benefit,
- the flexibility and the verification of the offer through reality - taking into account needs of customers and the market demand,
- caring for the financial liquidity - using funding partially of different kind, of EU programs, but about the uncomplicated formal side, drawing up a plan to possible emergencies,
- investing, the good situation in the company should induce for investing money in the sustainable development of the business,
- taking the individual responsibility behind the situation of the business - the success only depends and exclusively from founders,
- risking - one should take new challenges but at the scrupulous risk assessment,

- awareness of heavy responsibility, hard work, being consistent and persistent.

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IT Governance – How to increase the impact of Information Technology on firm performance ?

by

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ABSTRACT

Information Technology (IT) plays in modern enterprises a very important role, passing almost every aspect of their business. The long-term survival of firms is closely related to their ability to successfully managed Information Technologies in today's harsh and rapidly changing business environment. Amount of expenditure on investment in IT often consume more than half of the total capital expenditure of enterprises. At the same time often do not bring the assumed effects. There is a need for a structured approach to the effective use of Information Technology, which will seek to maximize the performance and value of the enterprise. The answer to this need is the concept of IT Governance.

The aim of this study is to present the stages of implementing IT Governance, which cover the following areas: strategic fit of IT, creating value of enterprise through IT, effective use of IT resources, IT risk management and IT performance measurement. The use of IT Governance allows the enterprises to maximize the resulting business benefits and has an substantial impact on firm performance.

6. Panel Session (Abstract)

Moderator:

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Panelists:

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DESCRIPTION

Shortcomings in infrastructure and fast changing regulatory environments in emerging economies create extra challenges for effective and efficient implementation and management of information and communication technologies (ICT). Knowledge and skills gained in highly developed countries do not always transfer easily due to these challenges as well as to cultural obstacles. The objective of this panel is to address the specific issues that technology professionals are faced with in emerging economies, and how these issues may be effectively handled. Based on their experiences, the panelists will share their opinions and lead a discussion as to how ICT knowledge and skills from highly developed countries can be transferred and adapted to the unique business environments of emerging economies.

Keywords:

Emerging economies, knowledge transfer, information and communication technology, information technology, information systems, project management, transition economies



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