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Faculty of Science and Engineering

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"Technologies and Management of the E-studies"

IMITATION MODEL OF KNOWLEDGE SHARING FOR THE PROVISION OF SUSTAINABLE COOPERATION BETWEEN ADULT EDUCATIONAL INSTITUTIONS AND ENTERPRISES

Summary of the Doctoral Thesis

Supervisor:

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DECLARATION OF ACADEMIC INTEGRITY

I hereby declare that the Doctoral Thesis submitted for the review to Riga Technical University for the promotion to the scientific degree of Doctor of Engineering Sciences is my own and does not contain any unacknowledged material from any source. I confirm that this Thesis has not been submitted to any other university for the promotion to other scientific degree.

Andra Jakobsone …….

Date: ……

The present Thesis has been written in the Latvian language; it comprises an introduction, five chapters, conclusions, bibliography and eight appendices. The total volume of the Thesis is 145 pages, it is illustrated by 7 tables and 44 figures. The bibliography lists 196 literary sources.

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INTRODUCTION

Access to education and the opportunity to gain practical experience is important for personal growth of every individual, as well as for companies to create and develop new, advanced products and services through high-quality work. Knowledge sharing is an endless process, where all parties involved need to be motivated constantly ensuring its sufficient intensity.

Nowadays, digital literacy provides additional features and support for new knowledge and practical skills on a daily basis. Many different information and communication technologies (hereinafter ICT) are used for this purpose and new information systems are also created (hereinafter IS) to improve the quality of life. New society models are formed between education providers and seekers emerge (LR Saeima, 2008). In order to ensure a sustainable success, emphasis should be put on building and strengthening the cooperation between educational institutions and enterprises with involvement of potential trainees and working individuals.

The research problem and justification

Because of a passive cooperation between educational institutions and enterprises, society is still in search of approaches and methods, new information systems and technology to improve the use of knowledge, skills, abilities and attitudes. To address the problem, innovative individual approach-oriented technological solutions are studied and new knowledge sharing models are created to achieve a sustainable trilateral cooperation process.

Studying the knowledge flow models and cooperation process methodologies, a simulation model of knowledge sharing between adult educational institutions and enterprises is created using the process management tool *QPR ProcessDesigner*. Consultations with industry experts as well as a survey of adults of different ages, social groups and professions are used. The knowledge sharing process involves the following (Latvian Academy of Science, 2015; Serban et al., 2002; Bukowitz et al., 1999):

- continuous exchange of information;
- development of cooperation and growth in attitudes;
- joint creation of new knowledge and skills;
- newly created results to improve development at a higher level;
- all parties responsible for the achieved results.

To raise the awareness of introduction of the new term “knowledge sharing”, the following explanation is proposed: “A focused exchange of information and communication process to ensure the involvement of all components of social interaction and the development of cooperation in order to jointly create a new knowledge and skills, pass them on, enhance the competitiveness, practical changes in growth

of attitudes and results." The author's proposed English term "knowledge sharing" (Latvian equivalent "zināšanu līdzdale") is approved by Latvian Academy of Sciences (LAS below) Commission of Terminology, Minutes No. 451 (01.23.2015).

Topicality

It can be assumed that the problem of access to information and various computer programs available is not as essential as the quality of the learning process and its practical usability. It is important to be coordinated while orderly promoting a sustainable cooperation between adult educational institutions and enterprises. Formal, informal and dual or internship-related education are equally important and mutually complement each other.

In different public environments a variety of needs and desires have been observed, but an easily understandable and successfully functioning approach that would solve the knowledge and cooperation sharing issue has not been explored. There is no specific, widely accessible practical solution to build mutual trust in the shortest possible period of time and improve the work of adult educational institutions that could lead to better offers for company representatives regarding necessary learning needs and training. It is equally important to support the involvement of young professionals in the labour market, which can be most successfully achieved if the information system additionally includes the target groups containing the profiles of individual users. This will further strengthen the ties of cooperation between educational institutions and enterprises.

Using the support by innovative and scientific multi-annual financial program *Horizon 2020,* the aim is to develop solutions and services that are based on information and communication technologies. ICT forms the basis for innovation and competitiveness in many private and public markets and provides the progress. Given the fact that technology interacting with all aspects of life is rapidly developing, the interaction between people and technology will have an important role in this process, and it is part of the ICT usability research (State Education Development Agency, 2014). It is very important to continuously explore, create more knowledge sharing models and information systems for cooperation. Greater awareness of the ICT services and availability will open the possibilities for a wide range of cooperation.

With the support of knowledge sharing imitation model and cooperative system, cooperation and mutual knowledge sharing among potential trainees/employed individuals, educational institutions and enterprises is promoted in electronic environment. The importance of sustainable cooperation and knowledge sharing is described in "Guidelines for science, technology development and innovation". The aim is to develop science, technology, innovation in the field of human capital in order to build a more effective transfer of knowledge, strengthening the business environment and absorption and innovation capacity (Ministry of Science and Education, 2013).

The existing collaborative arrangements and technological solutions in Latvia and Europe:

1) business clusters where mutual sharing of knowledge takes place have become very popular, leading to new ideas and common strategy as well as knowledge and technology transfers;
2) companies have access to business incubators, experienced entrepreneurs and a team of professionals who are ready to provide necessary funding and support for dedicated and motivated new business start-ups;
3) networks between universities, enterprises and municipalities exist in several regions, enhancing the knowledge exchange;
4) educational institutions have access to various e-learning platforms, which are created with the help of projects financially backed by the EU;
5) there are different free advertising websites, which contain internship requests and training offers.

It can be assumed that the support tools are available to each of the target groups to successfully communicate and develop within their communities, but in order to achieve new results it is necessary to ensure trilateral cooperation among potential trainees / working individuals, educational institutions and enterprises.

Research questions

1. How can cooperation information systems be improved to motivate users be actively involved in the process of knowledge sharing?
2. What are the criteria of knowledge sharing and cooperation efficiency measuring?
3. What kind of modeling tools and technological solutions can be applied to improve the sustainability and indicators of knowledge sharing efficiency and cooperation level?

Research object

The research object of the thesis is the development of a knowledge sharing imitation model and a prototype of information sharing for provision of a sustainable trilateral cooperation.

Research goal and objectives

The research aims to justify and develop the knowledge sharing imitation model and prototype for sustainable cooperation between adult educational institutions and enterprises. The goal involves innovative methods and web-based automated cooperation system.

One of the principal objectives is to identify the needs and desires of potential trainees/working individuals and representatives of educational institutions and enterprises as well as the opinion of experts concerning current situation and possible improvements to promote a sustainable cooperation. Sometimes society is unable to follow the rapid technological development that is why it is important to balance the use of technology in the cooperation process and to create a user friendly and motivating information systems and electronic database where possibilities of information exchange between adult education institutions, students and branch experts can be found.

The technologies are particularly important in the preparation stage of supply and demand in order to save financial and time resources. When developing a new cooperation system you should also think if the created system is flexible enough and if it allows any interested party to obtain conveniently the information of its specific interest acting in a planned manner and with a personalized approach.

To achieve the goal of the research, following objectives were set:

1. To analyze scientific literature in the field of similar cooperation promoting information systems, to learn about adult education guidelines in Latvia and Europe as well as to create theoretical basis concerning basic theories of system analysis, modeling and designing.
2. To describe methods for development of sustainable cooperation technologies between potential trainees/working individuals, educational institutions and enterprises.
3. To determine current knowledge sharing motivation and activity of educational institutions and enterprises as well as possible improvements to promote a sustainable trilateral cooperation.
4. To develop an imitation model of knowledge sharing for general planning, prediction of developmental advancements and an algorithmic model for creating a prototype of automated cooperation system.
5. To develop a cooperation system prototype and to perform system's approbation data acquisition, systematization, compilation and evaluation.
6. To propose recommendations for potential trainees/working individuals, educational institutions and enterprises concerning usage of individually oriented cooperation system.

Proposed premises for the defense of the doctoral thesis

1. Imitation model of knowledge sharing describes the availability of necessary information for the user, which directly affects the formation of sustainable trilateral cooperation between potential trainees/working individuals, educational institutions and enterprises.
2. The established algorithmic model enables the creation of an automated cooperation information system and its successful operation, which is demonstrated by eLine prototype.

3. User’s motivation and activity of knowledge sharing within the system's framework, level of mutual cooperation and its sustainability directly depends on practical usability of the system.

Research methods

1. Theoretical methods — the analysis of scientific literature in the field of similar cooperation promoting information systems and learning about adult education guidelines in Latvia and Europe, as well as an overview of system analysis’ modeling and design theories.
2. Methods of data acquisition:
   - Direct observations — for identification and exploring of the main problem.
   - Interviews with experts from educational institutions and enterprises — for identification and exploring of the problem, clarification of specific desires and needs,
   - Questionnaire — determining of cooperation system users' opinion about effectiveness, availability, efficiency and sustainability of technological solution.
   - Testing — for evaluation and control of the process development.
3. Information processing methods:
   Statistical data processing methods — essential for processing of data obtained from the imitation model, for evaluation of results of the elaborated cooperation promoting information system prototype.
   - Ranking — arrangement of results in the increasing or decreasing order.
   - Arranging — arrangement of selected or all stored information in accordance with certain requirements.
   - Deduction — separation of object's essential characteristics from insubstantial ones which obstruct the object's exploration.
   - Induction — unequivocal relationship between phenomena and observation of behaviour of the entire system according to behaviour of its elements.
4. Information analysis methods:
   Primary mathematically-statistical methods on the level of descriptive and conclusive statistics in order to analyse separate variables.
   - Frequency tables that describe the random distribution of data.
   - Central tendencies indicators for characterizing the random data.
   - Graphic display of data for visualization of numerical data series.
   - Non-parametric tests for characterisation of the statistical object units.
   - The arithmetic average of statistical tests to compare the results of the central tendencies.
     Secondary mathematically-statistic methods to analyse the correlations of the variables.

- Data analysis and review tables for characterisation of the correlations.
- Graphical representation of data for visualization and presentation.
- Correlation analysis for the correlation study.

5. Results evaluation methods:
    - Verification for examination of imitation model and cooperation system quality.
    - Validation for evaluation of imitation model and cooperation system quality.
        - Opinions of experts.
        - Questionnaire for system users.
        - Scientific publications and presentation of the results at conferences.

Empirical basis of the research

Empirical basis of the research consists of user surveys and interviews with experts in two phases: I – situation analysis in order to develop the technological solution, II – system model validation and prototype evaluation. 20 representatives from educational institutions and 20 entrepreneurs from 5 countries (Latvia, Lithuania, France, Czech Republic and England) participated in phase I interviews where they answered questions in Latvian and in English. 202 respondents participated in phase II: from various adult educational institutions – 17%, enterprises – 47%, potential interns and working individuals – 36%. 3% of all respondents have obtained doctoral degree. To evaluate the imitation knowledge sharing model and the system prototype, 10 experts from Latvia and 2 from abroad were invited. 254 respondents participated in both phases.

Research stages

1. 2010-2015: analysis of scientific literature in the field of similar cooperation promoting information systems and acquaintance with adult education guidelines in Latvia and Europe as well as the theoretical basis concerning basic theories of system analysis, modeling and design.
2. 2012-2013: analysis of research methodology and corresponding technology, obtaining the empirical data and analysis for the development of the theoretical model.
3. 2013-2014: elaboration of the knowledge sharing imitation model including the description of methods and technologies of sustainable cooperation promotion between adult educational institutions and enterprises involving the potential trainees and working individuals. Elaboration of algorithmic model and automated cooperation system prototype.

4. 2014-2015: acquisition, systematization and evaluation of cooperation system prototype data. Elaboration of recommendations for use of the knowledge sharing imitation model and cooperation system.

