Digital Business Ecosystem Prototyping for Agri-food SMEs

Miklós Herdon[1], Ádám Péntek[2], László Várallyai[3]

University of Debrecen, Hungary
[1]e-mail: herdon@agr.unideb.hu. [2]e-mail: Adam.Pentek@agr.unideb.hu,
[3]e-mail: varal@agr.unideb.hu

Abstract. There are many fields of application in the agro-food industry where interoperability of information system would be essential. Amongst others food tracking and tracing, logistics, Supplier Relationship Management (SRM) and Customer Relationship Management (CRM) integration all need interoperability solution in a heterogeneous environment. In order to carry out a successful research on this topic, we studied the „Open Source" Information and Communication Technology (ICT) solutions and tools that can be applied by the Small and Medium-sized Enterprises (SMEs). Furthermore, based on the researched technologies and systems, we assessed the electronic business activities of the Northern Great Plain Region of Hungary. Based on the results of the survey and analysis (variance analysis, cluster analysis, LISREL models) we pointed out other key information and we proposed an adequate solution system that uses open source solutions for the SME through the development of a prototype based on a Digital Business Ecosystem (DBE) concept.

Keywords: business ecosystem, information systems, agri-food, SME

1 Introduction

The ICT technologies are present in every area of life. They have become important production resource for the enterprises. In this aspect, the situation of the SME is difficult, as the utilisation of these technologies does not reach the desired level neither in Hungary, nor in the European Union. The SMEs have a difficult time adjusting to the integrated corporate information systems developed for the use large enterprises. Moreover, the systems developed for the SME market (especially systems produced by developers) do not make possible the accomplishment of inexpensive and flexible inter operational business relationships between the small enterprises. As SMEs are decisive factors for the economy of every country, many enterprises spotted the potential market in this segment. Unfortunately, these systems

In: M. Salampasis, A. Matopoulos (eds.): Proceedings of the International Conference on Information and Communication Technologies
for Sustainable Agri-production and Environment (HAICTA 2011), Skiathos, 8-11 September, 2011.

cover primarily the internal processes within the enterprise, so they do not provide enough support for the relationships and processes between the enterprises.

In general, integrated information systems ensure the integration of the suppliers and buyers (clients) into the business' own systems (communication). However, in case the companies used different information systems (from different vendors) in order to get on-line (real-time) connection they required special developments. Small and medium-sized enterprises which have implemented enterprise information system recognized that this system does not provide them with interoperability. The collaborative concept to achieve the particular case of SMEs may give benefits and ensures the appropriate use of different kind of Toolsets can provide interoperability. Our goal was to facilitate the implementation of the Digital Business Ecosystem concept modules, which allows existing systems to get access to the common marketplace more easily.

2. Research goals

The EU affirmed that new technologies need to be developed and implemented that can successfully used by the SMEs in their daily electronic business activities. In order to carry out a successful research on this topic, we wanted to study the „Open Source" ICT solutions and tools that can be applied by the SMEs. Furthermore, based on the researched technologies and systems, we would like to assess the electronic business activities of the Northern Great Plain Region of Hungary.

The analysis of the data gathered through our research, based on which we would like to assess the attitude of the SMEs of the Northern Great Plain Region of Hungary in relations to ICT solutions.

The development of a prototype, based on the existing technologies, methods and results of the analysis carried out at the enterprises of the region; a prototype that uses accessible free solutions through which the digital market space of the SMEs can be extended.

The theme of the research is in part defined by the Internet standards, e-commerce regulations and developed practices and regulations. Therefore one of our main objectives are to process, systemize and analyse from our theme's point of view the technological regulations and practical solutions pertaining to our theme.

The small and medium enterprises are not able to invest lot of money into studying the ever-growing Internet technologies and selecting the ones that could be useful for their business activities. At the same time implementing and using the newest technologies are keys to maintaining and improving one's competitiveness. Therefore our objective is also to present the technologies that are to be used when implementing the suggested prototype. To evaluate the conditions (e-preparedness) under which the new technologies can be applied we carried out a survey, in order to analyse the digital business communication of the small and medium enterprises of the Northern Great Plain Region of Hungary in 2010.

