“Development of information systems and modeling of their implementation in the business”

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Development of information systems and modeling of their implementation in the business

Abstract

The development features of the information systems and technologies are investigated. The analysis of their impact on the formation of the information society is carried out. The current level of the Ukraine's development in different directions of the information industry is considered. The advantages and prospects of development of the domestic IT industry are allocated. The role of information systems in the development of an economy that is based on knowledge and information is determined.

The types of information systems and their functionality are considered. The approach for improving the evaluation process in modeling of the information systems and at the enterprise is developed. It creates the conditions for taking into account all the costs during the process of information technology implementation, also in relation to the dynamic process of value changes to support the functioning of the enterprise information system.

Keywords: information systems, technology, society, modeling information, knowledge economy, business management, process, dynamics of the value.
JEL Classification: C30, M15.

Introduction

Information systems, with each passing year, are having more and more influence on the economic development of every country and social life of people. Thus, increasing the quality of many sectors (science, industry, trade, financial sector, etc.) related with the implementation of information systems and technologies (Jessup and Valacich, 2003). Under these conditions, manufacturing technology, information technology and the ideas related to them are changing very rapidly. Therefore, it is necessary to take into account the development potential of the information systems in the long term in a direct relationship with the financial support during the phase at a specific enterprise (Lucey, 2005; Taylor, 2004).

Thus, automated information systems are a major factor of the labor productivity growth and in improvement of its quality and efficiency, both in management and in the sphere of material production. This is because, taking into account the specifics of the company, the software inherent in the automated information systems allows the adaptation of existing enterprise management system to the new requirements (Laudon, 2002).

However, the engineering process in the stages of information systems implementation, its funding, budgeting, etc. should be considered as long-term investment which can be accompanied with the uncertain value of variable cost over time (Taylor, 2004). Therefore, a suitable mathematical apparatus is needed to take account for them in the future. It will allow to predict all the implementation costs and in-line service software information systems for their constant updating and supporting at the current level (Partyko, 2009).

To perform such tasks, it is expedient to build a functional model of the process of information system implementation in the company, taking into account the interactions of each process and structure of the enterprise or individual function (Romanuk, 2013). It allows to determine the optimal variant of information systems implementation and it also anticipates all the costs of their implementation and use in the course of its operation. Therefore, it will, ultimately, increase the efficiency of the enterprise as a whole.

1. Features of information systems development

The accelerated pace of the global information processes' development puts very important problem before the economy of Ukraine – the rapid technological re-equipment of the all economy branches, taking into account the high level of the global development of automated information systems (Nyzhnyk, Polinkevich, 2013). The solution of the task will create the conditions in which the acceleration of scientific and technological progress and that of modern computer technology will allow Ukraine to enter in the global information space with the industrialized countries at a high level. For this purpose, the law "On the National Informatization Program" was introduced in Ukraine (The Law of Ukraine, 2011).

The scaling up of the information systems and technologies' implementation depends on the level of both material and non-material provision of basic

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processes: production of software and hardware, personnel support, the development of international cooperation in the area of information technology, the formation of information and communication infrastructure (Voynarenko, Yemchuk, 2013).

Thus, the development of information and computer technologies and systems creates a common information space for the construction of an information society in our country.

The Law of Ukraine "On the main principles of information society development in Ukraine for 2007-2015" defines the following strategic objectives of information society development in Ukraine, namely: accelerate the development and implementation of the latest competitive information and computer technologies in all spheres of public life; the computer and information provision of the population literacy through the establishment of the education system, that is based on the use of new information and computer technologies and the formation of a fully developed personality; development of national information infrastructure and its integration into the global infrastructure; the use of information and computer technology to improve public administration; the improvement of legislation on regulation of information relations; improve the state of information security in the conditions of use of the latest information and computer technology (The Law of Ukraine, 2006).

The following facts testify to the implementation of many directions in practical life and achieved the benefits of our state in the area of information and computer technology. According to estimates Fund AVentures Capital, a multi-billionth of IT-industry has been formed in Ukraine until 2012. About 100 thousand programers who have reached the level of world-class developers are working in local IT companies. In 2012, Ukraine remained in first place in the number of developers in Central and Eastern Europe (Eremin, 2013). In recent years, Ukraine is among the five world leaders in the export of software products. Only China, India, Russia and Brazil are ahead of Ukraine. IT industry of Ukraine includes more than two hundred thousands of businesses, their total gross income is 12 billion UAN per year. The exports of information services and computer technologies are 9.5 billion UAN, or 80% of total government revenue (Ksenin, 2013).

