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Concepts of the development of information and communication technologies and management of the effectiveness of investing in their development in the modern economy

Conceptos del desarrollo de tecnologías de información y comunicación y gestión de la efectividad de invertir en su desarrollo en la economía moderna.

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Abstract
One of the essential characteristics of the modern stage of the development of the information society is the unprecedented level of development of information and communication technologies. The authors explore the phenomenon of communication in the framework of the concept of social and communicative, information and communication technologies and in the concept of the digital economy. The study substantiates the use of the factor analysis method in determining the effectiveness of investing resources in information and communication technologies of an enterprise.
Keywords: communication, information and communication technologies (ICT), resources, investment in ICT, assessment of the effectiveness of investing in ICT.

Resumen
Una de las características esenciales de la etapa moderna del desarrollo de la sociedad de la información es el nivel sin precedentes de desarrollo de las tecnologías de la información y la comunicación. Los autores exploran el fenómeno de la comunicación en el marco del concepto de tecnologías sociales y comunicativas, de información y comunicación y en el concepto de economía digital. El estudio corrobora el uso del método de análisis factorial para determinar la efectividad de invertir recursos en tecnologías de información y comunicación de una empresa.
Palabras clave: comunicación, tecnologías de la información y la comunicación (TIC), recursos, inversión en TIC, evaluación de la efectividad de invertir en TIC.

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1. Introduction

The process of the global movement of socio-economic systems into the information society (IS) indicates that there is a development and acquisition of new forms of relations in the political, economic and social spheres. The new information resource has a leading role in the production systems of not only countries with developed economies, but also in the socio-economic life of developing countries. Information becomes the most important resource that forms the basis of the production of the information society. In this regard, the information economy is interpreted as a production system that combines with the sphere of consumption, where information is perceived as the leading productive force (the decisive means and the subject of labor), as well as the main product of production and the subject of consumption.

The emergence of a new information society raises questions, disputes, discussions, and confronts society with a host of social and economic problems. In 1997, the Partnership for Global Knowledge program was created in Malaysia, whose members are more than 80 participants from 38 countries of the world (Melnik & Degtyareva, 2005).

By the definition given by the Partnership for Global Knowledge, the term “information society” refers to a society in which there is free access to information and knowledge, and their use contributes to sustainable development and progress (Gester & Zimmermann, 2005). The information society is characterized not only by free communication between the government and citizens, between citizens of the whole world, but also by the fact that every citizen is aware of current events in the country (in the world). The term “information society” has come into use along with information and communication technologies - the Internet, e-mail, mobile phones, which are now an integral part of our life and largely determine it.

At the Geneva summit, which was one of the large-scale events held under the auspices of the UN, the main principle of the information society was approved - the introduction of new information and communication technologies (ICT) in all spheres of social, economic and political life in order to create a single information world (World Summit on the Information Society. A Compendium of Materials, 2003).

The modern economic space is characterized by a high level of communications, which occupy a leading place in it. The study and generalization of various approaches to the definition of the term “communication” allows us to distinguish two main theses, or meanings, regarding this phenomenon:

1. Communication is a technology, method, means for creating the ability to exchange information between entities through channels of information transfer.

2. Communication is directly the process of information interaction between the sender and recipient of information.

Prominence is also given to the assessment of the effectiveness of investing resources in information and communication technologies (ICT). The determination of a quantitative indicator of the effectiveness of the use of investments is influenced by various factors: uneven provision of resources and the non-optimal nature of their use. A systematic approach is required, which is based on a combination of resources and factors, which makes it possible to form a mechanism for managing the effectiveness of investments in ICT and make the best investment decision.

2. Literature review

In the modern economic space, communication plays one of the central roles. Even the name of the company is information about it, which is a message to a potential client of the company.

Various types of communications in an organization are known, among which we highlight the following (Nazarchuk, 2009).

- internal corporate communications, that is, communications between company employees;

- business communications, which include communications with contractors of the organization;

- social communications aimed at potential consumers of enterprise products.

In this case, advertising and marketing in general in the most complete way include social communications.

Considering the basic understanding of social communication, it should be noted that communication (social communication) should be understood as an effective synchronous and diachronous interaction of social subjects (people and (or) their communities), the essence of which is the movement of meaningful information (communication substance or message in an ideal or ideal material form) from one subject (source) to another (recipient) (Agi, Kemeron & Olt, 2004).

The main distinguishing features of communication are as follows.

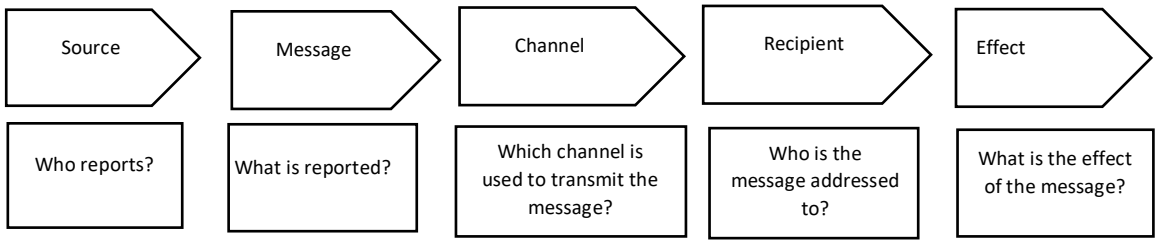
For the emergence of communication, at least two objects are necessary, and these objects must belong to society (that is, these are people and their groups).