Based on the results of the survey we proposed an adequate solution system that uses open source solutions for the SME through the development of a prototype based on a „Digital Business Ecosystem" (DBE) concept. In relation to the above we

have set as objective the development of a „hub – share centre" prototype portal aimed at gathering information and publishing it to the respective enterprises and experts.

2 DBE concept and tools

The Digital Business Ecosystem is an evolutionary, self-organized system, which can contribute to the sustainability of the local and regional development through a well-defined software platform. Moore first introduced the concept of a business ecosystem as a strategic plan (Moore, 1993). Moore indicated that organizations form a part of a business ecosystem and as such they should be viewed as a collective rather than an individual entity. The idea of the Digital Business Ecosystem is "to create an integrated, distributed pervasive network of local digital ecosystems for small business organizations and for local e-governance which cooperate exchanging dynamically resources, applications, services and knowledge." (Nachira, 2002). As envisioned by Nachira, the DBE is intended to foster new and flexible ways of co-operation and networking through a dynamic aggregation and self-organizing evolution of services and organizations by means of open-source methods of software and service creation. According to Nachira (2005), the key elements of a business ecosystem (top-most layer) include 1) governance, regulations and industrial policy, 2) human capital, knowledge and practices, 3) service and technical infrastructure, and 4) business and financial conditions.

The idea of a technology (or industrial) ecosystem has been used to describe relationships between technologies and organizations (Adomavicius at al, 2007). As an example, consider the specific ecosystem view, which had laptop computers as the focal technology and the wireless networking capabilities as the context. The framework is based on a laptop-related Wi-Fi technology ecosystem, but business ecosystem evolves participants to a new landscape (Li, 2009). Another more comprehensive demonstration of the analytical approach is an ecosystem model of technology evolution facilitates by focusing on the digital music industry (Adomavicius at al, 2007). The interoperability focuses on inter-enterprise distributed business processes and flows. According to IEEE's definition (IEEE, 1990), interoperability represents "the ability of two or more systems or components to exchange information and to use the information that has been exchanged". Application integration (comprising message, process, transport and interface) represents the technological part, while information integration refers to the linguistic, social and philosophical solution (comprising data, context, ontology and interpreter) (Peltoniemi and Vuori, 2004). By integration we mean the cooperation of processes and applications at the event and message levels while multiple systems become one logical unit (Chituc, 2007).

The very important point is the issue of the interoperability. The aims of the INTEROP project were to harmonize and synthesize existing researches around new, flexible and adaptive architectures of the interoperability, - such as the model driven approach, service-oriented architecture approaches, peer-2-peer architectures, agent architectures and federated architectures (Panetto at al, 2004). A P2P network is built

of interconnected smaller networks which are the result of long-running transactions corresponding to automated (B2B) business activities (Pappas at al, 2007; Razavi at al, 2009). ERPs for SMEs do not have such wide of range functions as ERP II which is for a organisation but many basic functions are necessary for the interoperability features with other SMEs in the DBE (Fig. 2.). An example for creation of a DBE for the shoe domain which requires a reliable and secure communication infrastructure among SMEs describe by Chituc at al (2007).

