Collaborative Virtual Organizations in Knowledge-based Economy

Ion IVAN, Cristian CIUREA, Mihai DOINEA
Department of Economic Informatics and Cybernetics
Academy of Economic Studies, Bucharest, Romania
ionivan@ase.ro, cristian.ciurea@ie.ase.ro, mihai.doinea@ie.ase.ro

The paper establishes the content of the virtual organizations concept, insisting on their collaborative nature. Types of virtual organizations architectures are developed and there are analyzed their characteristics compared to classical organizations existing in the pre-informational economy. There are presented virtual organizations for education, production and banking, focusing on their collaborative side. Metrics are built to evaluate the performance of collaborative virtual organizations.
Keywords: *Collaborative System, Virtual Organization, Banking, Production, Metrics*

1 The virtual organizations

In [1], virtual means the possibility that a potential effect to be achieved without actually occurs. The classical organization is a social institution that brings together people with common concerns and concepts, formed on the basis of some regulations for activities submission and for the achievement of common goals.

In [2],the virtual organization is presented as a routine formation, representing groups or associations of companies that are productive and competitive. Virtual organization is characterized by a unique identity, which implies the existence of loyalty and cooperation between partners based on mutual trust.

In [3], the virtual organization represent the ensemble of production companies placed in different locations, working together in a distributed environment, to achieve a common goal and between which runs deep appropriate communication processes with the help of new information technologies.

In [4] it is considered that virtual organization is a geographically distributed enterprise whose members are bound by a common interest, pursue a long-term goal, communicate and coordinate their work through specific tools of information technology.

Virtual organization is a collaborative system in which component organizational entities have more capabilities and have more power than individually. The working context of virtual organization is built on four elements, namely connectivity, purpose, technology and separation.

Virtual organizations are collaborative systems applied in the economy, where people share resources and realize complementary activities from distinct locations, in order to achieve a common goal.

It is considered that virtual organization is deemed to have together with the feature of flexibility also the interdependence feature, in the sense of cooperation between departments and authorized individuals within one unique organization.

The virtual organization features that distinguish it from classical organization are:

- semi-permanent structural units, geographically dispersed;
- performance level based on a common understanding of the business;
- continuous adaptation of organizational forms;
- intensive use of information technologies.

Conditions for the virtual organization existence are the followings:

- infrastructure that allows interaction in informatics plan;
- powerful database describing resources;
- very good virtual management.

There are criteria for the classification of virtual organizations, such as involvement of individuals, group membership, organization mission, the level of information technologies use [2].

Based on criteria established, in the

knowledge-based economy there are distinguished followings virtual organizations:

O_1– internal, comprising business units, consisting of autonomous groups and work teams;

O_2– stable, based on collaboration between internal organizations and have the purpose of acquiring non-specific competences through the main organization;

O_3– dynamic, involving widespread and extensive cooperation with other organizations;

O_4– temporary, which are extensions of internal virtual organizations and address multiple projects, developing responses to a specific market opportunity;

O_5– permanent, that implies the use of virtual concept in all operations performed, including tasks, virtual teams and management of organizational activities.

The lack of physical locations to conduct educational activities led to the development of virtual universities. In the classical university, the number of students is dependent on the capacity and number of rooms to support the courses and exams. Table 1 compares the advantages of classical and virtual universities.

Table1. Comparison between virtual university and classical university

Classical University	Virtual University
Advantages: - direct interaction with teachers and students; - the opportunity to ask questions and receive explanations in real time; - existence of reading rooms and laboratories;	Advantages: - flexibility of study program; - online exams; - transmission of homework and projects by email or upload to the platform online; - equivalence of diplomas.

Digital Libraries have increased in the same time with the development of techniques for data storage and Internet development. Physical books are scanned and can be found in the digital libraries, being accessible from personal computers or mobile phones connected to the internet.

Analysis of classical and virtual organization reveals differences between the two entities, the need and conditions in which virtual organization appears.

Peculiarities of virtual organization are:

- selectivity, which involved the allocation of resources necessary for the organization based on internal requirements;
- virtual management, which means efficient management of resources and activities in the virtual organization.