Novelty of the research, its theoretical and practical application

- Theoretical and practical factors affecting the intensity of knowledge sharing and changes in cooperation levels and criteria allowing to evaluate the current situation and to forecast possible development directions have been defined.
- Knowledge sharing imitation model has been elaborated. It describes the connection between information system users, data and processes, and provides the ability to analyse and forecast the behaviour and knowledge sharing activities between the potential trainees/working individuals, educational institutions and enterprises.
- Algorithmic model and information system prototype have been developed for knowledge sharing and trilateral cooperation promotion, which affects and creates positive consequences in the development of knowledge with emphasis on quickly obtainable and immediate benefits.
- The results of this research are intended to be used in practice as the promotional technology of knowledge sharing and cooperation development between all involved parties. If the model is adapted and modified, it can also be used for the purposes of business analysis.

Approbation of results

The results of the thesis have been included in 14 reports presented at international conferences as well as in 4 reports presented at conferences in Latvia. One-time participation in the presentation stand within an international scientific conference.

1. Cakula S., Jākobsone A. Perspectives of E-Learning and Technological support for Adults.// Proceedings of The First International Conference on e-Learning For All, Tunisia, 3 – 5 June 2010.
2. Jākobsone A., Kulmane V., Cakula S. Structurization of information for Group Work in an Online Environment.// Collaborative Learning & New Pedagogic Approaches in Engineering Education (IEEE EDUCON 2012), Morocco, 17 – 20 April 2012.
3. Jākobsone A., Cakula S. Online experience based support system for small business development.// 8th WSEAS International Conference on EDUCATIONAL TECHNOLOGIES (EDUTE'12), Portugal, 1 – 3 July 2012.

4. Jākobsone A., Cakula S. Information Flow Modeling to Provide Sustainable Cooperation between Educational Institutions and Entrepreneurs.// 4th International Conference on EDUCATION and EDUCATIONAL TECHNOLOGIES (EET '13), USA, 1 February 2013.
5. Jākobsone A., Motejlek J., Cakula S. Information Flow Modelling and Work Based Learning for Entrepreneurs in Online Environment.// The 5th Annual International Conference on Education and New Learning Technologies (EDULEARN13), Spain, 1 – 3 July 2013.
6. Jākobsone A., Motejlek J., Rozmajzl P., Puhalová P., Hovorková I. ICT Support for Work Based Preparation to Crisis.// International Scientific Conference "Liberec Economic Forum – LEF 2013", Czech Republic, 16 – 17 September 2013.
7. Jākobsone A., Motejlek J., Cakula S. Virtual Business Support Infrastructure for Entrepreneurs.// International Conference on Virtual and Augmented Reality in Education (VARE 2013), Spain, 7 – 8 November 2013.
8. Cakula S., Jākobsone A., Motejlek J. Customized Work Based Learning Support System for Less Academically Prepared Adults in Online Environment.// EDUCON2014 – IEEE Global Engineering Education Conference, Turkey, 4 – 5 April 2014.
9. Jākobsone A., Cakula S., Florea M. Modelling of knowledge sharing processes for the provision of trilateral cooperation.// 4th International Workshop on Intelligent Educational Systems, Technology-enhanced Learning and Technology Transfer Models, Czech Republic, 14 – 16 September 2016.

Presentations in conferences in Latvia:

10. Jākobsone A., Kulmane V. The Optimization of Group Work in the Online Environment Taking into Account Individual Characteristics of Participants.// 14th International Scientific Conference Society and Culture, Liepaja, 19 – 20 May 2011.
11. Jākobsone A., Kulmane V. Wiki Knowledge Repositories for Cooperation Improvement in Small Groups.// 15th International Scientific Conference Society and Culture: The changing and Constant in Cycle, Liepaja, 17 – 18 May 2012.
12. Cakula S., Jākobsone A. The Future Education Using Ontology for E-Learning Personalization.// Virtual and Argumented Reality in Education (VARE), Valmiera, 18 March 2011.
13. Jākobsone A., Cakula S. Knowledge Sharing Modelling for Sustainable Cooperation between Adult Educational Institutions and Enterprises.// 18th International Scientific Conference Society and Culture: Roots and Growth, University of Liepaja, Liepaja, 14 – 15 May 2015.

Stand presentation:

14. Jākobsone A., Cakula S. Modeling of Individual-Oriented Teaching Process and Support of the Technology for Adults.// The International Red-Conference – Rethinking Education in the Knowledge Society, Switzerland, 7 – 10 March 2011.

Publications. The results of the thesis are included in 16 publications in various local and international scientific editions (Annex No. 10):

1. Cakula S., Jākobsone A. Perspectives of E-Learning and Technological Support for Adults.// Proceedings of The First International Conference on e-Learning for All, Tunisia, 2010. Page 100–107, ISBN: 978-0-9809498-2-7.
2. Cakula S., Jākobsone A. E-learning Modelling – Fostering More Effective Training Process.// 8th International Conference on Emerging eLearning Technologies and Applications, Slovakia, 2010. Page 84 – 89, ISBN: 978-80-8086-166-7.
3. Jākobsone A., Kulmane V. The Optimization of Group Work in the Online Environment Taking into Account Individual Characteristics of Participants.// The 14th International Scientific Conference Society and Culture: New Frontiers and Horizons, Latvia, 2011. Page 139–150, ISSN 1407-6918.
4. Cakula S., Jākobsone A. The Future Education Using Ontology for E-learning Personalization.// Virtual and Argumented Reality in Education (VARE), Latvia, 2011. Page 85–91, ISBN: 978-9984-633-18-3. (EBSCO database)
5. Jākobsone A., Kulmane V., Cakula S. Structurization of Information for Group Work in an Online Environment.// Collaborative Learning & New Pedagogic Approaches in Engineering Education (IEEE EDUCON 2012), Morocco, 2012. Page 715–721, ISBN 978-4673-1455-8, ISSN 2165-9559. (Scopus un Thomson Reuters databases, IEEE Xplore Digital Library)
6. Jākobsone A., Cakula S. Online Experience Based Support System for Small Business Development.// 8th WSEAS International Conference on EDUCATIONAL TECHNOLOGIES (EDUTE'12), Portugal, 2012. Page 170–175, ISBN 978-1-61804-104-3, ISSN 2227-4618. (Thomson Reuters database)
7. Jākobsone A., Cakula S. Information Flow Modeling to Provide Sustainable Cooperation between Educational Institutions and Entrepreneurs.// 4th WSEAS International Conference on EDUCATION and EDUCATIONAL TECHNOLOGIES, USA, 2013. Page 88–93, ISBN: 978-1-61804-155-5, ISSN: 2227-4618. (Thomson Reuters database)
8. Jākobsone A., Kulmane V. The Integration of Knowledge Management Principles in the Computer Supported Collaborative Learning.// 16th International Scientific Conference Society and Culture: Dilemmas and their Solving Possibilities, Latvia, 2013. Page 231–239, ISSN 1407-6918.

9. Jākobsone A., Motejlek J., Cakula S. Information Flow Modelling and Work Based Learning for Entrepreneurs in Online Environment.// The 5th Annual International Conference on Education and New Learning Technologies (EDULEARN13), Spain, 2013. Page 140–147, ISSN: 2340-1117, ISBN: 978-84-616-3822-2. (Thomson Reuters database, IATED Digital Library).
10. Jakobsone A., Motejlek J., Rozmajzl P., Puhalová E., Hovorková I. ICT Support for Work Based Preparation to Crisis.// XI. International Scientific Conference. Proceedings of the 11th International Conference "Liberec Economic Forum", Czech Republic, 2013. Page 240–249, ISBN 978-80-7372-953-0.
11. Jākobsone A., Motejlek J., Cakula S. Virtual Business Support Infrastructure for Entrepreneurs.// International Conference on Virtual and Augmented Reality in Education (VARE 2013), Spain 2013. Page 281–288, ISBN: 978-9934-8271-1-2. (Scopus, Direct Science and Thomson Reuters database).
12. Cakula S., Jākobsone A., Motejlek J. Customized Work Based Learning Support System for Less Academically Prepared Adults in Online Environment.// EDUCON2014 – IEEE Global Engineering Education Conference, Turkey, 2014. Page 523–528, ISBN: 978-1-4799-3190-3. (Scopus and Thomson Reuters databases, IEEE Xplore Digital Library).
13. Jakobsone A., Cakula S. Automated Learning Support System to Provide Sustainable Cooperation between Adult Educational Institutions and Enterprises.// ICTE in Regional Development, Procedia Computer Science Volume 43, Latvia, 2015. Page 127–133, ISSN: 1877-0509. (Scopus and Direct Science database).
14. Cakula S., Jakobsone A., Florea M. Automated Learning Support System for Adult Education Institutions and Enterprises.// ICTE in Regional Development, Procedia Computer Science Volume 77*,* Latvia, 2015. Page 191–198*,* ISSN: 1877-0509. (Scopus and Direct Science database)
15. Jākobsone A., Cakula S. Knowledge Sharing Modeling to Provide Sustainable Cooperation between Educational Institutions and Enterprises.// 18th International Scientific Conference Society and Culture: Roots and Growth, Latvia, 2016. Page 151–159, ISSN 1407-6918.
16. Jākobsone A., Cakula S., Florea M. Modelling of Knowledge Sharing Processes for the Provision of Trilateral Cooperation.// 4th International Workshop on Intelligent Educational Systems, Technology-enhanced Learning and Technology Transfer Models, Czech Republic, 2016, ISBN 978-3-319-45320-0. (Springer Link database)

Structure of thesis

The Doctoral Thesis consists of introduction, 5 chapters, final part with conclusions and recommendations for possible future strands of the research, bibliography and appendices. In total, 196 sources are analysed. The results of theoretical and practical conclusions are visualized in 44 figures and 7 tables. This study is intended for potential trainees/working individuals, educational institutions and enterprises in order to rise their theoretical awareness of the importance of the knowledge sharing and also the practical involvement through technological solution eLine, which allows all involved parties to promote the motivation and sustainable cooperation.

In the first part, the author presents the most important policy planning documents, concepts, categories and underlying theories in the field of further adult education. A brief insight into the variety of formal and informal education institution objectives and operating principles is provided. A short description of the status quo and the current societal understanding is provided as well as the future possibilities for sustainability in education and business cooperation. The second part deals with the system analysis, modeling and design underlying theories of automated systems of cooperation models and the basic principles of these systems. The third part focuses on the study of needs and wishes for learning and describes the accordingly developed methodology process. Expert opinions are analyzed and most successful approaches are identified in order to make the cooperation process possible. In the fourth part of the study, the conceptual model of the information system as well as the algorithmic model are described; it contains the development of the imitation model and analysis of its data, the criteria of knowledge sharing activity and changes in the level of cooperation assessment and model verification and validation. The fifth part describes the requirements for development of the cooperation system prototype and evaluation of the system support function, and contains the analysis of pilot data. The summary of the thesis includes the findings and conclusions, recommendations and possible future strands of the research.

CHAPTER 1: FURTHER EDUCATION FOR ADULTS

Chapter 1 consists of 12 pages.

Adult learning is a particularly important aspect of lifelong learning, which is understood as a continuation of the previously acquired education and the enrichment of professional skills according to the demands of the vocation in question (LR Saeima, 2015). With the development of new technologies and the necessity of adaptation to the new demands of labour market, the need for further education increases with every coming year.

Many documents are developed on Europesn and national level, which define the strategy of education development. A policy planning document that specifes the education development structure and perspectives for the upcoming seven years is the "Guidelines for Education Development 2014 - 2020" (Ministry of Science and Education, 2013).

The strategic framework of e-governance is determined by "Guidelines for development of the information society 2014-2020" (came into force with the Cabinet of Ministers instruction No. 468 of 14.10.2013) The framework describes crucial elements that need to be established and effectively developed to promote the development of e-governance. The purpose of this document is to establish a knowledge-based economy and increase the general quality of life through provision of access to technologies thus improving the overall quality of life, investing in development of effectiveness of public administration and national competitiveness, economic development and creating new jobs.

To ensure that by 2020, 15% of adult population is involved in educational process, it is pivotal to broaden the educational curriculum and to improve the regulatory framework for education, as well as to provide an effective distribution of resources (including financial resources) by means of the existing infrastructure.