Interoperability is a multidimensional problem that can concern different layers of the enterprise (Salampasis at al, 2005; Tektonidis at al, 2006). The above mentioned problem is mainly caused by incompatibility in the information representation and in the adopted software application methods (Jardim-Goncalves at al, 2006). Information /knowledge interoperability has to focus on the following aspects: information/knowledge representation and management, learning ability, rights to access information, knowledge sharing, aspect related to adaptation and recombination of knowledge in a collaborative network during its life-cycle. The Framework for Enterprise Interoperability (FEI), which is currently under standardisation (CEN/ISO 11354) defines a classification scheme for the categorisation of knowledge for interoperability in the line of three dimensions: interoperability barriers, interoperability approaches, and enterprise levels (Naudet at al, 2010). The technical architecture of KodA is based on SOA and subsequently consists of three basic layers: business process management layer, business services layer, business application layer. In food tracking and tracing system we have to create a communication channels among partners (Manicas and Manos, 2009; Manicas at al, 2010) The KodA focuses on the supply chain for processing food products which was communicated and discussed at different forums. This has resulted in establishing the agriXchange group that has the objective of harmonizing agricultural data exchange on a European level (Wolfert at al, 2009).

3. Research methods

The methods and tools of the electronic business technologies (e-business) and the Information and Communication Technologies (ICTs) pertaining to business applications. The activities accomplished through e-business mean both the e-commerce transactions (procurement, acquisition, sales) performed in the B2B (Business to Business) relations, as well as implementing ICT technology for the internal and external business processes with the proper IT support. The business opportunities offered by the e-commerce and the Internet reach beyond the earlier solutions. They contain new and constantly changing possibilities with their direction changing dynamically, but their impact being sensed in our everyday life. The technological pressure generated by the Internet presents the enterprises with new challenges day by day. It is not easy for the company leaders to adapt the ever changing Internet to their existing systems in order to achieve the strategic goals of the company.

On the electronic market appeared not only businesses but the private as well as state sectors with the aim to carry out their internal and external business transactions

in electronic form, through the Internet. Multinational companies – as they were the first ones to step into the network – forced and are still forcing all other participants of the business sector to perform their business transactions in this way. Connecting to these systems that have great resource requirements is a great burden for the small- and medium enterprises (SME).

The starting point of the analysis was in-depth professional interviews and consultations were pivotal to preparing the case studies. The professional interviews provided vital and direct background information that helps understand the examined topic. Thus the validity of the gathered information was not only supported by the quantity research but also by primary type quality research as well.

As the result of the professional interviews and primary research we have prepared the appropriate questionnaire with the aim of analysing the digital business communication of the small and medium-sized enterprises of the Northern Great Plain Region of Hungary. The professionalism of the questionnaire was checked by professional-, and it's interoperability by 20 randomly selected control groups. We have amended the questionnaire based on the feedback of the control groups. As target group for the research we have considered all existing small and medium size enterprises that are based in the Northern Great Plain Region of Hungary.

In order to support the survey, an on-line version of the questionnaire was prepared with the help of the Lime Survey software system. The survey was needed for the research to set up in a way so that the audience could answer the essential questions regardless of their professional background. As there aren't holistic and accessible statistics about this period on this topic, we wanted to scan the actual status of the region through the help of the survey. Purpose of the research was to have the following questions answered:

What type of IT infrastructure do the SME of the Northern Great Plain Region of Hungary have? To what extent do they take advantage of the new software technologies that appear on the market? What is the degree of importance of the different info-communication tools at the given „connection points" during day to day operation? What is the mental attitude of the given SME towards the ICT tools? What is the level of ICT preparedness of the SME of the Northern Great Plain Region of Hungary? What percentage of the yearly revenue is designated to maintain their IT systems?

We selected 750 companies that we approached in person and/or per telephone. Of these, 250 were willing to fill out the questionnaire. We have mailed the questionnaire to them and 210 were returned by deadline. Some of the questionnaires that were sent out were filled out on-line through the research server of our faculty. Based on this, the 210 responses meant that the willingness to respond was over 25%.

As the survey encompasses 15 questions and 17 question blocks (224 questions altogether), we have reduced the questions – with the help of the main component analysis – into 22 components. As aim of the main component analysis is to expose the background variables (dimensions) that control the variables in a way that the variables that are connected with each other are gathered into a main component, we have gained data that was easier to handle without substantial loss of information. Moreover 2 quantitative and 4 qualitative characteristics were preserved. On the resulting main components we applied the Variance Analysis and built 2 LISREL

(Linear Structural Equation System Involving Multiple Indicators of Unmeasured Variables) models. Beside this we tried to point out other key information with the help of cluster analysis.