Thus, Ukraine has, first and foremost, a powerful intellectual potential and could become one of the biggest software hub in the world that can bring significant revenue to the state. However, the difficult political and economic situation in Ukraine creates a number of problems, which affect the development of information systems and computer technologies. At the same time, the most important problem is the implementation of the latest scientific achievements and developments in the practice of industrial enterprises.

In the Global Report on Information and Technology (The Global Information Technology Report 2015) that has been prepared by analysts of the World Economic Forum (WEF), it is noted that Ukraine took 71th place in the ranking of the information society development in the countries around the world. The technologies are used most effectively in Singapore. Finland and Sweden are second and third, respectively. Such countries as the Netherlands, Norway, Switzerland, USA, United Kingdom, Luxembourg and Japan have entered the top ten. Ukraine was ahead: Moldova – 68 place, Romania – 63, Slovakia – 59, Hungary – 53, Poland – 50. Thus, measures to implement the achievements of national developments in the sphere of production and services are being implemented very slowly in Ukraine (Rating of Ukraine for the development of information technology, 2014).

At the same time, the current annual growth of IT-specialists in Ukraine is 15.5 thousand men, but they are unable to meet the needs of this industry. According to preliminary data, the deficit in 2015 will be about 100 thousand professionals in the IT-export and about 70 thousand – in the internal market (Zerkalo nedeli, 2014).

2. Information systems and technologies effect on the development of economic and social processes

For the possibility to evaluate the main directions of the information society development in Ukraine, we will conduct the analysis of statistical data on the use of advanced technology by type and timing of implementation (Table 1) according to Statistical information (2015).

Table 1. The dynamics of the use of advanced technologies in the context of scope and the duration of implementation (units)

Scope of implementation	Total			Including on terms of implementation								
				Under 3 years			From 4 to 9 years			10 years and more		
	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
Total	13219	14038	17442	5666	5845	7585	5191	5512	5249	2362	2681	4608
Design and engineering	2093	2392	1911	873	811	589	953	1139	828	267	442	494

Table 1 (cont.). The dynamics of the use of advanced technologies in the context of scope and the duration of implementation (units)

Scope of implementation	Total			Including on terms of implementation								
				Under 3 years			From 4 to 9 years			10 years and more		
	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
Production, processing and assembly	3789	3954	7097	1639	1644	4596	1361	1473	1498	789	837	1003
Automated transport of materials and details, the implementation of automated loading and unloading operations	268	297	151	149	157	74	92	115	52	27	25	25
The equipment of the automated monitoring and control	839	1008	781	439	547	372	317	347	300	83	114	109
Communication and control	4217	4360	4514	1503	1464	1347	1846	1879	1989	868	1017	1178
Production information system	317	402	383	130	158	140	137	166	156	50	78	87
Integrated management and control	217	318	220	118	169	110	59	99	86	40	50	24
Nanotechnology	54	64	51	13	29	19	28	20	13	13	15	19
Health care	1258	1042	526	1031	444	212	363	120	266	154	88	48
Others	167	201	1808	61	132	126	35	54	61	71	15	1621

Thus, during 2012-2014, the communication and management received highest proportion of advanced technologies implementation in such activities: 31.9% in 2012; 31.06% in 2013; 25.88% in 2014. However, as compared to 2012, in 2014, the number of advanced technologies implementation decreased significantly in areas such as design and engineering services up to 8.7%; automated transport of materials and details, the implementation of automated loading and unloading operations – on 43.7%; health care – on 58.2%.

Meanwhile, in 2014, the number of advanced technologies in production, processing and assembly increased up to 87.31%, in the communication and control – up to 7.1%, in other areas – more than 8.9%. In total, in 2014, the use of advanced technologies in Ukraine has increased up to 31.95% in 2012, and in 2013, up to 24.25%.

Thus, the analysis shows that the potential of the information society building has incremented in Ukraine and related events affect all areas of the economy. Building the information society is accompanied by new economic phenomena such as intellectual property, changes in employee motivation, the emergence of new professions, formation of information culture.

Massive development of information systems, communications and relations, implementation of advanced technologies form the basis of the knowledge economy that is based on knowledge and information, which are key components of the information society and are an important component of production of material wealth and economic development of any country (Bereza, Ustenko, Galuzynskiy, Guzhva at al., 2012).

Information systems and technologies have a crucial role in the economy that is based on knowledge and information. Information systems are used primarily for organizing the flow of information and knowledge within each industrial enterprise and serve as a stimulus to maximize the reserves of knowledge. Large industrial enterprises and small firms need different types of information systems to obtain the necessary information, to implement the operational and strategic tasks for decision support and assistance in performing the functions at different levels of management. In addition, modern information systems in the era of the information society and the knowledge economy allow each company to optimally structure the information flows and provide timely quality information at all levels of management.