Adults normally enjoy being actively involved in theeducational processes but currently still not so much in the collaboration. To achieve it, both self-motivation is needed as well as easily comprehensible and interesting technological solutions, which encourage to collaborate and learn from one another (Jakobsone, 2015; Kapenieks, 2003). Adult education can be divided into formal, informal and dual (practice-oriented) learning (Jakobsone, 2015, 2013; Cakula, 2014; European Commission, 2013; Cedefop, 2009), each of all being equally important and mutually supplementing for gradual and consistent development of personality.

It is important for every individual to find its own motivation to work on own self-development (Armstrong, 2009; Balaisiene, 2004; Praude, 2001) as well as to create the support mechanisms for the access of further adult education via information and communication technologies (ICT). Since the access to technological solutions does not definitely ensure their usability however, the users need to be motivated for acquisition of new knowledge and practical skills (Armstrong, 2009; Balaisiene, 2004; Kehre, 2004;

Praude, 2001; Davis, 1989). The collaborative system needs to satisfy the individual demands according to the existing knowledge base and skills of each individual (Kravčik, 2014; Attwell, 2008). In order to establish worthwhile collaborative systems, different societal groups need to think and evaluate the essence of the processes equally.

Results of Chapter 1:

1. The author introduces the crucial policy planning documents, concepts, categories and basic theories of adult education.
2. A summary of different types of formal and informal tasks and actions of educational institutions is provided.
3. Current situation, social understanding and future possibilities of sustainable collaboration between educational institutions and enterprises are described.

Main findings of Chapter 1:

1. In the modern period, it is not possible to maintain a sustainable competition in professional environment without improvement of existing practical skills and knowledge, which leads to increased popularity of further education.
2. Most adults enjoy to get involved in self-directed acquisition of new skills and knowledge, provided there is an adequate accessibility of such and that their motivation is stimulated.
3. All forms of education are equally important and complement one another thus enriching the culture and experience of learning, and broadening the learning environment of individuals and general public.
4. It is crucial to continuously monitor the ever-changing circumstances of market and apply accessible technological solutions approprately to promote a sustainable cooperation between adult educational institutions and enterprises, attracting the potential interns and working individuals.
5. Development and modification of methods and available technologies will increasingly affect the development of a sustainable society and will determine the tendencies in education thus changing the nature of adult further education.

CHAPTER 2: SYSTEM MODELLING

The chapter consists of 17 pages, 4 figures and 1 table.

Information technologies in today's world are breaking down the geographical borders and function sumultaneously as a support net for sharing knowledge and information as well as a promoter of cooperation in the development of further education of adults. However, in order to ensure not just the exchange of certain data but also the knowledge-sharing and promotion of sustainable cooperation, it is necessary to create a model is based on active participation of all involved groups. Modelling of the knowledge sharing allows to plan, develop and monitor the entire cooperation process as well as the separate steps of each activity, the actors involved, and to describe in detail the knowledge streams within the system. It is also possible to analyse how the changing factors modify the shared environment of the system. Modelling and simulation have generally proved to be useful when addressing the issues in analysis, design (Bartusevičs, 2015) and optimisation of complicated information systems (Sanguinetti, 2015; Merkuryev, 2008, 2012; Maier, 2007). Analysis of the results of the imitation model allows to arrive at well-grounded conclusions on ensuring a sustainable cooperation and necessary support mechanisms to achieve more precise and higher quality results for the knowledge sharing between trainees/working individuals, educational institutions and enterprises.

2.1 Main theories of analysis, modelling and designing of information systems

System analysis is understood as a study of an existing or a planned system in order to determine demands and processes of the information in question as well as to find out how these processes are linked mutually as well as with any other system (Latvian Academy of Science, 2011). System analysis combines the elements of science and practice. It builds on creating a general model, considering all possible real-life factors and links. The designing is understood as a body of actions for acquisition of practicable system description from the specification.

In order to simplify the planning process of development of information systems, the modelling methods and technologies are applied more and more often. The modelling is a study of cognitive objects based on the models of real-world processes and phenomena in order to gain understanding of these processes and phenomena and forecast any changes (Ping Ho, 2006, Loucopoulos, 1999). The main aim of the modelling is to anticipate the behaviour or a process or a system. A model is an abstraction, which is used to better understand complicated issues and possible solutions. (Gray, 2011; Pressman, 2009). The process modelling allows not only to discover the correlation between different elements and explain past events but also to predict the situation development in the future. The acquired information helps to

determine the parameters of the system efficiency, to substatntiate its optimal structure and to provide suggestions for inmprovement of options for future analysis (Dukulis, 2013; Muharar 2012).

The modelling can be used in many different contexts and situations since it is classified based on the character of the modelled objects and on the field where the modelling is used. Depending on their characteristics, the models can be split into three categories: business process models, abstract and combined models (Krons, 2013). In this thesis, the abstract graphic model approach is used. The abstract models are descriptions of abstract originals, using certain signs. These are called formal or logical models.

The designing is a process where the description of the planned information system is created from previously obtained specifications. Designing of software has the following phases:

- investigating and analysing the problem;
- identifying one or several solutions and choosing the simplest one;
- describing every abstraction used in the solution.

Data flow diagram (model of objective reality) applies to the work process, the involved parties and modelling of resources. Data flow diagrams are usually easy to perceive and very useful both in the early stages of research as well as during the project realization (so that the overall framework and important details are not lost during this phase). In addition, individual functions are singled out as well as their connection is found and input and output data of the functions are specified. Input as well as initial data is important for designing of any system and arriving at the final data (see figure 2.1). The system data describe the data transformations.

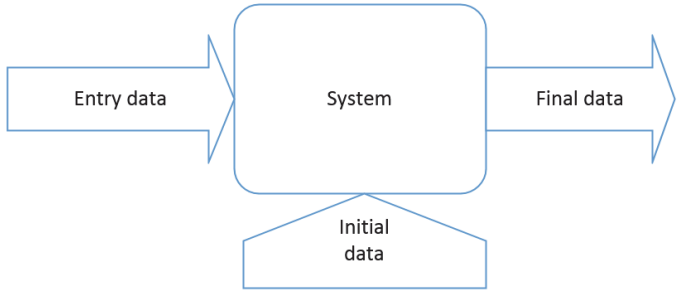

Figure 2.1 Data flow

Designing of databases (Grundspeņķis, 2010) is intended to create a detailed data model. Data modelling is a process, during which the most important data objects are analysed, eventually leading to the creation of a data model. A well-designed logical model helpt to create a database.

If we understand the database as a database control system (such that sorts, stores, copies and deletes data), then it is called the automatic data processing system. Almost every activity where people are involved is social. It means that socially addressed processes where social problems are solved with the

lelp of technical means are sociotechnical in their nature (Sawyer, 2013; Jakobsone, 2010; Kling, 2000). Designing of such systems is complicated because of many parameters that are scattered. The sustainability of a system under design should be provided for and possible solutions should be verified in real time. All aforementioned circumstances determine the cost increase of the development of the technologies in question (Ginter, 2011).

2.2 Modelling of automatic cooperation system

The automatic data processing system includes a computer system, network and technical and information resources and uses a user-oriented approach (Joo, 2015; Ķinis, 2014). Today, automation of technological processes is an objective necessity and contributes to increased productivity, improved service quality, reduced consumption of materials and energy and improved working conditions. That is just why an automatic system of collaboration needs to be developed, improving the knowledge sharing and societal processes between the potential interns/working individuals, educational institutions and enterprises. The process of automatisation takes place without direct participation of people, instead automatically receiving a feedback from system users with important information that has been demanded previously.

In order to define and connect data in a way allowing to discover, integrate and re-use it in other applications, the semantic data networks are used (Bartusevičs, 2014; Petrovskis, 2013; Heijst, 1995; Uschold, 2004). Data construction on semantic level differs since it puts emphasis on assigning more meaning to the data itself instead of merely depicting the relationship between attributes and their data (Cakula, 2011; Heijst, 1995). Use of these technologies ensures that the computer systems (web applications) understand and communicate with one another. One of the greatest challenges is the ability to share and analyse data stored in independent applications (Jansone, 2012). Semantic depiction of web data can be considered as the next step in data management.

To develop such complicated systems, the intellectual agents are used (Dāboliņš, 2013, Lavendelis, 2012), which are mainly asociated with the concept of artificial intelligence and should be defined as the "intellectual systems" (Lavendelis, 2012). These agents are most often used for program-based computer systems. Such agents can function autonomously, perceive the world around them, exist within unlimited period, adapt to changes and reach goals set by others (Ribickis, 2006).

They are featured by the following characteristics: autonomy, ability to reaspondt, activity, knowledge and trust (intellectual conceptions). Internet is the most resourceful channel of information and data available to any user according to their need and aims. Unfortunately, a large part of this data, structured documents and online databases but not so many formal knowledges coded (Boronwsky, 2013) using vatious programming languages (Grundspeņķis, 2012, 2010, Zhong, 2002). The trilateral cooperation

system between educational institutions, potential interns/working individuals and enterprises needs agents possessing most of the aforementioned characteristics so that it would be possible to independently assess the most appropriate alternatives of the knowledge sharing and cooperation (Anohina-Naumeca, 2007).

When creating information systems and computer programs with the use of intellectual agents, more opportunities to motivate the users of the system appear, especially those who are not certain of their needs yet, since these agents provide advice regarding most appropriate options and individualised development scenarios. Types of intellectual agents entail the following: reactor agents, model-based agents, proactive agents, goal oriented agents and effectiveness-oriented agents (Dāboliņš, 2013; Boronowsky, 2013; Ribickis, 2006; Institute of Electronical and Electronics Engineering, 1993). Effectiveness-oriented agents are most appropriate for the development of a trilateral cooperation system. They follow the principle of 'task carried out' and 'task not carried out' and thus this more general criteria allows to compare different states of the surrounding environment as well as how well the agent can carry out a task (Institute of Electronical and Electronics Engineering, 1993).

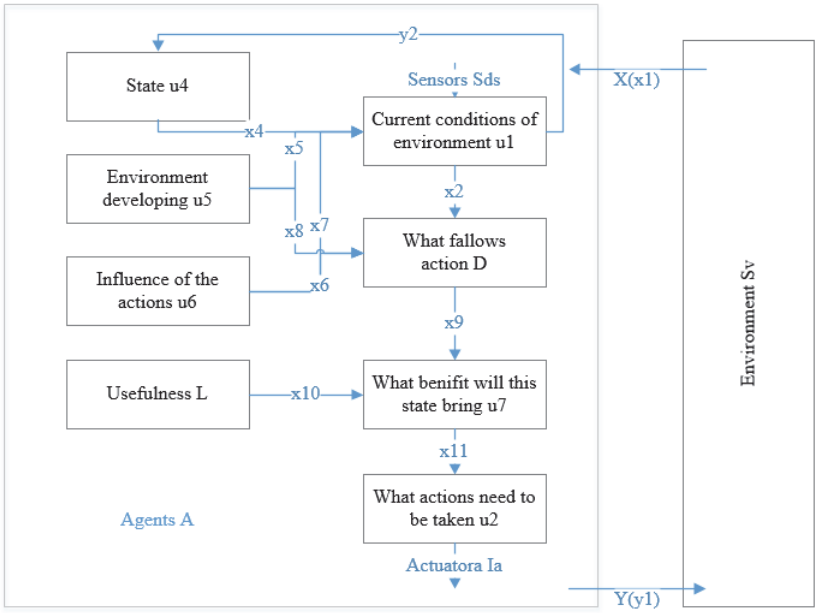

Figure 2.2 Efficiency-oriented agent (Institute of Electronical and Electronics Engineering, 1993).