Our method of approach was to draw general conclusions about e-business and observe trends based on considering and systemizing both the theories revealed in the first part of this work as well as the knowledge gained from the interviews and survey (inductive approach).

4. Results of survey

With the help of variance analysis we were looking to find the differences in the attitude of the SMEs based on their answers, while grouping them based on specific criteria. Using cluster analysis we have examined the areas of connective operation that companies should concentrate more on. With help of LISREL models we examined the factors that impact the use of the community applications and the factors that impact the increase of the on-line sales.

4.1. Differences in attitude of SMEs

After performing the analysis we have made the following main observations.

No company, regardless of category, makes use of the advantages offered by the gathering pages and free on-line voice transmission solutions.

In companies with low revenues the spread of the ICT products is hindered to a greater extent, when compared to others, by

- lack of sufficient IT expertise of the employees,
- the fact that they do not know the services provided,
- employees handle the tools with difficulty.

Personal referral is an important factor in every category, but it is relatively of most importance in services, constructions and commerce.

Short and long term profit, as a goal is important in every sector, with the relatively highest role in the group of commerce and other industrial enterprises.

There was a sensible difference in how companies viewed the potential business impact of the gathering pages and free on-line voice transmission solutions. In case of the industrial sector these applications have a relatively lesser role compared to the agricultural sector where their role is relatively great.

The role of company website and web shop is significant in the commerce and in the other industrial enterprises sector.

The spread of the ICT products is hindered to a greater extent by the lack of sufficient IT expertise of the employees, their lack of knowledge about the services provided, and the fact that they handle the tools with difficulty in agriculture, commerce and industry and seems to be less of a problem in the area of services.

The IT development increases in direct proportion to the increase in the number of personnel. Searching and browsing is relatively high in companies with 11-250 employees.

The spread of the ICT products is hindered to a greater extent by the lack of sufficient IT expertise of the employees, their lack of knowledge about the services provided, and the fact that they handle the tools with difficulty in companies with less than 50 employees.

4.2. Analysis the types of communication

To determine this we have inserted questions into the survey to reveal who is the communication partner for the given company. We have made a distinction between internal-, customer-, and vendor communication. Once providing these three forms, we have defined the form and purpose of communication. We then created the three tables that provided an easy possibility for the experts of the different companies to give an answer. After the survey was completed and the answers systemised through cluster analysis, we were able to determine the communication areas that the enterprises should also consider based on their existing preferences. We have conducted the analysis for each sector separately and illustrated the results on the Fig 1. Below is the description of the three part connotation for the proper interpretation of the diagram: **XYZ**

X: Communication Channel: SZ: personal, T: telephone, E: e-mail, H: Internet voice solutions, F: forum, K: Community platforms, I: Information system based

Y: Other party (With whom I am in contact): B internal, Ü: customer, S: Vendor

Z: Name of business process: G: gathering information, É: inquiry, A: requesting an offer, M: ordering, F: payment, S: services