It should also be noted that the implementation of modern information systems in the enterprise management system provides the integration of management functions at all levels of the hierarchy, which can significantly improve the efficiency of enterprise management and significantly reduce the time to make informed management decisions.

Corporate information systems provide a clear definition of the automation of management functions. Today, they are being introduced at all major industrial enterprises. Corporate information system supports the automation of management functions in the company and provides information for decision-making (Jukic and Jukic, 2010). This is a holistic software and hardware system, which satisfies both current and strategic needs of the enterprise data processing, with allocation of functions and tasks for each level of personnel management.

The provision of clients' distributed work and remote access to the necessary data is a requirement for corporate information systems.

Management information systems have minor analytical capabilities. They service managers who require daily information about the state of affairs. The information comes from the operational level of the information system. These systems are used to support decision making of structured and semi-

structured problems at the level of operations' control; focused on monitoring, reporting and decision-making on the operational status; based on the data and flows within the organization; have minor analytical capabilities and a rigid structure.

Decision support systems solve semi-structured tasks, the results of which are difficult to predict in advance. The systems have more powerful analytical device with several models. They receive information from the management and operational information systems.

3. Improving the modeling of the evaluation process of information systems implementation in the business

A huge variety of computer systems and technologies exist today. As a result, the problem of assessing the effectiveness of their implementation at each enterprise specific of its economic activity occurs. Traditionally, it is necessary to take into account the main types of expenses for technical equipment, their location on the software and the possibility of training the staff of state employees, losses arising from errors in the system operation in the implementation of information systems (Antonov, 2007).

We propose to take into account such an important moment as a dynamic process of change in the cost of support of the information systems' use throughout the entire period of its operation at the beginning of the information systems' implementation.

In this regard, simulation of the information system's implementation should be presented in the form of the directed graph GR (V, E). A plurality of components of the future system vertices $V = \{ v_i \}, i = 1, 2, ..., n$, and the necessary order of implementation $E = \{(v_i, v_j)\}$, $v_i \in V, v_j \in V$ – serves as its directed arcs.

In addition, we need to define a range of components and stages of implementation. Therefore, we assign the value of a comprehensive assessment of the cost-effectiveness of the j-th component implementation after the i-th component implementation in view of cost installation and support accordance in the arcs of the graph $d(v_i, v_j)$. It should be taken into account that the cost of maintenance is not a constant and changes over time. We also take into account the effect of the degree of components compatibility and the criticality of their automation.

$$d(v_i, v_j) = \frac{c_{ij} \cdot r_{ij}}{s_{ij}} + z_{ij} \cdot kd_{ij}, \; c_{ij} \geq 0, z_{ij} \geq 0, \; 0 \leq r_{ij} \leq \leq 1, \; 0 \leq s_{ij} \leq 1, 0 \leq kd_{ij} \leq 1, \quad (1)$$

c_{ij}- the cost of *j*-th component implementation (for example, the cost of the computer or the software and services of its installation) after the implementation of the *i*-th component;

r_{ij} – coefficient that determines the degree of the need to use information technology to the *j*-th component after the implementation of the *i*-th component (that is the degree of possibility of the *i*-th component functions without use of information technology. For example, the development of a specialized unit reporting forms, which must be given every five years. The formation of such reporting forms by selection from other existing documents can take up to two hours at a time), r_{ij} = 0 – if allowed to complete execution of work by hand with minimal effort, r_{ij} = 1 – if the unit is maximum criticality;

s_{ij} – the degree of the components' compatibility, s_{ij} = 0 is not allowed, as it is not appropriate in the complete absence of the compatibility arcs $d(v_i, v_j)$, s_{ij} = 1 – at full compatibility of the *j*-th and the *i*-th components within a single technological and information space;

z_{ij} – the cost of *j*-th component's support after the implementation of the *i*-th component (for example, the cost of cartridge refilling of the printing apparatus, the cost of servicing the switch, the cost of author's support of special application software);

kd_{ij} – dynamic coefficient of changes in the cost of *j*-th component's support after the implementation of the *i*-th component, taking into account the passage of time.