For description of virtual organizations are taken into account: the followings elements: goal, structure, flows, inputs, outputs and activities specific to each organization.

2 Structures of virtual organizations

By level of complexity criterion, virtual organizations are classified in organizations with low complexity level, with medium level and virtual organizations with high complexity level [5].

The structure of virtual organization with low complexity level, Figure 1, is characterized by interactions between homogeneous components.

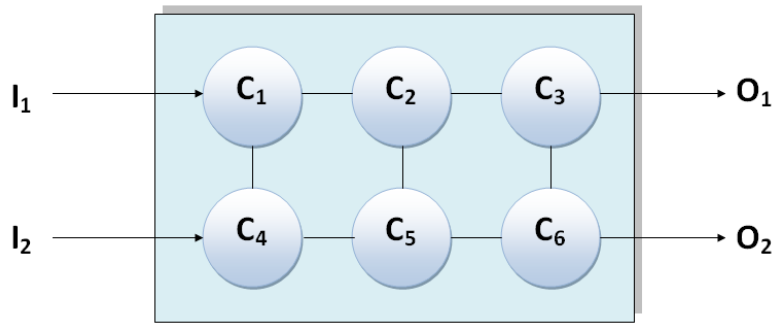

Fig. 1. Structure of virtual organization with low complexity level

In Figure 1, all components C_1, ..., C_6 belong to the same category and are homogeneous.
The structure of virtual organization of medium complexity level is shown in Figure 2 and is characterized by the appearance of heterogeneous components and interactions between them.
In Figure 2, components C_1, $C_3$and $C_5$are heterogeneous and belong to different categories.

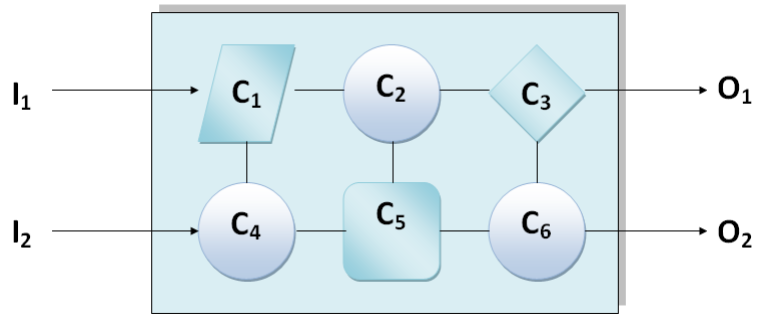

Fig. 2. Structure of virtual organization with medium complexity level

The structure of virtual organization with high complexity level, shown in Figure 3, is characterized by interactions between heterogeneous components, which belong to different categories. Heterogeneity of components increases the complexity of virtual organization and amplifies the difficulty of the message exchange between components.
In the case of virtual organization with high complexity level, all components are different and determine the heterogeneity of the structure.

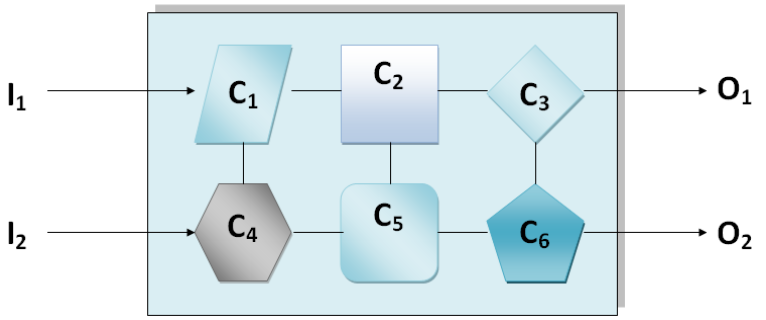

Fig. 3. Structure of virtual organization with high complexity level

Translation from the virtual organization with low complexity level to virtual organization with high complexity level is achieved by insertion of heterogeneous components in the organization structure.

3 Applications in economy of virtual organizations

The ***virtual bank*** is a virtual organization created to facilitate banking transactions handled by physical banks.

In [6] are presented the structure, features, benefits and risks of virtual bank as an application to carry out online transactions. It defines the virtual bank as a bank to distance that gives great advantages to consumers, offering simplified and cheaper operations in than traditional banks.