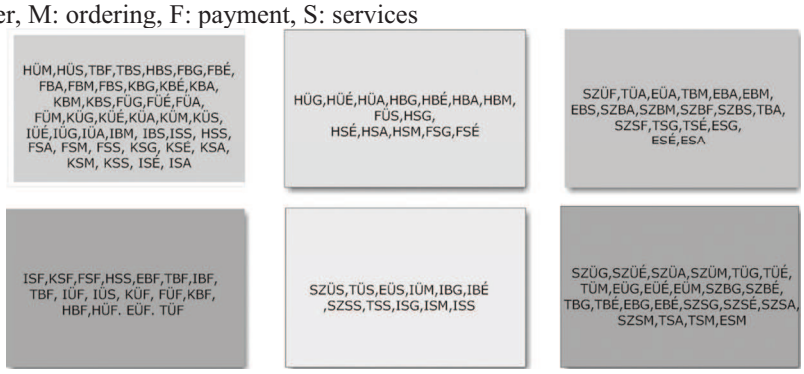

Fig. 1. Cluster analysis for the agri-food sector

The following conclusions can be drawn through cluster analysis. Any enterprise, once the sector of activity is defined, has to find the communication channels listed on the diagrams that are considered to be important (For example the information gathering done via E-mail (EBG)). Once the appropriate clusters are defined, they can then find within the clusters further methods that could be important for their business. From these, only the existing ones are worth improving.

4.3. Impact factors for e-sale

We developed two LISREL models aiming to examine the factors that impact the use of the community applications and how they impact them, as well as the factors that impact the increase of the on-line sales.

In the case of both models the GFI value shows an over 0.8 value that proves the validity of the model from a statistical perspective. After analysing the completed models we were able to draw the following conclusions.

There is an increase in importance from the business perspective of the internet community market spheres, the B2C and C2C market spheres and of the community platforms.

There is a decrease in importance from the business perspective of the internet community market spheres, the B2C and C2C market spheres and of the community platforms, if the main goal is cost reduction, because the introduction of a new technology at corporate level definitely implies an increase of expenses in the first stage of the rollout.

From business perspective the personal community spheres are important in case the goal is to increase the on-line income. Not overly surprising is their expectation that these spheres will help improve their image and lead to cost reductions. Of course maintaining and updating such sites demands time and energy, therefore the businesses need to invest money in it.

The information sharing community portals are advantageous for those businesses that consider searching and browsing to be important by default. They are considered to be important by the businesses that believe that more on-line presence will lead to an increase in both short term and long term profit. Furthermore they are considered to be important by those businesses that believe that such spheres will help improve their image and lead to cost reductions.

4 A Prototype Solution and Possible Application Domains

Applications based on DBE philosophy can be used in many places. As it can be seen in the figure (Fig. 2) the data are stored in individual peers separately and there are DBE servers which require data from these peers. This structure of the data storage creates the possibility that all of the data owner store own data securely and the data are send only to an appropriate request by a duly authenticated server. This method is very advantageous in many ways.

The Fig. 2 shows that many master servers can be implied in the ecosystem and the peers can connect to them.

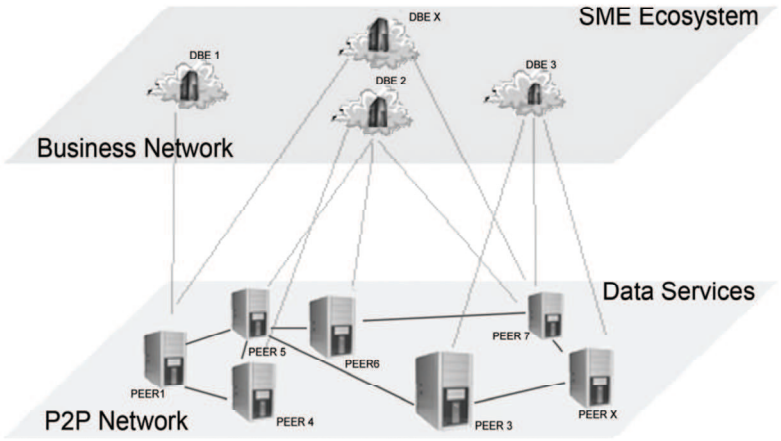

Fig. 1. The DBE model

Since it is designed in a way that a peer can connect to more than one main servers the data modified in one place (maintained) can be displayed in several places (servers). The contact between peers and servers are made by XML, so a peer can connect to any of this ready-made ERP for accepting the request to join.