Activities of an efficiency-oriented agent Y is dependent on the influences of the environment X (see figure 2.2). Agent A , via analysing the conditions of environment Sv during time t, receives a signal x1 from a sender Sds and carries out an analysis according to the chosen scale while taking into consideration the state of u4 and influencing this state with y2, also considering that environment is developing (u5) as well as considering its measurements (x5) and the action-influence analysis of u6 as a signal x6, so as to determine measurement u1, following by submitting the measurement u1 analysis' results

as x2 and thus acquiring an additional measurement and, while taking into consideration the development of external environment and the mutual influence of the action x7 and x8, an analysis is undertaken to determine what will happen if action D is taken and the signal about this is forwarded for the planning of next action x9, where, considering effectiveness L and its measurement x10, the usefulness of this state (u7) is analyse as well as its measurement x11. Then, the agent makes a conclusion according to the previously set up program and forwards it to the executive mechanisms Ia via command y1, thus affecting the environment with Y. The use of such agents when developing information systems and computer software brings a great potential for the future, promising to ensure an important and sustainable cooperation between trainees/working individuals, educational institutions and enterprises.

Precisel determination of these internal and external factors of system modelling simplifies and allows predicting and understanding the aspects of socialisation also explaining why and how people are/are not ready to share their knowledge during cooperation amongst themselves. In the prototype of the cooperation system developed by the author, every participant registers with a concrete goal in mind and shares his or her data with other participants of the process by their free will, without any specific structure. In the initial phase of such system prototype has to be easy to comprehend to improve motivation of cooperating sides. Ministry of Science and Education of Latvia proposes setting up a common database as one of the possible solutions for adult learning monitoring, the aim of which would be to coordinate the work of the state institutions, enabling the cooperation between employers and individuals in the context of demand and supply of further education for adults (Matisāne, 2014).

As the interviews with experts regarding the needs and wishes of the target audience conducted for purposes of the research suggest (discussed in more detail in Chapter 3), both educational institutions, as well as entrepreneurs are of a similar opinion about current situation regarding mutual cooperation and both want to get more actively involved in the promotion of knowledge-society.

Results of Chapter 2:

1. Core theories of system analysis, system modelling and management are summarised.
2. Core principles of automatic systems of cooperation and models of these systems are described.

Main findings of Chapter 2:

1. In the case of the knowledge sharing imitation model and cooperation system prototype, it is crucial to evaluate factors that affect the precision, cooperation intensity and quality of knowledge sharing, all of which affect the motivation and user activity in the system.
2. The success of cooperation in the information system is largely dependent on the initial model of the information flow on strategic and operational levels.

3. When establishing a cooperation system and using intellectual agents, new opportunities of motivating those users who are not sure about their needs are created, offering the most appropriate choices and individualized scenarios for development.
4. When ensuring the functionality of the cooperation system eLine, it is not sufficient to only focus on providing something innovative for the user, it is also important to provide all basic functions on appropriate quality level.

CHAPTER 3. STUDY OF KNOWLEDGE ACQUISITION: NEEDS AND DESIRES

Chapter 3 consists of 22 pages, 1 figure and 1 table.

Current economic conditions increase demand for knowledgeable and professional employees. Companies should pay great attention to the employees' motivation, skill improvement and growth-oriented team building. Human factor is a key here: the ability to motivate, bring people together for joint actions and objectives, respecting each individuality, personality, their specific needs, wishes and possibilities. Judging by the expert interviews and observations, the organizations are slowly becoming aware that information and knowledge are the most valuable assets.

The best indicator of the effectiveness of knowledge transfer is adult achievements, so it is important to focus on motivation to share knowledge and skills of navigating information, rather than give up on the acquisition of new knowledge due to inconceivably large amount of information available (Žogla, 2002). Almost every person experiencing a new and unknown environment and adapting to it has to deal with a number of innovations, which occasionally leads to difficulties and problems. People often do not know how to deal with the difficulties, since they have not faced these kind of problems before. The sooner individuals adapt to the new environment, the sooner they are able to productively perform a variety of tasks. This includes becoming aware of new possibilities and for self-identification in a collaborative environment.

Productive knowledge and information that is transformed into skills, abilities, technological processes and ultimately into a product demanded by the market can be called an innovation (Osis, 2005). Any kind of job involving knowledge is ocnsidered as the content generation - a generation of new knowledge, in order to stimulate the development of innovative processes. Innovation is essential for supporting education and knowledge as they provide an opportunity to develop a common knowledge building (Guerin, 2002). Not only knowledge management and governance processes should be innovative, but also products and services or technologies.

The same approach should be used when dealing with a variety of development and collaborative models, as well as research methods. Motivation is needed in order to achieve any goal. Without proper motivation approach, it is difficult to achieve maximum return, which in turn affects future development. One should choose to become educated by their own will and feel the need to do so. The most important factor in creating motivation, is believing that education suits people's needs. In reality, everything works better if the individual has a personal interest.

3.1. Methodology for studying of learning needs and desires

The research methodology determines an aggregate of research methods, operations, circumstances and regulations used to carry out a purposeful work (Dukulis, 2011). This study focuses on identifying the interests or needs and desires that contribute to development of knowledge sharing imitation model and sustainable framework for cooperation.

The theoretical foundation is based on scientific literature. Qualitative and quantitative research methods, such as observation, interviews, analysis, expert systems and user surveys are used to study the subject. To evaluate data, the consequential statistics is used along with its secondary mathematical statistical methods including correlation, chi-square distribution test, the arithmetic average comparison with the T-test, tests of nonparametric distribution by Kolmogorov-Smirnov, graphical analysis, parameter assignments and the reporting tables (annex no. 4). Evaluation criteria and set of methods for the verification and validation of knowledge sharing model and cooperation information system prototype are developed.

Existing promotion measures for trilateral cooperation in Europe and Latvia and technological solutions were identified first. A lot of work has been done already so companies, educational institutions, as well as young professionals could receive the necessary support. Since all of these target groups are intricately interwoven, the next step in the development process is to form a tripartite knowledge sharing imitation model and prototype framework for cooperation. The needs and desires of initial user forthe prototype framework for cooperation are identified by interviewing representatives from educational institutions and enterprises. Equally important is the knowledge management and management of the basic principles of theoretical cognition (Kapenieks, 2003; Davenport, 1998) so that it would be possible to fully understand knowledge sharing and cooperation influencing factors between the parties. Summarization of experts' views and theoretical aspects became the basis of development of knowledge sharing model and afterwards eLine, a prototype framework for cooperation, was developed. To visualise the algorithmic model of the designed IS prototype a block diagram is used and the database is described by ER models to gradually understand and develop a technical solution. Conceptual database model and algorithmic model are created by using MS Visio software.

Online knowledge sharing and cooperation promoting system eLine prototype (Beaudouin-Lafon, 2002; Dills, 1997) is used to display the system's functionality and understand the benefits of saving time, finances and energy searching for information through a variety of search engines. Knowledge sharing and cooperation influencing factors are identified and described in detail by using criteria categories - effectiveness, efficiency, accessibility and sustainability. To evaluate eLine cooperation system prototype, measurements were carried out using both qualitative and quantitative criteria. Knowledge is created more

rapidly if it is described and shared in an electronic environment. Thus, it becomes more accessible and sufficiently motivatied for individuals involved a sustainable cooperation process.

3.2. Organization of cooperation process, aquisition and analysis of empirical data

The study includes direct observations and interviews with experts (annex no. 6), attended by a 20 representatives from educational institutions and 20 entrepreneurs. Most educational institutions' representatives believe that the continuous increase of staff qualifications is relevant and necessary. During interviews, a large part of the experts acknowledged that the response time to fulfilling the demands of enterprises was too long. Approximately 80% of all educational institutions' representatives who participated in the interviews stated that an idea of an automated system of cooperation is promising. Such a system of cooperation is necessary because very often entrepreneurs select their staff after training courses, and citizens could choose their educational development programs, taking into account employers' requirements regarding labour force with specific knowledge. Company representatives state that continuous improvement of qualification of employees is essential. Continuous self-improvement in the professional field is like an objective. Training opportunities serve as a motivation, help employees follow current developments in their field and improve working results at the same time. Most experts say that an electronic database designed for that purpose would be needed, if only to let the educational institution know what enterprises need, and take it into account. It seems to be a good idea to also have the ability to keep track of students' research topics, planned internships and graduated young professionals. A database containing useful information is essential, since today it is very important to access information in a single place in a straightforward manner. Company representatives have expressed a variety of views on the perspective cooperation framework between adult educational institutions and enterprises. In general, this idea seems to be supported, and with a perspective.

The need to create communities for trainees and potential trainees, the involvement of employees in knowledge sharing model, promoting cooperation and the quality of it between educational institutions and enterprises was also discussed with the experts. They state that it would be very useful for young people and adults in search of an internship, existing training opportunities or retraining.

3.3. Knowledge sharing model development

First of all, knowledge transfer based on knowledge demand is associated with the cooperation, which depends on having the knowledge necessary and, secondly, knowledge can be formed when knowledge "suppliers" and "beneficiaries" meet. When providing and developing the prototype of cooperation system, functionality knowledge sharing is promoted which leads to educational institutions

gaining experience in communicating directly with enterprises and creating personalized training courses on the particular case and actual topics. In turn, companies, showing initiative and cooperating with educational institutions will gain the knowledge required for more effective work in industry and first-hand information on how to acquire young professionals and their knowledge. This trilateral knowledge sharing model is unthinkable without the young professionals as its main users, since they would be the ones getting actively and creatively involved in promoting electronic cooperation, while ensuring sustainable competitiveness of the system with their enthusiasm. Benefits of knowledge sharing and cooperation can manifest on several different levels - individual, educational institution, business, regional, national and international level.

Results of Chapter 3:

1. A study is conducted on learning needs and desires and the accordingly developed methodology is described.
2. Based on the opinions of experts analyzed, the most possibly successful approaches of creating cooperation process are identified.

Main findings of Chapter 3:

1. After analysing the obtained data, the needs and desires expressed by representatives of enterprises and adult educational institutions in different environments regarding professional skills development are collected. Findings show that a very readable, well-functioning model and an information system intended for a wide audience and capable of solving cooperation problems has not been created yet.
2. Cooperation system will work if the user is aware of the positive correlation between causes and consequences.
3. The available services in the cooperation system should be rather informative and motivating for everyone to return to the cooperative framework, use available resources. The cooperation system should also work as a means of sharing desires and needs, rather than as advertising that targets a large majority of users.
4. Educational institutions need to actively monitor the needs of enterprises in the field of education are and companies have deeper understanding what educational institutions require.

CHAPTER 4: RESEARCH MODEL AND TECHNOLOGY OF USE

Chapter 4 consists of 27 pages, 20 figures and 5 tables.

Research of cognition objects has never been as important as in today's dynamic environment to promote sustainable knowledge economy with support of technologies, involving implementation of innovation and the transfer of knowledge in the economy.

4.1. Modelling of knowledge sharing and sustainable cooperation

After compilation and processing of the results of interviews with educational institutions' and business representatives valuable recommendations for knowledge sharing and real information system elaboration had been received. In the knowledge sharing model, a block of trainees/working individuals along their desires and needs was included in addition to blocks of educational institutions and enterprises. The general model of cooperation system describes its principal target groups or users as well as what kind of cooperation-promoting information and other benefits it provides.

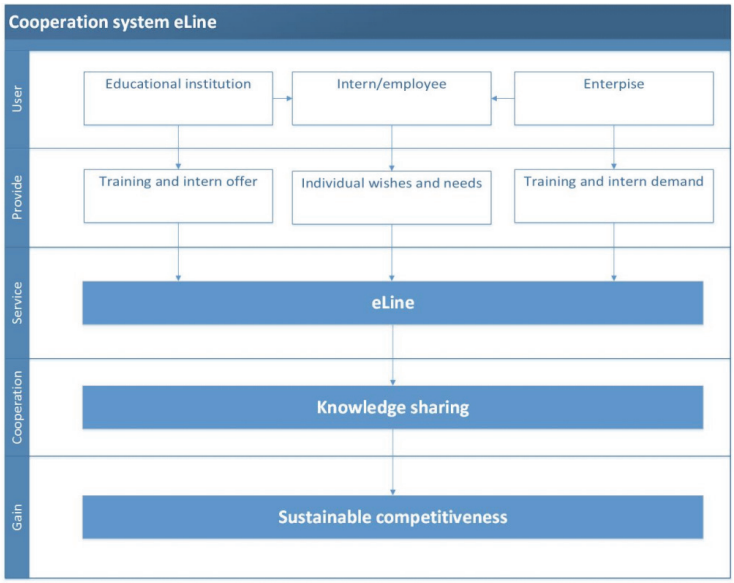

Figure 4.1. General model of systemic cooperation.