The virtual bank facilitates the purchase of banking services and products, contributes to increasing interbank competition and allows banks to enter on new markets. Virtual bank is exposed to the same risks as physical bank, namely the administrative risk, legal risk, operational risk and reputation risk, risks that a virtual bank aggravates them. In the case of virtual banks there is the operational risk represented by the transition to new technologies that make security and informatics system availability the main operational risk. Risk management in virtual banks is analyzed inside the digital economy, given the growing number of Internet users and of those using the services of virtual banks.

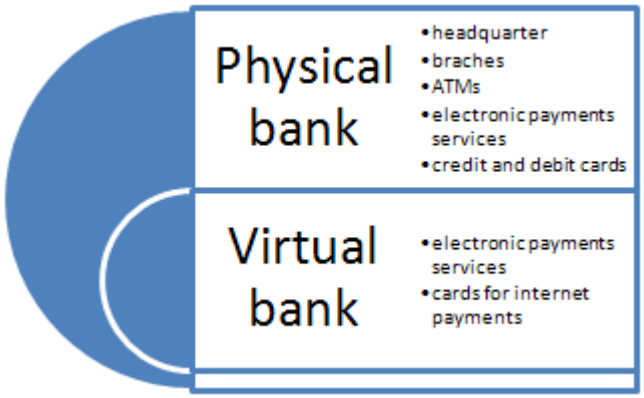

Fig. 4. Structure of virtual bank

The virtual bank is characterized by a very strong collaborative nature and the effective allocation of resources is irreversible in relation to costs. Making erroneous banking operations suppose the payment of related amounts, fees and any damages.

The virtual bank objective is to reduce the costs incurred by processing banking transactions, by redirecting customers to use electronic payments.

Virtual bank structure in relation to physical bank is shown in Figure 4.

Real banks build virtual banks to minimize costs, the virtual bank operation being dependent by the physical bank to achieve effective transfer of money. It is considered that the real bank has, before building a virtual bank, *CBR* clients and *KBR* costs. After setting up the virtual bank, real bank remains with CBR_1customers and KBR_1costs and the virtual bank has CBR_2 clients and KBR_2 costs, so that $CBR_1 + CBR_2 = CBR$and$KBR_1 + KBR_2 < KBR$.

Flows that occur in a virtual bank are similar to those of the real bank, except that are realized online.

Virtual bank entries are represented by scriptural money, new customers, electronic orders, regulations, rules and procedures.

Outputs are given by scriptural money related to payments orders processing, contracts for enabling electronic services, cards for online payments.

The specific activity of virtual bank is represented by submission to physical banks of instructions for real debit and credit of customer accounts involved in the transactions carried out by virtual bank.

Table 2 compares the elements of virtual bank and classical bank.

Table 2. Comparison between virtual bank and physical bank

	Virtual bank	**Classical bank**
Objective	reduce transaction processing costs	maximize profits through diversification of products, increasing the number of customers and volume of transactions
Structure	without offices, branches, ATMs	complete
Flows	fully online	online and physical
Inputs	scriptural money, new customers, electronic payments orders, regulations, rules and procedures	scriptural and physical money, new customers, electronic payments orders, regulations, rules and procedures
Outputs	scriptural money, contracts for enabling electronic services, cards for online payments	scriptural and physical money, contracts for enabling electronic services, banking cards
Activities	submission to physical banks of instructions for real debit and credit of customer accounts	interbank transfers, granting loans, making deposits

The ***virtual enterprise for software development*** represents a virtual organization encountered in the field of information technology and communications, having as activity object the development of informatics applications.

In [7] there are presented new business enterprises in the globalized and virtual economy, the life cycle of virtual enterprise, the virtual production system, the reference architecture of modern production systems, informatics systems for virtual organization management, information technologies used for virtual organizations.

The objective of virtual organization for software development is to create software products and informatics applications of high quality and minimum costs.

The structure of virtual organization for software development is presented in Figure 5.