With our prototype solution the SMEs can provide safe, transparent, direct services to potential customers. According to the Client-Server architecture, all data are stored on an assigned server. This can provide great advantages for the server's owner. Our vision is based on P2P SOA technology and all components are written with Open Source tools. In multi-agent systems, the underlying networks in a Digital Business Ecosystem are always dynamic and network topologies are always changing over the time.

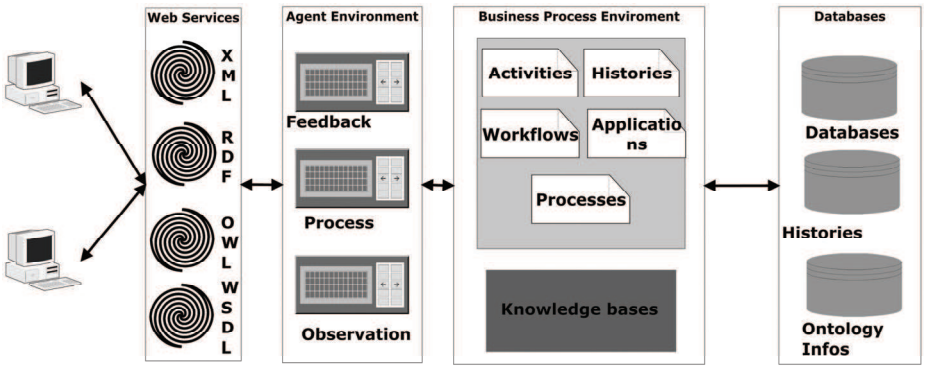

Fig. 3. Layered model of the prototype

The main server is always able to work, but the other habitats sometimes are up or down. The P2P communications are working via OWL (Web Ontology Language),

WSDL (Web Services Description Language), XML, RDF (Resource Description Framework) technologies (Fig. 3).

The Fig. 4 shows the structure of the database and as it can be seen in the portal it is made up of modules. Some modules are compulsory (example user or log), and others are optional. The peer tables are installed on the peers. The peer-specific offerings are stored in these tables, which are downloaded to the portal after the site selection process. The other tables are located in the main server (portal). These tables help to communicate, sharing the knowledge, blogging, etc. (Fig. 4)

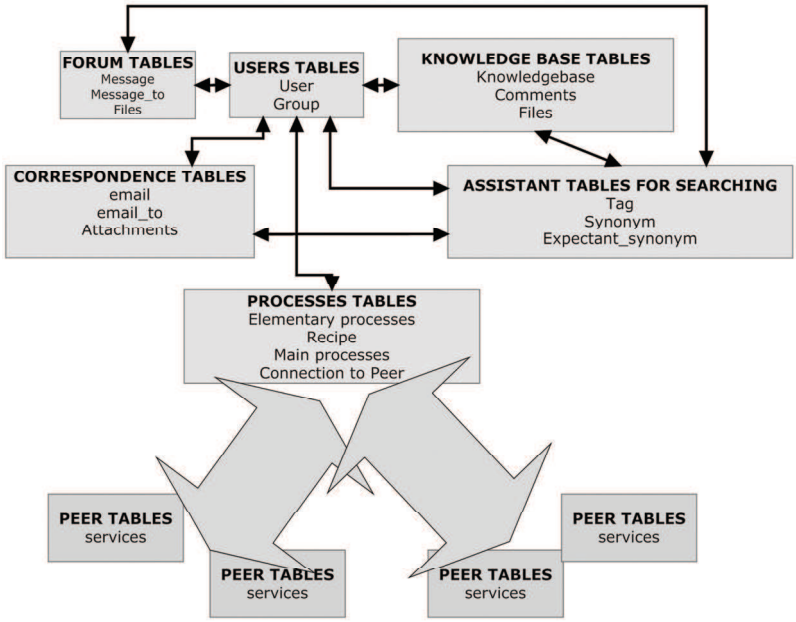

Fig. 4. Database structure of the prototype

4.1 Applications in (agro) tourism

We believe that it is worth to capitalize the potential of the DBE philosophy in much more fields. Our prototype can assist that kind of businesses which are able to join to any value chain. For instance the typical good application area is the tourism management, especially the destination management.