As shown in figure 4.1 the primary goal of educational institutions is to provide existing training courses and potential trainees with offers; the enterprises request the necessary theoretical training courses and young specialists for internship vacancies, and trainees are sharing their individual needs and desires as well.

The algorithmic model of information system (see figure 4.2) defines functions or those data processing and/or verification algorithms that should be integrated into function. In the trilateral cooperation system between educational institutions, potential trainees/working individuals and enterprises, the agents are included in order to evaluate most useful alternatives and to offer more optional variants. Wherever possible, the separate process automation through the agents' technology helps to reduce the time of the entire process, improve the quality and understand better the needs of customers.

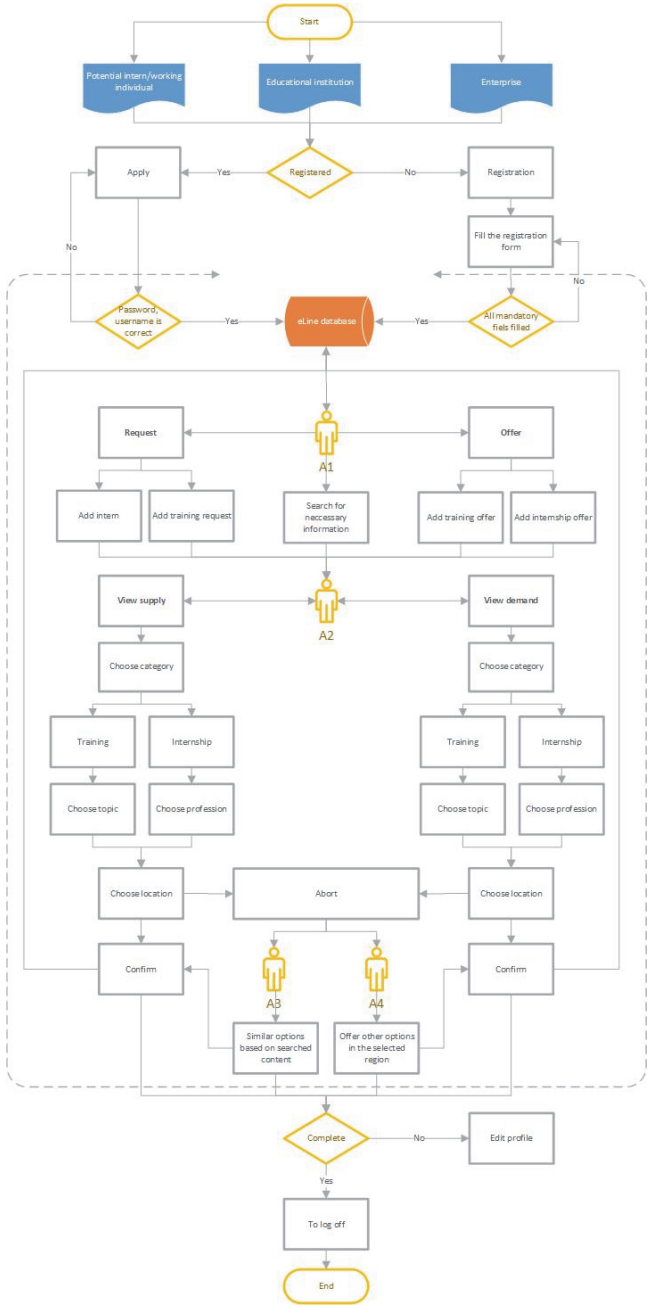

Figure 4.2. Agents' based algorithmic model of cooperation system

Agents of information system, provided they cooperate with one another, are capable to analyse situations and learn from users' behaviour as well as to assess their usefulness, evaluating the communication style and activity between parties involved. The principal goal of agents is to simplify the identification of possible solving of cooperation system users' needs and desires, to filtrate useless information and to display offers of utmost interest first. Information filtering agents are used in order to select the most relevant information for the offer from the database. The functions of the programme agents are connected with maintaining system functions in activities that do not require permanent involvement of users. System user enters the necessary parameters via a graphical interface and the agent carries out the selection of available options to provide feedback. Using this kind of scheme simulates the process of user's presence (see figure 4.3.).

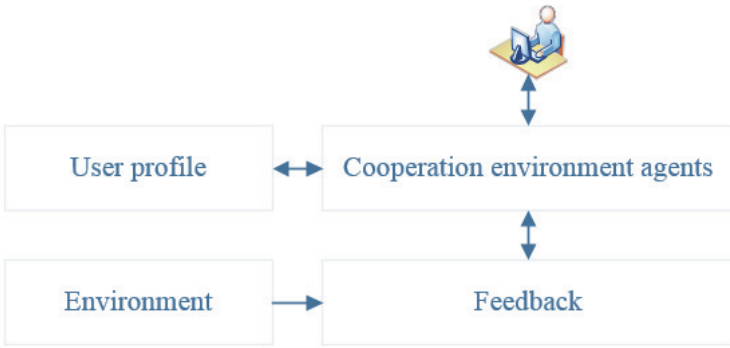

Figure 4.3. Use of filtering program agents.

General problem solution diagram (see figure 4.4) depicts how all tasks are divided into several subtasks, each of them having a specific responsible agent.

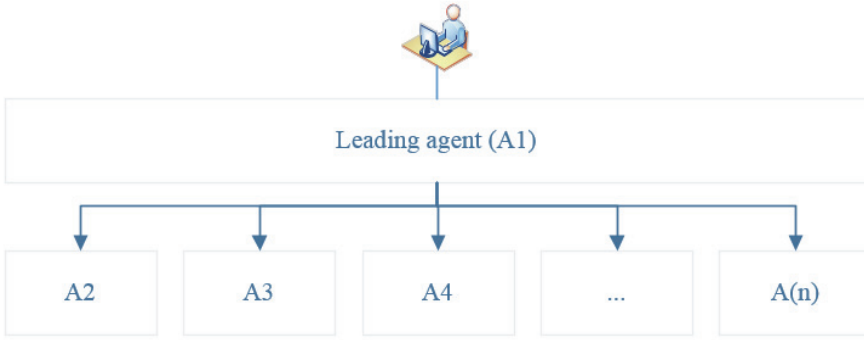

Figure 4.4. General task solution diagram.

The leading agent (Anohina-Naumeca, 2007) performs the coordination of general task solution and displays the information in form necessary for the user.

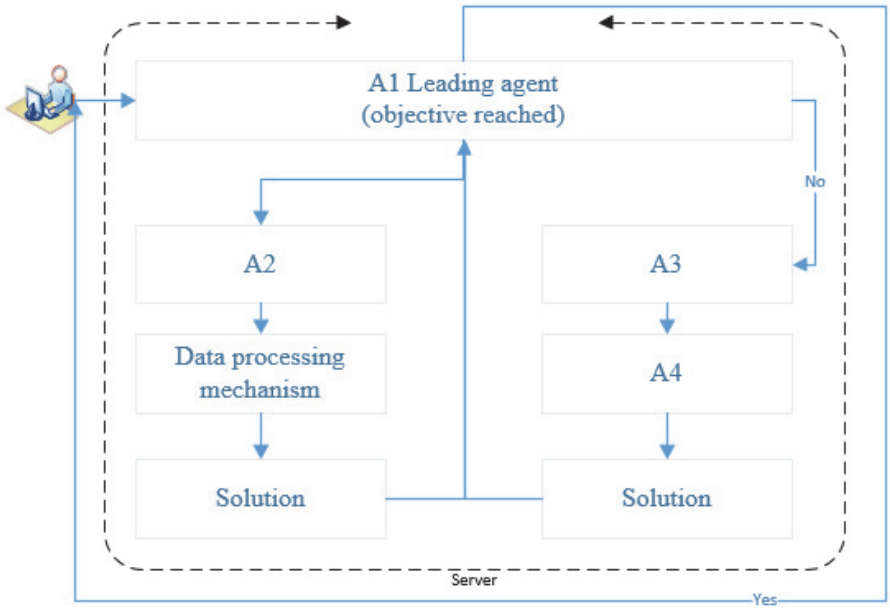

Figure 4.5. Solution of user tasks.

Each agent can perform one or several functions; consequently the agent cooperates with other agents in the global network where necessary information has been selected according to some other parameters (Ribickis, 2006). Four intellectual agents are originally intended in the cooperation system of knowledge sharing between potential trainees/working individuals, education institutions and enterprises (see figure 4.5.):

- A1 — leading agent;
- A2 — offers the choice of theme and place;
- A3 — searches the similar according to the theme;
- A4 — searches the options within a certain radius.

After provision of the functionality of the basic processes of the information system, the next step could be the development of the agents' technologies in order they are able to ensure the system's self-development and, when analysing the data of all users, the search of hidden connections and discovering of unknown relations between them can be performed (Clifton, 2010; Hastie, 2009; Fayyad, 2008). Additional training offers recommendations for the trainees who search for internship possibilities or who have already chosen certain cooperation partners can be mentioned as an example. As is the case for enterprises when courses are chosen, it could be useful to receive information concerning individuals who have already acquired specific or similar skills in the same or a similar educational institution.

Current algorithmic model of information system has been developed as a primary model because in the long run each agent learns and develops their role in this part or the entirety of the model through

dialogue with users about their preferences and needs (Roost, 2013). It is possible to evaluate practical benefits of all agent-based systems when there is a large number of user accounts and all the parties involved are actively participating.

Entry as well as initial data is a very important factor in any system design since it leads to final data. System users - trainees/employees, individuals, educational institutions and companies - express their offers and requests in eLine environment where these offers and requests are processed and stored in the database. The more data is collected and stored in the database (Cakula, 2011), the more successful knowledge sharing and cooperation between all parties is possible in order to overcome the challenges of meeting the objectives. The conceptual model describes the database content and structure. To represent the current database data model of the cooperation system, the ER model is created (Dullea, 2003; Armstrong, 1974). The aim is to justify the usefulness of the system, exploring the scope of the problem and its prevention method, which is being implemented to improve the cooperation IS prototype and to give an idea of the possible benefits.

4.2. Criteria for evaluation of changes in knowledge sharing activity and cooperation level

It is important to assess the factors affecting knowledge sharing activity and choose the criteria of changes regarding the level of cooperation. Public opinion states that the main reason slowing the cooperation between educational institutions and enterprises is by general lack of trust or an existence of large proportion of small and medium entrepreneurs with limited resources. In order to identify all the possible options, factors affecting the involvement in knowledge sharing and cooperation are characterized. Knowledge sharing activity is measured by how often potential trainees / employees, individuals, educational institutions and companies share their needs and desires via cooperation framework eLine. In contrast, the level of cooperation is measured in units of demand and supply, which meet the requirements of the side interested in cooperation. Identifying influencing factors and criteria allows analysing the current situation and forecasting possible future developments.

People's willingness to cooperate and share their knowledge could be affected by a wide range of factors that have been identified within the study (Abdussalam, A., Hawryszkiewycz, I. 2014; Anantatmula V., Kanungo S., 2005) are further developed by the author and are then summarized in four categories: usefulness, efficiency, accessibility and sustainability (see table 4.1.). Based on these criteria, a survey for the framework for cooperation prototype users is created (annex no. 5), and the results obtained are analyzed in Chapter 5.

Table 4.1. Categorized influencing factors

Usefulness	Efficiency	Accessibility (electronic system)	Sustainability

• Skill evaluation level (on scale 1-5)
• Offer evaluation level (on scale 1-5)
• Improved offers (complemented % of all)
• Recognisability level (view factor)
	• Cost
	  o Self advertising (savings from average market price)
	• Time
	  o Storing of contacts in the database (saved time when searching repeatedly)
	• Data security (no access to third party)
		• Technically
		  o Electronically for different OSs
		  o Mobile, tablet
		• Content related
		  o Offer precision and content
		  o Request precision and content
		  o Eligibility of intern/internship
			• Motivation (repeated use of the system)
			• Increase of offers and requests (number)
			• Reliability level (on scale 1-5)
			• New knowledge and experience (on scale 1-5)
			• Long term profit (increase of trainees, efficiency of qualified employees)

Attention should be also paid to the fact that the ability to communicate directly and humanly without the ICT is reduced (Karnītis 2004). It is often heard that communication capability development will provide a major benefit in the future, so we should not be limited only by the possibilities offered by technology. Considering all of the above, knowledge sharing and cooperation quality management is needed when creating models and information systems.