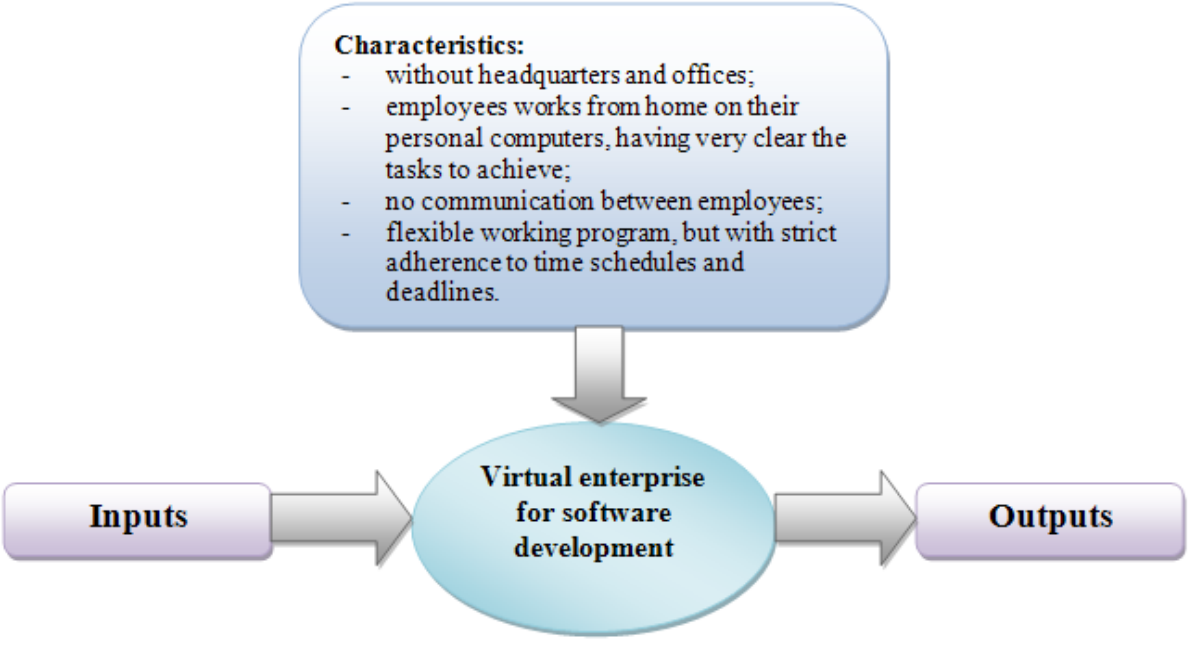

Fig. 5. Structure of virtual enterprise for software development

Unlike traditional enterprise, which has branches, offices, computers, employees comes to the company, the work is carried out at office based on a fixed schedule of work, in the case of virtual organization is required a very good coordination between its members, being oriented to teamwork. Teamwork, cooperation and collaboration between employees are key features of virtual organizations [8]. Working from different locations and lack of physical contact between employees is supplemented by appropriate tasks sharing by managers, so that every employee knows exactly what to do.

The virtual enterprise for software development enables better risk management and effective cost control, compared to the traditional enterprise. The software products supplied are checked in terms of the insertion of open source code.

Flows realized in a virtual enterprise for software development aims the exchange of messages between managers and applications developers regarding technical specifications. Unlike traditional enterprise, communication is done exclusively with the support of information technology tools.

Table 3. Comparison between virtual enterprise for software development and traditional enterprise

	Virtual enterprise for software development	**Enterprise for software development**
Objective	development of software products and informatics applications	development of software products and informatics applications
Structure	without headquarter, offices, equipment	complete
Flows	communication exclusive online	direct and online communication
Inputs	orders, customers, employees	orders, customers, employees
Outputs	software products	software products
Activities	analysis, design, implementations and testing of informatics applications	analysis, design, implementations and testing of informatics applications

Entries are represented by orders for application development, technical and functional specifications, new customers, developers.

Outputs are given by software products developed and post-implementation support services.

Activities achieved include analysis, design, implementation and testing of software applications developed, based on requirements specified by customers.

In Table 3 are compared the virtual enterprise for software development with the traditional enterprise.

The ***virtual enterprise for goods production*** is the virtual organization producing assets and material goods.

In [9] is considered that two essential features of virtual organization are collaboration and cooperation. The work in the virtual environment requires interoperability and involves conveying knowledge flows between different participants.