Many SMEs who work variety of business activity can join to the value chains in tourism sector. These SMEs can create value chains according to community principles and find our places within the value chain. Additional services make the site to become more useful for the members of the community and for the potential costumers as well. The different types of knowledge basis which are characterized by meta-data attached to each other and to adequate part of the value chain as well thus extend the usefulness of the portal. Because the most of enterprises already use

different ERP system or at least their data are stored somehow. To get out the problem of the duplicate storing, we offer the opportunity supplying the data from their own database with the help of XML technology. With the XML technology the companies without any particular investment can join to the DBE community and they can find new markets, knowledge and community.

4.2 A prototype tracing solution in the agri-food sector

The food chain traceability are more and more important (Herdon and Füzesi, 2011) and it could be based on DBE solutions. One of the most important properties of this method that all data is stored in the owner database and the data is served if it is requested by the authenticated DBE server. All connected nodes have own database are stored in their own database server. Forasmuch many organizations have exiting information system (ERP), where they store the necessary data. We assure possibility to connect other existing systems to the DBE by XML technology (We use the portability property of the XML).

The database structure is available for download and use. In case of the traceability the XML file contains the following information: Company name, TRU (Traceable Resource Unit) identification number, Output id., Input id. In addition, we need a web server where the portal software is running. The portal was prepared with open source tools according to DBE principles. The prototype system is suitable for both top-down and bottom-up tracking and tracing.

With this prototype we have an opportunity to trace the full path of life of the product, if only all participant have been joined to the community. The above solution can greatly facilitate the precise monitoring the flow of substances occurring in food. Thus, the appearance of any food safety hazard we have opportunity to achieve rapid and efficient product recall.

Conclusions

Enterprises are faced with new challenges as they try to keep up with the continuous technological changes. The decision makers of the enterprises are in a more and more difficult situation trying to figure out which systems they should integrate into their existing systems, and which ones they should introduce in order to support their business processes. We have carried out our research along these questions. The results of our research have proven that the introduction of modern IT solutions could significantly enhance the business opportunities of the SME, and they could thereby ensure for themselves a sustainable presence in the on-line segment. Of all the results of our research, we would like to highlight the following.

Utilising the main component and variance analysis methods, we have grouped – based on the answers to the survey - the communication directions and types according to importance. The survey makes it possible for the SME to identify the useful, yet unused communication forms, and develop their communications portfolio along these forms.

Using the method of variance analysis we have observed that although considered as very important by the private sector, the advantages of the free on-line voice transmitting solutions and of the gathering pages is not being exploited by the SME.

We have prepared 2 LISREL models, through which we have concluded, that the on-line market spheres, the B2C, C2C community spheres are important for the businesses that would like to avoid leeway, are interested in long-, and short term profit increase and those that recognise that training of the employees and getting them familiarised with new technologies, methods and procedures is very important.

We have designed and created a prototype system that can be used for the set-up of digital business networks, with its most important partial results being.