4.3. Justification of modelling software choice and input data preprocessing

Modelling software and language is required to write down patterns so that others can understand and use these patterns. Simulation modelling has become one of the most common methods of researching processes and management in the world, which, if used properly, can save both financial and time resources. Simulation is a simplified computerized representation of the real system that allows manipulating the operational values, thus allowing the right decisions and directions of development (Taylor, 2014; Bakken, 2007; Banks, 1998). When creating a simulation model, the existing general knowledge sharing processes should be identified as well as their connection. Visualization integration is an important aspect of all simulation stages, starting with a conceptual model development and ending with the simulation results obtained (see figure 4.6.). This data can then be used for decision-making process, as well as an aid for simulation model verification and validation (Lektauers, 2008).

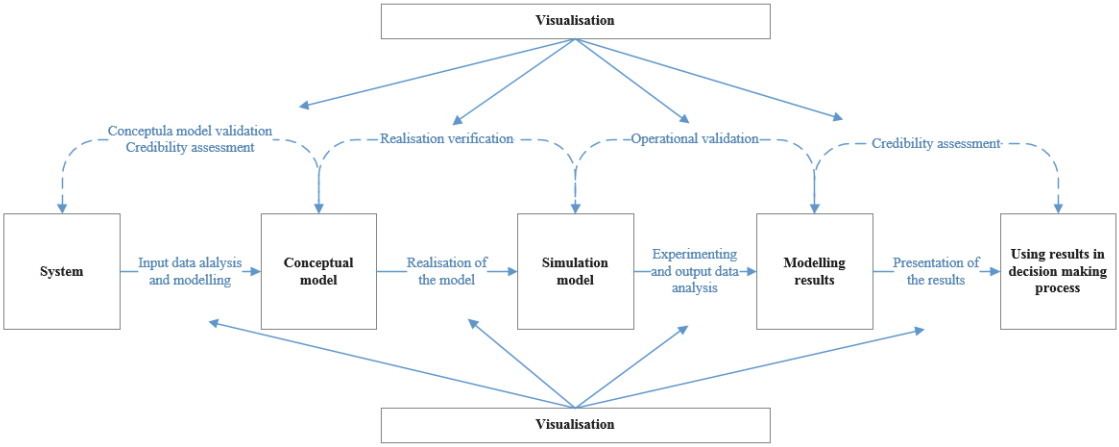

Figure 4.6. Connection between simulation modelling and visualization.

For imitation modelling of knowledge sharing processes, the process management tool QPR ProcessDesigner was selected, which is a solution for rationalization of different operations. Knowledge sharing and cooperation process is revaluated and modelled using business process management tool QPR ProcessDesigner on purpose, since by modifying the flow of knowledge model it would be possible to analyze and predict user behaviour and knowledge sharing activities and business purposes in the long term. Based on theoretical knowledge sharing imitation model, a business plan was developed for the planned information system in order to ensure accessibility and to promote trilateral cooperation in adult continuing education. Business plan was developed in collaboration with LCC International University in Klaipeda.

4.4. Simulation model data analysis

Model simulation data analysis is conducted in order to demonstrate knowledge sharing effectiveness using modelling results leading to improved co-operation process. Use of this model allows to conclude that there is a need to introduce a system for modern knowledge sharing.

In order to achieve the objectives, it is necessary to define the following:

- step process rules (name, type of process steps, process time, resources, resource distribution in %, inbound flows, and outbound flows);
- flow rules (name, type, process of origin and target process, process time);
- resources (name, resource type, quantity, period).

Three main processes and three supporting processes are set in the imitation model. The basic processes include the analysis of factors influencing knowledge sharing and cooperation organization, while supporting processes are there for user technical support, functionality and design improvement and attraction of funding to ensure the development process (annex no. 3).

When the the process steps conditions, the flows conditions and the resources are identified, the model simulation can be started. The basic conditions are set in the simulation, in this case: the maximum numbers of activities (1000), simulation start time, duration, and real-time acceleration. Simulation results in output data - resource and activity maps (annex no. 2), as well as informative graphs depicting the results obtained in various cross-sections. The activity maps that help to make appropriate conclusions regarding the potential risks in the real situation are very useful. Informed decisions are more likely to be made by monitoring the risks, thus improving the efficiency and quality of the entire process.

4.5. Verification and validation of the simulation model

During the modelling process, a special attention should be paid to the methods used for verification and validation of the model (Sargent, 2004; Nikoukaran, 1999) to make sure that it is properly designed and installed accordingly to the original requirements. Verification procedure consists of testing, analysis of sub-results and using graphical depiction. When no error has occurred, activities and resources are logically and evenly distributed, it can be considered that the figurative representations are adequately approximated to the real situation.

Model validation has to be carried out to determine if the developed model is behaving as expected by the user. According to the developed imitation model cooperation system assessment criteria, potential users of the system were surveyed, involving representatives of the various target sectors. Individuals involved in the evaluation process view the whole model as positive. The model was presented for evaluation to experienced experts in various sectors, which were selected using criteria suggested by Dzidra Albrehta (Albrehta, 1998). The interviewed experts evaluated the model as positive and admitted that the proposed model concept was well thought out, its creation took into account both the current situation and the most important aspects of a positive outcome in the future (for more information see section 5.3.).

During the study, positive scientific reviewers' assessments were received, as well as the opinions of industry experts speaking at international and national-level conferences.

Main findings in Chapter 4:

1. The conceptual model of information system and the algorithmic model are described.
2. The development of knowledge sharing imitation model, its data analysis, criteria for evaluating knowledge sharing activity and changes in the level of cooperation are described.
3. The simulation model verification and validation is described.

Main conclusions in Chapter 4:

1. Any of the parties must take into consideration that successful cooperation requires not only a technically successful communication but also an active participation and time in order to

obtain mutual trust, therefore this model is designed to support and promote the cooperation in the long term.

2. During modelling process, it is easy to make mistakes, if the process is influenced only by observations. These mistakes can only be detected by repeating the simulation numerous times and by experimenting with rules set to the regulations.
3. There is no need to measure all possible factors - the number of parameters to be monitored is not decisive. It is important how the obtained information is used for decision-making.
4. Evaluating all the practical benefits of agent-based collaboration system is possible if there is a large number of user accounts and all the parties involved are actively participating.
5. Imitation model allows to conclude that introduction of a cooperation system for modern knowledge sharing is significant.

CHAPTER 5: DEVELOPMENT OF THE PROTOTYPE AND TECHNOLOGICAL FUNCTIONALITY

Chapter 5 consists of 26 pages and 19 figures.

The prototype imitates the structure of the actual program and is pivotal for the process, since during the development of the information system it is changed and adapted several times to achieve the desired outcome. The system users are the main driving force behind the development of the system's functionality. This is precisely why direct interaction is so important for the prototype - it has to be easy to grasp, should not be challenging for the users and should allow to process the functionality of the system easily.

5.1. Requirements for the development of cooperation system eLine prototype

Prototyping method is used when no previous experience with similar system exists or when the external environment is unstable and unpredictable, as it is in this case, since there exist many external and internal factors that need to be considered (see Chapter 4 for more information). Main benefits of this method are the following: possibility to change the system during early stages of its development, as well as to stop further development of dysfunctional systems or developing a system that corresponds to the needs and requirements of the users (Sazi, 2015). In all stages of eLine development, the main emphasis is put on establishing a convenient form of cooperation for educational institutions, interns/working individuals and enterprises. The initial requirements of the system users are identified prior the development of the prototype already, but with practical involvement in the knowledge sharing and online cooperation the additional requirements appear, which are crucial for further improvements in the information system development.

Information base consists of two main categories: educational process and practical experience. These categories are then split in requests and offers, which consist of needs and desires of users and are transformed, categorised and stored in a single location that is easy to access for all those involved. Having the needs of potential interns/working individuals, educational institutions and enterprises all combined in the offer and request database allows to achieve the established goals, provided knowledge sharing is set up in an effective manner. Simulation data of the imitation model indicates that in order achieve active knowledge sharing and sustainable cooperation, the critical mass for such a system is at least 200 motivated registered users.

Each individual user of the system can determine own needs independently from other users. Everyone has a chance to offer educational opportunities or topics they are interested in studying, as well as express their wish to become an intern or offer an internship to someone. While being involved in mutual

knowledge sharing and cooperation processes, it is also pivotal to receive feedback (Dāboliņš, 2013) (see figure 5.1.).

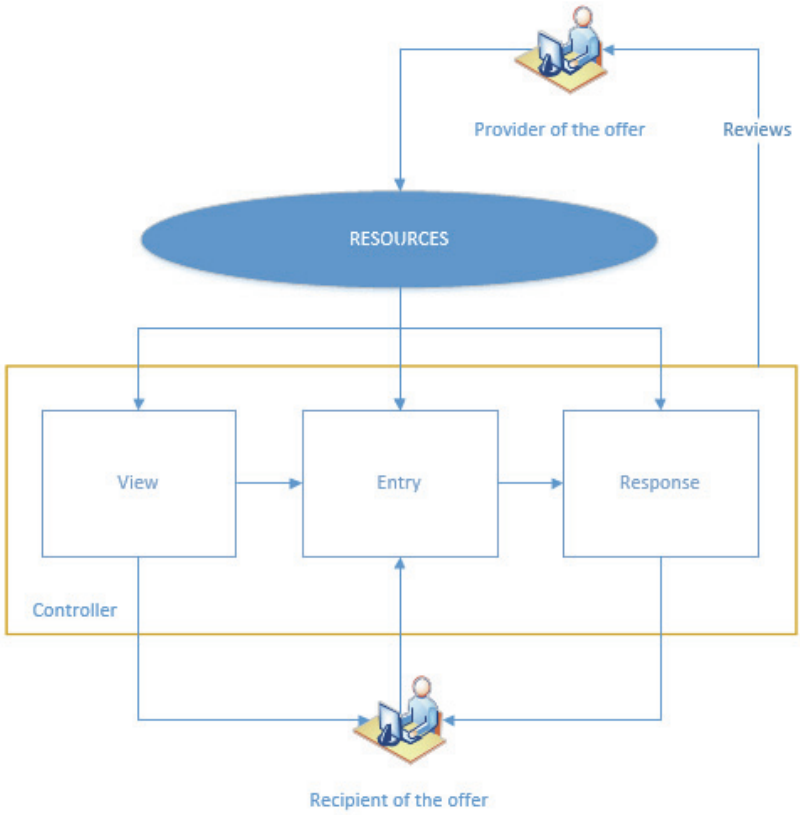

Figure 5.1. Feedback of knowledge sharing.

During the process of knowledge sharing, the users are expressing their proposals and adding reviews or suggestions for improvements of other proposals. This way, effective cooperation-oriented communication is established.

For this information system the following technologies are used - PHP, MySQL, CSS3 and HTML5. All data added by the user is managed and stored in the virtual server of the DigitalOcean.com database, which operates in the Ubuntu 13.04 operating system and is maintained by Apache2 web server program. To manage MySQL database, open source web tool phpMyAdmin is used. This allows to administer MySQL server and view commands and contents of the databases and tables via the use of the web browser. Information system provides access to databases from both the Windows as well as Unix operating system and from any web browser. The user interface is in Latvian. The usefulness and convenience are two distinct criteria (Hauser et Shugan, 1980; Larcker et lessig 1980). In 1986, Davis developed a technology acceptance model, basing it on the motivated action theory with the purpose to predict the acceptance of information systems (see figure 5.2.) (Davis, 1989).