The objective of virtual enterprise for goods production is to maximize the profit obtained by automating production processes and reducing costs with personnel and locations.

The structure of virtual enterprise for goods production is presented in Figure 6.

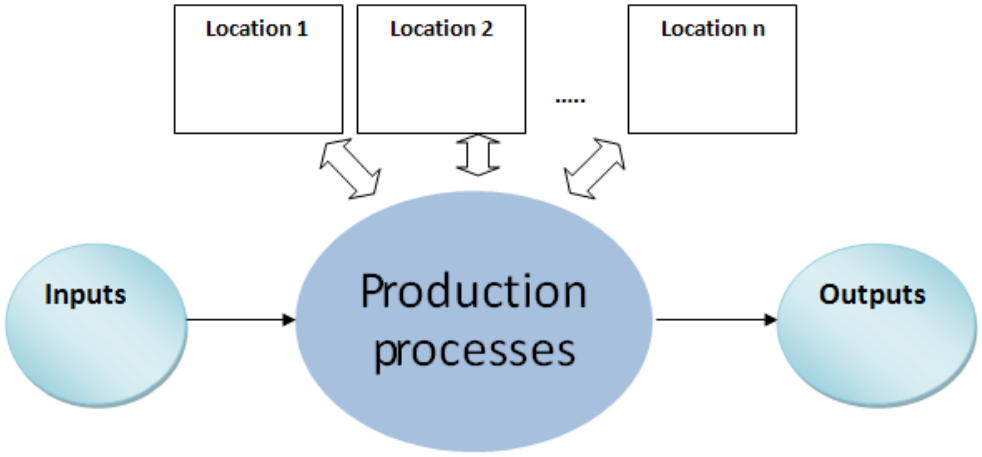

Fig. 6. Structure of virtual enterprise for goods production

Unlike traditional companies, which maintain offices, equipment, machinery manufacturing, the virtual enterprises are characterized by lack of physical components.
Flows within the virtual enterprise for goods production intended exchange of messages, documents and specifications of production processes.
Inputs are represented by raw materials, customers, new orders and employees.
Outputs include finished goods, services, customers, employees.
Activities include operations performed to complete production processes.

Table 4. Comparison between virtual enterprise for goods production and the classical enterprise

	Virtual enterprise for goods production	**Enterprise for goods production**
Objective	automating production processes and reducing costs	automating production processes and reducing costs
Structure	without headquarter, offices, equipment	complete
Flows	exchange of messages, documents and specifications, exclusive online	exchange of messages, documents and specifications
Inputs	raw materials, customers, new orders and employees	raw materials, customers, new orders and employees
Outputs	finished goods, services, customers, employees	finished goods, services, customers, employees
Activities	specific to production processes	specific to production processes

In Table 4 is compared the virtual enterprise for goods production with the traditional enterprise.
In [9] is considered that virtual organizations offer the following advantages:

- encourage the creation of a new competitive environment for industrial products and services;
- favors active companies able to respond quickly to the demand for quality products;
- integrates flexible production technologies and creates management structures able to meet cooperation initiatives within the enterprise and with business partners.

The major advantage offered by the virtual organization is the employee's working program flexibility, namely the opportunity

to use the tele-work. Tele-work represents the ensemble of activities necessary for the proper functioning of a business that employees meet without actually being present to office, but intensively using the information technologies and communications [2].

4 Performance of virtual organizations

Efficiency of virtual organizations is much higher than that of traditional organizations, because the structure of expenditures is allocated efficiently for virtual organizations. Table 5 presents the differences between the expenditures realized in the case of each category of organizations.

Table 5. Comparison of expenditures structure

Types of expenditures	Virtual organization	Classical organization	Comparison
Personnel	A_0	A_1	$A_0 < A_1$
Equipment	B_0	B_1	$B_0 < B_1$
Energy	C_0	C_1	$C_0 > C_1$
Indirect	D_0	D_1	$D_0 < D_1$
Information	E_0	E_1	$E_0 > E_1$

There are built indicators regarding quality of processes, quality of products and quality of virtual organizations.