References

1. Adomavicius, G., Bockstedt, J. C., Gupta, A. and Kauffman, R. J. (2007) Technology roles and paths of influence in an ecosystem model of technology evolution. Published online: 14 February 2007. Springer Science+Business Media, LLC 2007. *Inf Technol Manage*. 8, p.185–202. DOI 10.1007/s10799-007-0012-z
2. Chituc, C.-M., Toscano, C. and Azevedo, A. (2007) Towards the Creation of a Digital Business Ecosystem for the Shoe Manufacturing Domain. *In Proceedings of the Digital EcoSystems and Technologies Conference*, 2007. DEST '07. Inaugural IEEE-IES 88 – 93 Digital Object Identifier 10.1109/DEST.2007.371951
3. Herdon, M., Füzesi, I. (2011) Information Technologies in Quality Management Systems of Meat Product Chains. In: Zacharoula Andreopoulou, Basil Manos, Nico Polman, Davide Viaggi (eds). *Agricultural and environmental informatics, governance and management: emerging research applications*. Hershey: IGI, pp. 207-226.
4. IEEE: IEEE Standard Computer Dictionary (1990) *A Compilation of IEEE Standard.* Computer Glossaries. Institute of Electrical and Electronics Engineers, NY
5. Jardim-Goncalves, R., Grilo, A. and Steiger-Garcao A. (2006) Challenging the interoperability between computers in industry with MDA and SOA. *Computers in Industry*, Volume 57, Issues 8-9, p.679-689.
6. Li, Y. (2009) The technological roadmap of Cisco's business ecosystem. *Technovation*, 29 p.379–386.
7. Manikas, I., Manos, B. (2009) A review of factors affecting tracebility in agrifood supply chain. *International Journal of Postharvest Technology and Innovation (IJPTI)* p.430-445
8. Manikas, I., Manos, B., Vlachopoulou, M. and Manthou, V. (2010) An activity-oriented web application for fresh produce traceability. *International Journal of Business Information System (IJBIS)* 5: (4) p. 348-372 DOI: 10.1504/IJBIS.2010.032937

9. Salampasis, M., Tektonidis, D. and Batzios, C. (2005) Methodologies for solving the integration problem of agricultural enterprise applications: Agents, Web services and Ontologies. *Operational Research. An International Journal*, Vol. 5 (1), p.81-92.
10. Moore, J. F. (1993) Predators and Prey: A New Ecology of Competition. *Harvard Business Review*, Vol. 71, No. 3, p.75-85.
11. Nachira, F. (2002) *Towards a Network of Digital Business Ecosystems Fostering the Local Development.* European Commission DG INFSO, Tech. Rep., p.1-23
12. Nachira, F. (2005) Innovation Ecosystems: *Una Strategia europea per l'innovazione e lo sviluppo economic.* Retrieved on 21 Aug 2006 from http://www.digital-ecosystems.org
13. Naudet, Y., Latour, T., Guedria, W. and Chen, D. (2010) Towards a systemic formalisation of interoperability. *Computers in Industry*, Volume 61, Issue 2, p.176-185
14. Panetto, H., Scannapieco, M. and Zelm, M. (2004) INTEROP NoE Interoperability Research for Networked Enterprises Applications and Software. R. Meersman et al. (eds.) *In Proceedings of the OTM Workshops 2004*, LNCS 3292, Springer-Verlag Berlin Heidelberg p.866–882.
15. Pappas, N., Kazasis, F. G., Anestis, G., Gioldasis, N. and Christodoulakis, S. (2007) A Knowledge Management Platform for Supporting Digital Business Ecosystems based on P2P and SOA technologies. *In Proceedings of the IEEE DEST 2007*.
16. Peltoniemi, M., Vuori, E. (2004) Business ecosystem as the new approach to complex adaptive business environments. *In Proceedings of the eBRF Conference: Frontiers of e-Business Research*
17. Razavi, A., Moschoyiannis, S., Krause P. (2009) An open digital environment to support business ecosystems. *Springer Science + Business Media, LLC 2009. Peer-to-Peer Netw Appl*. DOI 10.1007/s12083-009-0039-5
18. Tektonidis, D., Bokma, A., Oatley, G. and Salampasis M. (2006) ONAR: An Ontologies-based Service Oriented Application Integration Framework in Konstantas, D., Bourrières, J-P., Léonard, M. and Boudjlida, N. (eds) *Interoperability of Enterprise Software and Applications*, p.65-74. DOI: 10.1007/1-84628-152-0_7
19. Wolfert, J., Verdouw, C.N., Verloop, C.M. and Beulens, A.J.M. (2010) Organizing information integration in agri-food -A method based on a service-oriented architecture and living lab approach. *Computers and Electronics in Agriculture*, Volume 70, Issue 2, p.389-405.