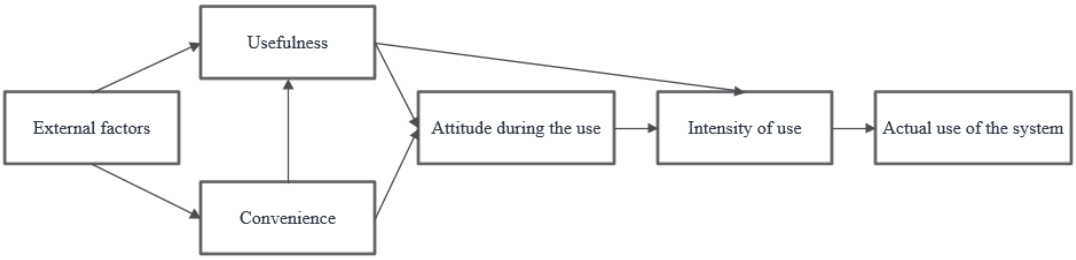

Figure 5.2. Technology acceptance model (Davis, 1989).

Variable external factors influence both usefulness and convenience, which in turn affects the system users' attitude, intensity of their activity and the actual application. The level of usefulness is assessed by how the user evaluates the level up to which his or her performance is enhanced by using the available opportunities. Convenience, in turn, relates to how easy it is to perceive the system. The interface of the prototype of the cooperation system eLine is designed in a simplistic manner, with more attention paid to its logical functionality, so that the final result is as useful as possible.

The wish of the user to use these technological solutions can be affected not only by interface but also such factors as previous experience with cooperation, internal and external motivation, available resources (time and financial means) as well as the functionality and security of the system (see figure 5.3). These factors have been identified as the most important ones, determining choice of the users to apply information and communication technologies in their everyday life as well as to share their knowledge and cooperate with others. Evaluation of factors is crucial to more thoroughly understand the acquired data and the intensity of the entry data as well as changes in the data quality. Without the entry data there can be no final data, which means that no feedback is received.

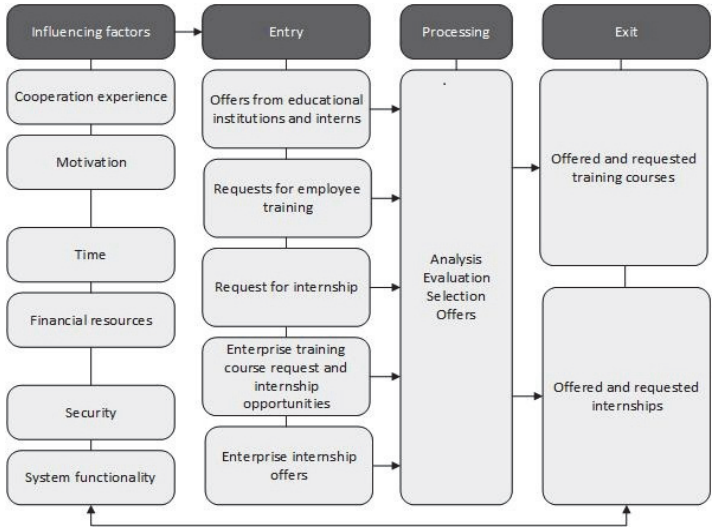

Figure 5.3. Factors affecting entry data of information system.

In order the information system is sustainable, attention should be paid to all previously mentioned factors. It needs to be ensured that, when the entry data is attained, the final data is received as quickly and precisely as possible. Technological solutions help storing, analysing, evaluating, selecting and preparing appropriate proposals that are then received by the interns/working individuals, educational institutions and enterprises.

5.2. EVALUATION OF THE COOPERATION SYSTEM SUPPORT FUNCTIONS

The cooperation system offers a platform for three user groups: potential interns/working individuals, educational institutions and enterprises. Classification of users allows flexible interaction with each user, creating additional features for each group according to what they may require. The content of published offers and requests is visible to members of all groups but adding owm enterprise or educational institution to the system is only possible with appropriate profile status.

When the user has created a profile in the system, it is then possible to register an enterprise or educational institution (see figure 5.4). Unregistered users can only access the following sections of the system: ‘home’, ‘about’, ‘log in’ and ‘register’. When registering, it is mandatory to mark the appropriate category, which can then be changed at a later stage. The registered users can access the following sections: ‘home’, ‘about the system’, ‘educational institutions’, ‘enterprises’, ‘learning’ (offers and requests), ‘internships’, ‘search’, ‘add an educational institution’ and ‘add an enterprise’. Every user from these groups can add an educational institution or an enterprise once the profile has been created. Potential interns/working individuals can add their requests in sections “internship requests” and “course requests”.

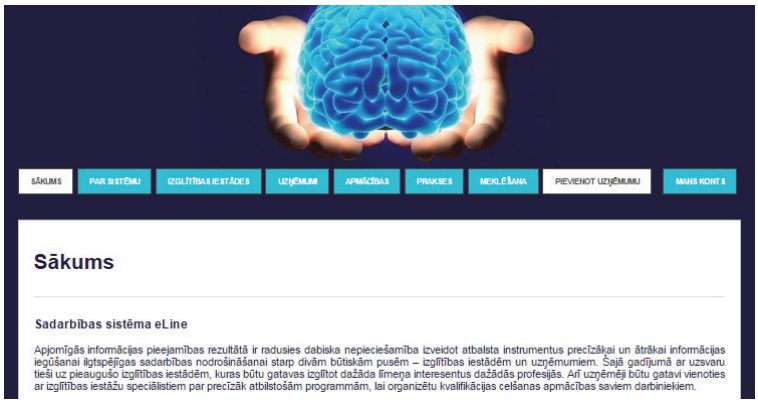

Figure 5.4. Cooperation system eLine.

Cooperation system user can delete or amend ownr profile at any point and can also search for offers and begin the cooperation process. ‘Search’ function allows separately finding the individuals, enterprises and educational institutions by using keywords.

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5.3. Analysis of the Pilot Project data

In order to evaluate the pilot project, users of the cooperation system were interviewed. In addition, experts in the field were invited to review the theoretical and practical findings of the research. During this phase, a hypothesis was proposed which suggesting that the motivation of users and their activity within the system framework as well as the level of cooperation and sustainability directly depend on the functionality of the system.

The usefulness, functionality, effectiveness, accessibility and sustainability of the eLine system was evaluated via questionnaires for system users. In total, 202 respondents participated. The target audiences of the research are educational institutions, potential interns/working individuals and enterprises. From all respondents 35 (17%) were educational enterprises, 83 (41%) were potential interns/working individuals and 84 (42%) were enterprises (see figure 5.5.).

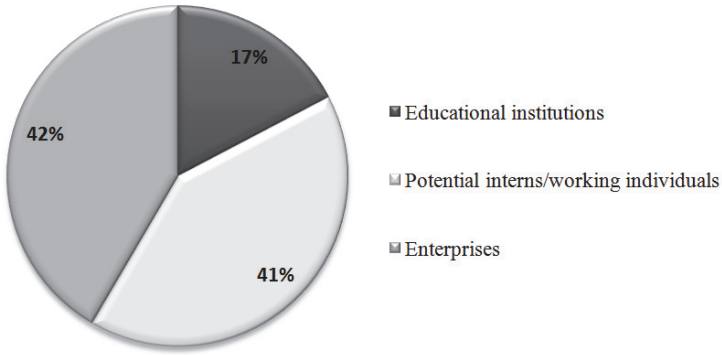

Figure 5.5. Percentage distribution of system user target audience.

The analysed data demonstrates that successful categorisation and easily accessible functionality ensures faster and more precise locating of the necessary information. On average, the usefulness of the cooperation system was most highly evaluated by potential interns/working individuals. The usefulness of determining levels of the required skill in scale from 1 to 5 where 5 is ‘very useful’, and 166 respondents answered with either 4 or 5 (82% of all responses). This target-audience group also evaluates the possibility to receive cooperation recommendations as prepared by the system most highly (see figure 5.6).

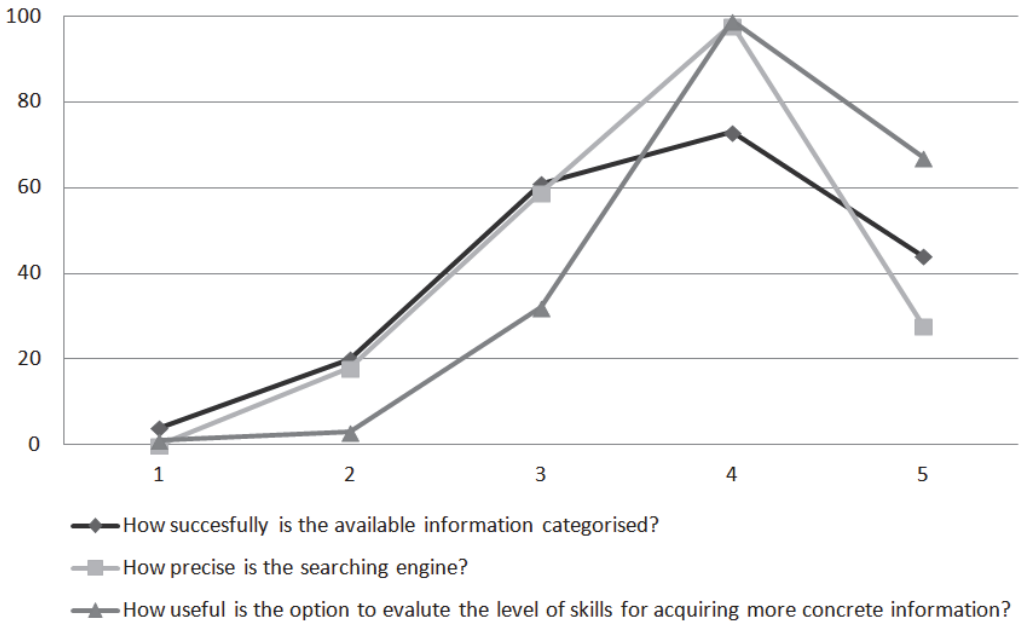

Figure 5.6. Evaluation of information categorisation and search result precision.

This shows that the potential interns/working individuals and enterprises are least interested in spending a lot of time on searching for opportunities corresponding to their needs.

Respondents were also asked to evaluate their motivation to use this type of cooperation systems. One or several answers were allowed. The total number of responses was 414. Most respondents (41%) indicated that they would like to follow the updates of new opportunities and requests, 19% stated they would like to add new course requests, 16% - to add internship opportunities, 12% - to add internship requests and 12% - to add training opportunities (see figure 5.6.).

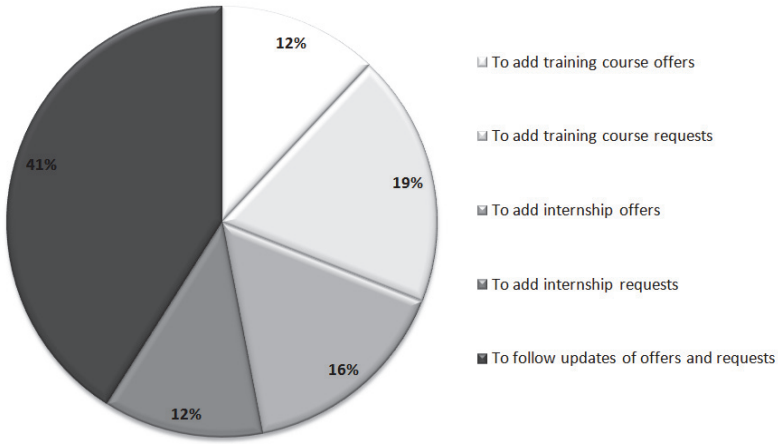

Figure 5.7. Percentage distribution of user-motivating activities.

It is possible that the acquired data is distributed in this way since more enterprises were interviewed than educational institutions. Potential interns and working individuals have also expressed their wish to add their requests. The number of users indicating that they would only wish to follow news updates is very small and thus alloes to conclued that most users are willing to get involved.