In order to demonstrate the efficiency of virtual organizations there are established weights p_1, p_2, p_3, p_4, p_5, associated to the types of expenses and whose values are determined experimentally.

It is determined the indicator for costs structure of virtual organizations, *EOV*, as follows:

$$EOV = p_1*A_0 + p_2*B_0 + p_3*C_0 + p_4*D_0 + p_5*E_0$$

It is calculated the indicator for costs structure of classical organizations, *EOC*, as follows:

$$EOC = p_1*A_1 + p_2*B_1 + p_3*C_1 + p_4*D_1 + p_5*E_1$$

It shows that $EOV << EOC$ which determine the efficient character of virtual organization.

Human resources are considered a significant factor in the development of virtual organization and the maximization of its profit. The training of human resources is done both at universities and at work through training programs. Professional training of employees at work is performed at least every five years. In this period, an employee performs one or more courses. An indicator for assessing the level of staff training is the efficiency of training activities.

The efficiency of training activities performed by an employee, *EAFP*, is determined as follows:

$$EAFP = \frac{NT}{NP} \times 100$$

where:

NT– total number of training courses supported by the organization in five years;

NC – number of employees qualified in five years.

Financial results of a virtual organization depend significantly by the quality of its staff and the efforts made by every employee.

The indicator for evaluating the efficiency of training a student in the virtual campus, *EPS*, is calculated according to the relation:

$$EPS = \frac{NSE}{TPE + TOE}$$

where:

TPE – average time spent for preparing an exam in the virtual campus;

TOE – average time for rest between two exams in the virtual campus;

NSE – average of marks obtained by a student to the exams held in the virtual campus.

Indicators reflecting the knowledge level in the virtual campus are initially determined at the beginning of the academic year, at time t_0, and then at the end of the semester or academic year, depending on the context. By comparison of indicators values, at times $t_0$and t_1, it is assessed the performance of the educational process.

5 Risks of virtual organizations

The security in virtual organization architectures is treated different from the one of a distributed system [10], because of the intrinsic characteristic of this type of systems, namely, heterogeneousness of the resources. This fact drives to different approaches, with different solutions and results in a complex system with a lot of resources.

Risk analyses in virtual organization systems has the objective to identify, clarify and rank the possible unwanted events, risks, that can affect the system with damages upon the users and the processed data. Risk management represents the way of following a methodology well documented for identifying, measuring, acting and monitoring the risk in a virtual organization system.

In [11], there are defined the managing steps of the risks in project management. When approaching to risk management for a virtual organization network that has as objective improving the quality characteristics of the network, the following approach is proposed:

- risks' identification step – detecting the risks at the key levels of the virtual organization system;
- the step of measuring the effects produced upon the virtual organization – achieving a classification and a ranking regarding the effects generated by the identified risks;
- counters' identification step that are implemented for removing the risks defined at the previous step, for temporal removing of those effects of diminishing the impact that those risks has upon the system in case they are not fully eliminated;
- monitoring step of the evolution of the system based on some actions taken for treating the identified risks – implementation of controls that has the goal of tracking the systems' activities and, based on a collection of information regarding the possible risks that can influence the system, to identify the risks in time, before they produce major damages, their possible events and to call for coercion measures appropriated set in the previous step.

The procedure for improving the performances of virtual organization systems by using techniques of risk management is given in Figure 7.

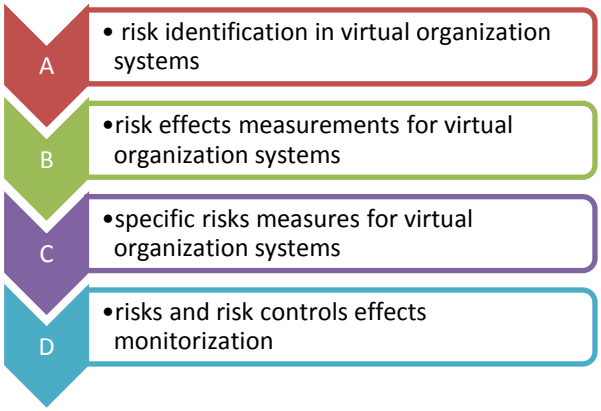

Fig. 7. Risks' management process

Risks' identification in virtual organization systems aims to track the levels at which the vulnerabilities take place, allowing the existent risks to take advantage of them, manifesting them, with negative effects on the entire system:

- the central level of processing and management of the resources – represents the level that manages the resources of the virtual organization network, sending to processing at different workstations, users, assigning and releasing authorization levels; Table 6 represents the risks from this level of virtual organization system as long as the measures that are taken for neutralizing them.