Using Dijkstra's algorithm, we get a range of values of P-shortest path from the vertex of the graph to the other vertices:

$$P = \{p_k = (V_k, E_k, h_k)\}, k = 2,3,..., n \quad (2)$$

$V^k = \{v_i^k\}$, $i = 1,2,..., n^k$ – the range of vertex values that defining the path from the vertex $v_1 = v_1^k$ to the vertex $v_k = v_{n^k}^k$;

$E^k = \{(v_i^k, v_{i+1}^k, c_{i(i+1)}^k, z_{i(i+1)}^k)\}$, $i = 1,2,..., (n^k - 1)$ is the range of arcs that define the path from the vertex $v_1 = v_1^k$ to the vertex $v_k = v_{n^k}^k$; the $c_{i(i+1)}^k$ is a cost of implementation (i + 1)th component after the implementation of the *i*-th component; the $z_{i(i+1)}^k$ is a cost of support (i + 1)th component after the implementation of the i-th component;

the $h^k = \sum_{i=1}^{n^k-1} d\left(v_i^k, v_{i+1}^k\right)$ is the path from the vertex $v_1 = v_1^k$ to the vertex $v_k = v_{n^k}^k$.

The subsequent calculations of the cost of information systems implementation in business management will remain unchanged (Skrypnik, 2011). Thus, if the experts of IT-service have defined the range of ending vertices of the tree branches' introduction of the information technologies $Y = \left\{ v_j^Y \right\}, j = 1,2,...,m.$

If we use a range of P and Y, we will get the range of paths of the information technologies implementation that is subordinate to values of hj:

$$P' = \left\{ p_j' : p_j' \in P,\ v_{n^j}^j = v_j^Y \right\}, j = 1,2,...,m. \quad (3)$$

We also define the range of recurring arcs B in the range of P':

$$B = \left\{ b_o = \left(E^o,\ u^o\right) \right\}, o = 1,3,...,v \quad (4)$$

$E^o = \left\{ \left(v_i^o, v_j^o, c_{ij}^o, z_{ij}^o\right) \right\}, o = 1,2,...,w$ is a range of recurring arcs in the range of P', v_i^o, v_j^o are the pair of vertices that are found in several paths of the range P', c_{ij}^o - is the cost of the *j*-th component implementation after the *i*-th component implementation, z_{ij}^o - is the cost of the *j*-th component service after the *i*-th component implementation, u^o – the number of repetitions of the arc E^o.

In this way, projected cost of information technology implementation will be:

$$C = \sum_{p_j' \in P'} \psi\left(p_j'\right) - \sum_{o=1}^{w} c_{ij}^o \left(u^o - 1\right), \quad (5)$$

$$\psi\left(p_j'\right) = \sum_{i=1}^{n^j-1} c_{i(i+1)}^j. \quad (6)$$

The projected cost of support of information management system's components after the implementation is:

$$Z = \sum_{p_j' \in P'} \phi\left(p_j'\right) - \sum_{o=1}^{w} z_{ij}^o \left(u^o - 1\right), \quad (7)$$

$$\phi\left(p_j'\right) = \sum_{i=1}^{n^j-1} z_{i(i+1)}^j. \quad (8)$$

Thus, the improved model provides a comprehensive assessment of the cost-effectiveness of the information systems implementation taking into account the dynamics of changes in the value of their support during the whole period of their operation.

Conclusions

Today, the trend of the world economy is determined by the growing influence of information systems, the gradual transition of developed countries from an industrial economy to a knowledge economy, the information society building. Therefore, the main macroeconomic objectives should be defined:

Sustainable economic growth of the state and the material welfare of its nationals through the implementation of information systems.

Ensuring an enhanced contribution to growth companies that operates in the field of information and the industries that make extensive use of information systems through the formation of a balanced regulatory and, in particular, tax policy.

Promotion of entrepreneurship in the field of information systems through the formation of administrative, legal and economic mechanisms. The mechanisms will stimulate demand for information products, attracting investments in the IT sector, the development of competition, promotion of domestic products on the international market.

New trends of leading countries' economic development of the world economy suggest that the use of the achievements of information technology industry and information management systems in the management of enterprises are essential ingredients for success of any company or association of companies (Geyts, 2011). Strategic prospect of each enterprise depends on whether information systems are able to function in the long term. For qualified creation, use of information systems needs to clearly deliver its purpose and functions.

Therefore, it should be noted that today's software and hardware complexes provide the interaction of different information technologies, exchange of information flows, enhance the effectiveness of the implementation of enterprise information management systems. Hence, the correct calculation of the cost of information systems' implementation and support throughout the entire period of their operation with the possibility of development is an important task.

Thus, we have developed an approach for improving the modeling of the process of information systems implementation at the enterprise. This approach creates the conditions for taking into account all costs at the stage of information technologies implementation, including costs associated with support of the enterprise's information system during the entire period of its operation.

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