The potential knowledge sharing activity in the system is evaluated as high by most respondents, predicting that the educational institutions would be the most active ones. In the trilateral knowledge sharing model both motivation of all those involved as well as mutual trust are key. It seems to be the case, that the level of trust for the enterprises regarding their potential partners is slightly lower than the level of trust of educational institutions and potential interns/working individuals. However, since it is not a negative number, this indication is not critical. Considering the opinions of current prototype users allows to evaluate important factors that may affect the system in the future. After processing statistical results, recommendations have been developed for the use of a more individually oriented, automatic cooperation system for the potential interns/working individuals, educational institutions and enterprises.

For purposes of the research, the author has chosen to involve experts of the field to evaluate the knowledge sharing model and the prototype of the cooperation system. The selected experts are both from Latvia and abroad, all having an appropriate knowledge base, practical experience in further education and information systems related projects, as well as working in senior positions at different enterprises or educational institutions. For foreign experts, a description of the general knowledge sharing general and cooperation system prototype was prepared in English. As to selection of the experts, criteria proposed by Dzidra Albrehta were used (Albrehta, 1998). Coefficients of the experts' competencies were determined by their working experience (both academic and professional), education and experience in business environment, management of further education and development of information systems.

To evaluate the knowledge sharing model and the cooperation system, 10 local and 2 foreign experts were selected:

- Marina Skļara – an expert in professional education and e-solutions, founder of Baltic Video Art (master's degree in Economics);
- Raitis Roze – deputy director in a public institution of Ventspils municipality "Ventspils Digital Centre" (master's degree in IT and a master's degree in Business Management);
- Jānis Letinskis – Chairman of the Liepaja university board of Science and Innovation Park (master's degree IT didactics);
- Ainārs Sviklis – Head of Information and Communications Technologies (ICT) at the ministry of Education and Science (master's degree in project management);
- Māra Jākobsone – Vice-president of the Association of ICT of Latvia (PhD in Economics);
- Egons Spalāns – Deputy head of Ventspils City Council for ICT (master's degree in Engineering);

- Gatis Ozols – Head of the Electronic Services Department at the Ministry of Environmental Protection and Regional Development (master's degree in Business Management);
- Salvis Roga – Chairman of the Board at LLC 'Business Incubator Kurzeme' (master's degree in Business management);
- Antra Skinča – Head of the Information Resources and Technologies at the Zemgale region Development Centre for Competencies;
- Kārlis Dimza – Expert in intelligent agent development at LLC Tilde (master's degree in IT from National Tsing Hua University, Taiwan);
- Weston Hankins – Co-founder of WunderAgent UG lin Berlin (master's degree in Engineering, Western Institute of Technology (ITESO), Mexico);
- Athanasios Podaras – Researcher at the Technical University of Liberec, Czech Republic (PhD in Engineering).

Questions to the experts were tailor-made to their individual experience and the field they are working in (annex no. 7). The overall evaluation of the knowledge sharing model and cooperation system's prototype is positive. No substantial errors were identified by the experts, but some ideas were proposed for the improvement and development of the model and the cooperation system. All experts have indicated that the theoretical and practical results were important for facilitation of sustainable cooperation between educational institutions for adults and enterprises.

As stated in Chapter 4, satisfaction of users with the system can depend on both the base process of an activity, as well as the quality of support processes. It is crucial that the processes are easy to percieve for all those involved.

Results of Chapter 5:

1. Requirements for the development of the cooperation system prototype and support functions are described.
2. Data analysis of the pilot project is carried out using statistical analysis of interviews with the users and reviews of the experts.

Main findings of Chapter 5:

1. Users of the system are the main driving force for the development of the system functionality, therefore the interface is particularly important for the prototype. It has to be intuitively easy to comprehend, not take a lot of effort to use and be straightforwardly useful.
2. Evaluation of the user activity is important to understand data flow intensity and changes in quality more accurately as well as to obtain feedback.
3. The opportunity to express the need for and offer opportunities increases the motivation to share users' needs and wishes. In addition, motivated participation of the users could establish a sustainable cooperation.
4. Quality provision should include the context, the content, the process and the results, putting emphasis on the results of bothknowledge sharing and cooperation.

CONCLUSION

Conclusion consists of 6 pages.

The aim of the thesis was to theoretically justify and develop a knowledge sharing model to promot a sustainable cooperation between adult educational institutions and enterprise. The aim includes innovative methods and a web-based automatic cooperation system.

To achieve the aim, the following **specific tasks** were realized:

1. A literature review was carried out to analyse similar information systems that promote cooperation; guidelines for adult education in Latvia and Europe were reviewed as well as main theories of system analysis, modelling and project design was created.
2. Methods and technology for sustainable cooperation between potential trainees/working individuals, educational institutions and enterprises were described.
3. Current situation with knowledge sharing motivation for sustainable cooperation of educational institutions and enterprises was determined as well as possible improvements of sustainable trilateral cooperation promotion.
4. Approbation data of the cooperation system was attained, systemised and evaluated and a cooperation system model was created.
5. Recommendations were developed regarding the use of an individually oriented cooperation system for the potential interns and working individuals, educational institutions and enterprises.

The following methods were used for approving the proposed premises of the research:

1. Design of a knowledge sharing imitation model and evaluating simulation data to verify and identify relation between information access to the user and promotion of sustainable trilateral cooperation between the potential interns/working individuals, educational institutions and enterprises.
2. Design of a cooperation information system prototype on a base of an algorithmic model, in order to test functionality of an automatic information system.
3. Evaluation of the pilot project via 12 expert interviews and analysis of statistical data obtained in 202 questionnaire responses in order to review the premise that user motivation and activity within the system is in direct correlation with the system functionality. The experts for the evaluation were selected by using selection criteria proposed by Dzidra Albrehta.

Carrying out the tasks of the research, the following **theoretical results** were achieved:

- Research and analysis carried out for purposes of the thesis justify that process imitation modelling and the designed information system prototype is topical for the general public and useful for knowledge sharing and promotion of trilateral cooperation.
- Imitation model of knowledge sharing describes relation between potential interns/working individuals, educational institutions and enterprises, data and processes.
- Conclusions and suggestions of the thesis are important for promotion of sustainable trilateral cooperation in further education.

Carrying out the tasks of the research, the following **practical results** were achieved:

- Imitation model of knowledge sharing allows to analyse and predict the potential knowledge sharing activities of the interns/working individuals, educational institutions and enterprises. If the model is adapted and modified, it can also be used for analysis of business process.
- All three actors involved benefit directly from being involved since they receive an additional information for commencement of cooperation and as a result gain useful knowledge for a successful career, obtain new, field-specific studying modules or attract competitive employees for development of innovative business product.
- Cooperation information system eLine prototype can be used in practice as a promotional tool for knowledge sharing and cooperation between all involved actors.

Novelty of the research:

- Factors and criteria affecting the intensity of knowledge sharing and levels of cooperation have been identified allowing to assess the existing situation and predict the potential future developments.
- Imitation model for knowledge sharing was designed, which allows to analyse motivation of the general public as well as the activity between interns/working individuals, educational institutions and enterprises.
- Cooperation information system prototype for trilateral cooperation has been designed, which makes a positive impact on development of knowledge-society, with an emphasis with immediate and easy-to-achieve benefits (saving time, financial resources, access information, improve communication skills, participate in social life and to increase own competitiveness in the labour market).
- Algorithmic knowledge sharing model for knowledge sharing and improvement of trilateral cooperation was designed.

Cooperation of all involved sides, knowledge and experience sharing will help to achieve the set aims on regional, national and European (European Commission) level (LR Saeima, 2015; Ministry of Science and Education, 2013; European Commission, 2011).

Conclusions and Recommendations

1. Development and modification of available methods and technologies increasingly affect development of sustainable information society and determine educational tendencies thus also affecting the specificity of adult education.
2. Nowadays, it is impossible to retain competitiveness in the professional environment, unless the existing knowledge and skills are enriched and enhanced, which is why further education is becoming more popular.
3. All forms of education are equally important and mutually supplement each another thus enriching the learning culture and experience as well as broadening the educational environment on individual and societal level.
4. It is pivotal to focus on changing market conditions constantly and apply technological solutions that are easy to comprehend, promote a sustainable cooperation between adult educational institutions and enterprises, and attract potential interns and working individuals.
5. All involved parties must be aware that successful cooperation requires not only ensuring successful technical communication but also active participation and time in order to obtain mutual trust. This is why this model has been designed for a long-time cooperation support and promotion.
6. Educational institutions need to be aware of needs of enterprises in educational sector and enterprises need to be familiar with functions of educational establishments.
7. In the case of the established knowledge sharing model and cooperation information system prototype, it is crucial to evaluate those particular factors influencing the knowledge sharing precision, cooperation intensity and changes in quality, all of which affect user motivation and activity in the system.
8. Evaluation of factors affecting the user activity is crucial for successful review of received entry data flow intensity, changes in quality and feedback.
9. Quality provision should include the context, the content, the process and the results, putting emphasis on the results of bothknowledge sharing and cooperation.
10. Opportunity to express more precise requests and receive offers increases motivation to share needs and wishes. In addition, motivated involvement of the users ensures a sustainable cooperation.

11. Judging only by observations, it is easy to make mistakes during the modelling process, which can only be detected in numerously repeated simulations and experiments with the set conditions.
12. It is not necessary to measure everything possible - the number of controlled parameters is not crucial. What is crucial is how the obtained information is used in decision-making.
13. Imitation model allows to conclude that introduction of a cooperation system for modern knowledge sharing is significant. Success of the cooperation system largely depends on a well-designed initial information flow model, on both strategic and operational level.
14. Users of the system are the main driving force for the development of system functionality, therefore the interface is particularly important for the prototype. It should be easy to comprehend intuitively, not take a lot of effort to use and be straightforwardly useful.
15. When creating information systems and computer programs with the use of intellectual agents, more opportunities to motivate the users of the system appear, especially for those who are not certain about their needs, since these agents provide an advice regarding most appropriate options and individualised development scenarios.
16. It is possible to evaluate the benefits of the agent-based cooperation system if there is a large amount of user accounts and high activity of all actors involved.
17. Based on the theoretically justified model and the designed technological solution, the cooperation system ensures the innovation transfer, sharing of latest knowledge in order to promote the industry's competitiveness and regional development.

Summarising the theoretical and empirical conclusions of the thesis, it can be considered that the aim of the doctoral thesis has been achieved. The results of the thesis show that the applied information technologies play an important role in knowledge sharing and cooperation-promoting activities. The outcomes of thesis provide a basis for further studies associated with the knowledge sharing, promotion of cooperation and design of support technologies.

Possible future strands of research

The most important result of the research on both theoretical and practical level is the knowledge sharing imitation model, which allows to analyse and predict the behaviour of the involved actors, the activity of the knowledge sharing and motivation for cooperation. Identifying further strands of the research, the author concludes that more research is needed on factors that motivate and hinder that involvement. Summarising general user comments on the system, it was mainly emphasized:

- A more user-friendly and modern interface is needed with an option to log in with a social-network account. Improvements should be made to benefit as many people as possible.

- Meaningful cooperation is only possible if there is a sufficiently large number of registered users, requests and offers. It is pivotal to achieve the critical number of users in the system, which would allow to test and use all technological solutions available.
- A mobile version of the system is necessary for more convenient use with a tablet or a smartphone. One fourth of all respondents have indicated that they mostly use smartphones or tablets in search for information.

When developing the cooperation system functionality, it is necessary to work actively on the use of agents in information exchange between all involved parties in order to provide self-development of the information system. In the long run, the cooperation systems will allow to evaluate what events (interactions) between system users bring about changes and new knowledge and generally improve a product (program, internship vacancy) or create something new (methodology, approach). In this case, the methodology described in the thesis and the designed technological solution will be further improved. Choice of QPR ProcessDesigner business management tool for examination of knowledge sharing and cooperation processes was not accidental. It allows to analyse and predict user behaviour and activity of knowledge sharing also in the business world for a long period. To ensure the model stability, it should be monitored to assess whether it does not becomes self-destructive. In addition, its integration with medium and long-term industry models, human resources models and territory development planning models carried out by public administration institutions should be considered.

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