Table 6. Risk and measures at the level of the kernel of a virtual organization network

Risks	Measures
Breaking the authorization system of the resources' access	SSL, time stamps added in packages between the system and the user
Blocking the access at the system's services through DoS technique, Denial of Services	Filtering the packages that send requests to the the server, Distributed Packet Filtering DPF
Modification of the data by other processes that are executed in the system	Virtualization, creation of virtual workspaces that doesn't allow direct access at the resources of the virtual organization system
Using all the resources by the external processes and not by the network, process starvation	Isolation of the processes using different techniques like sandboxing – adding references to attest the safety of the code, virtualization

- the level of the communication between the workspaces, components of the virtual organization network- represents the point in which the risks that stand for the communication management have an impact upon the data that runs in the network; at this level, the risks that appear are open, together with the measurements for countering, in Table 7.

Table 7. Risks and measures at the level of the communication channel

Risks	Measures
Risks concerning the routing protocols of the information in the virtual organization network and also the interception of the communication at the router's level	Using routing protocols that use receiving confirmations for avoiding impersonation by unauthorized users
Risks concerning the interception of information over the communication channel by unauthorized persons	Using asymmetric cryptographic algorithms of information
Risks concerning unauthorized modification of information along the communication channel	Using correction codes of errors, ECC, for highlighting if data were or not altered during the transmission process

- users' level – possible risks generated by malicious users who try to use input interface as a tool to endanger the safety of the system; risks and measures at this level are presented in Table8.

Table 8. Risks and measures at the users' level

Risks	Measures
Adding SQL phrases for disclosing inaccessible information in this situations, SQL injections at the database level in the virtual organization system	Using of SQL phrases with validated entry parameters from the syntactic and functional points of view
Risks concerning the execution of malicious code in the system's interfaces, XSS injections	Validation of the entries of HTML code type that come from uncertain sources, deactivation of the scripts at the interface

	level, text sequence formatting that is entered in the system

The correct identification of the risks in a virtual organization system leads to a more rigorous implementation, a more efficient one and with not so many moments of interruptions of function with low risks of information' loosing.

The risk management process, if done right, will identify controls which implemented, will lower the total amount of risk. The process of risk control implementation has also the disadvantage of increasing the complexity of the system, implicitly altering the amount of resources used for processing by requiring new computational power. This level of risk, covered by any risks control that were implemented into a virtual organization system must be carefully determined based on the level of resources used for supporting them. Figure 8 depicts the balance that must be achieved between the complexity given by the implemented risk controls and the amount of resources needed in order to have enough computational power for the virtual organization system.

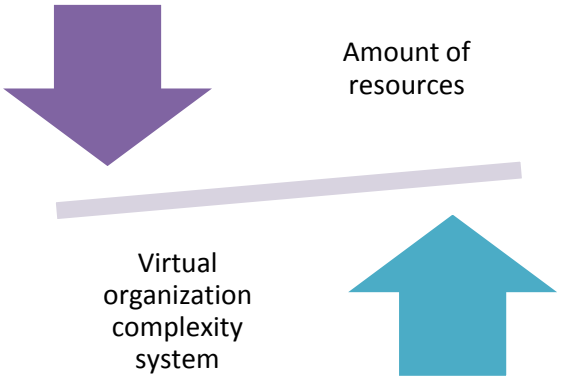

Fig. 8. Virtual organization complexity equilibrium

The concept of virtual organization security is treated strictly from the point of characteristics view of this type of architecture for capturing as well as possible the particularities that directly influences the level of vulnerabilities of the entire concept. The advantages offered by the method of processing in virtual organization have a high cost of security because of the multiple risks that those systems are exposed.

6 Conclusions

In the context of transition to knowledge-based economy, organizations undergoing various changes depending on their type, virtual or traditional. While a company such as a bank, cannot justify its existence without profit, in a higher education institution, the main objective is to meet the educational needs of its members.

In the case of a virtual organization represented by an enterprise for goods production, unlike the traditional enterprise, the virtual enterprise enables lower production costs, reduces production cycles and requires very large databases containing different types of resources and raw materials.

References

[1] DexOnline 2011, Available at: http://dexonline.ro

[2] B. Ghilic-Micu, M. Stoica, *Organizaţia virtuală*, Editura Economică, Bucharest, 2010, pp. 304.

[3] O. Nicolescu, *Noi tipuri de firme bazate pe cunostinte*, Available at: http://www.topbusiness.ro/romania/archive/article/Noi+tipuri+de+firme+bazate+pe+cunostinte.html

[4] D. Fotache, *Groupware şi management*, Available at: http://portal.feaa.uaic.ro/arhiva/Unclassified%20Records/2009-04-15T07-06-49Z/CAPITOLUL3_EXAMEN_YNIWWK.pdf

[5] C. Ciurea, *Metricile sistemelor colaborative, PhD Thesis*, Academy of Economic Studies, Bucharest, 2011.

[6] A. N. Precup, *Noi tehnologii informatice în sistemele financiar – bancare, PhD Thesis*, Academy of Economic Studies, Bucharest, 2008.

[7] G. Carutasu, C. Botezatu, C. P. Botezatu, *Sisteme informatice pentru managementul*

organizatiilor, Editura Universitara, 2011, 280 pg.
[8] Y. Malhotra, *Knowledge Management and Virtual Organizations*, Idea Group Publishing, Hershey PA, USA, 2010, 450 pg.
[9] I. Bacain, "Modelarea cunoaşterii în organizaţiile virtuale," *Analele Ştiinţifice ale Universităţii Alexandru Ioan Cuza din Iaşi*, Vol. 51, 2005.
[10] C. Tănasie, S. Vînturis, A. Grigorovici, "Reliability in Distributed Software Applications," *Proceedings of the Tenth International Conference on Informatics in Economy, IE 2011*, May 5-7, 2011, Bucharest, Romania, ASE Printing House, ISSN 2247-1480.
[11] Project Management Basics, Available at: http://www.projectperfect.com.au/info_risk_mgmt.php
[12] M. Doinea, *Optimizarea securităţii aplicaţiilor informatice distribuite, PhD Thesis*, Academy of Economic Studies, 181 pg., Bucharest, Romania, 2011.

Ion IVAN has graduated the Faculty of Economic Computation and Economic Cybernetics in 1970. He holds a PhD diploma in Economics from 1978 and he had gone through all didactic positions since 1970 when he joined the staff of the Bucharest Academy of Economic Studies, teaching assistant in 1970, senior lecturer in 1978, assistant professor in 1991 and full professor in 1993. Currently he is full Professor of Economic Informatics within the Department of Computer Science in Economics at Faculty of Cybernetics, Statistics and Economic Informatics from the Academy of Economic Studies. He is the author of more than 25 books and over 75 journal articles in the field of software quality management, software metrics and informatics audit. His work focuses on the analysis of quality of software applications.

Cristian CIUREA has a background in computer science and is interested in collaborative systems related issues. He has graduated the Faculty of Economic Cybernetics, Statistics and Informatics from the Bucharest Academy of Economic Studies in 2007. He has a master in Informatics Project Management (2010) and a PhD in Economic Informatics (2011) from the Academy of Economic Studies. Other fields of interest include software metrics, data structures, object oriented programming in C++, windows applications programming in C# and mobile devices programming in Java.

Mihai DOINEA has a PhD in the field of Economic Informatics, within Academy of Economic Studies, Bucharest, Romania. His PhD thesis approaches the field of Informatics Security, with clear objectives about finding security optimization methods in distributed applications. His research is also backed up by a master diploma in Informatics Security (2006). He is a lecturer assistant, teaching Data Structures and Advanced Programming Languages at the Academy of Economic Studies. He published more than 30 articles in collaboration or as single author and his research interests are directed to areas such as security, distributed applications, artificial intelligence and optimization algorithms.