Between these entities there should be a sending or exchange of messages containing any significant information. Moreover, the implementation of communication requires the ability to decode the message.

As a result of communication between its subjects, there is a movement and exchange of information.

In his model, Harold D. Lasswell (Bulkina, 2000) most fully discloses all the elements that make up communication (Figure 1).

Figure 1
Harold D. Lasswell Communication Model



When comparing the Harold D. Lasswell model with the traditional two-way communication model that is most often found in the educational literature (Nazarchuk, 2009) and includes such elements as the sender, the message itself, the channel, the receiver, feedback, and sometimes noise, we can conclude the following. The author highlights the main difference, which consists not only in feedback as such, but also in the effect of the transmitted message, which is evaluated directly using feedback.

Thus, the structure of communication involves the inclusion of the following elements:

- two participants (people or their society) who know the norms of a semiotic system, for example, language or the possibility of translation;

- a common topic, interest or situation, possibly specially provoked by one of the participants in communication, which is fundamental in communication;

- text or other encoding of the transmitted information;

- the purpose, motive, meaning of the interaction of communicators;

- material transmission of the text, that is, the creation of conditions under which the recipient of information will be able to receive it.

2.1. Communication in the concept of social and communicative technologies

More broadly, social technologies are considered as a certain activity of the subject which is based on a specific action program aimed at solving social problems, and which is a system of various procedures, actions and the use of various means and social resources for the complex solution of a certain socially significant problem (Konovchenko, 2001).

Given this definition, social-communicative technology can be described as a purposeful systemically organized activity for managing the communication of a social subject, based on a specific plan (program of action) and aimed at solving any socially significant problem.

Consequently, it is advisable to define the applied term of “social and communicative technology” as a systemically organized set of operations, structures and procedures that rely on a program (plan) to achieve the goal of a social subject through controlled social communication (Ustinova & Khayrullina, 2015).

The above definitions are equivalent to each other and characterize the defined phenomenon with varying degrees of completeness.

One of the types of social and communicative technology is PR technology. PR technology is a communication technology aimed at managing the external and internal communications of a company or structure with its target group of the public (Chumikov & Bocharov, 2009).

The object of social communication technology (SCT) in the broad sense is social space and society. In a narrow applied sense, the object can be called the subconscious, perception, reaction and attitude of social subjects to the source of communication. In the scientific literature, the subject of social and communicative technology is the systematic process of managing communication objects, organized on the basis of communications (Chumikov & Bocharov, 2009).

Thus, we can conclude that social communication is a tool, a means and a way to achieve the goal of influencing the object of communication.

Therefore, the subjects of SCT can be social institutions and social organizations.

The following can be distinguished as common features of subjects and tools of social and communicative technologies:

- focus;

- structuring, delimiting, dividing an object into elements;

- operations, stages, phases;

- coordination and phased actions;

- the unambiguity of the procedures and operations.

Thus, we can conclude that social and communicative technologies are a complex and multifaceted process, the achievement of the goals of which requires serious efforts and well-coordinated actions.

We single out the main types of communications:

1. One of the central roles is media relations. At the state level, this is the universal broadcasting of messages from authorities, in particular, the government, the president, the State Duma and the Federation Council.

2. Communication with the population. This technology is implemented in order to provide support of the local authorities by the population (for example, personal meetings with the population, and visits to commercial and municipal enterprises, personal speeches of government representatives).

For example, communication with the population is carried out through:

- organizing public hearings on issues of significant public interest within a separate municipal entity of the region (Khludnev, 2019);

- conferences with the participation of authorized representatives of local and regional authorities.

Modern researchers note the special role of Internet technology in organizing the interaction of power and the population. “It is Internet technologies that are called upon to provide adequate information support for the process of interaction between government and society on a widely accessible, continuous and timely basis” (Ustinova & Khayrullina, 2015).

3. A slightly different form of communication is making reports, analysis of the work done, recognition of errors, identification of ways for further actions. All kinds of preventive measures and their results. It is when using this form that feedback is of great importance, reflecting the performance of subjects, their actions, efforts and results (Chumikov & Bocharov, 2009).

4. Cultural and leisure communications during various holidays - City Day, Harvest Day, Cossacks Day and so on, almost all authorities are involved. As a result, each institution that somehow participates in the event should direct its efforts to creating a favorable image of its structure.

2.2. Communication in the concept of information and communication technologies

By modern information and communication technologies we currently mean various methods of creating, fixing, processing and dissemination of information. The category of technology is acquiring a dominant, system-forming significance at the present stage of social development. If in previous eras, technology was considered as a simple set of recipes and thought to be secondary to culture, in recent decades it has been recognized that technological improvement is the basis for the development of modern technogenic civilization, and radically new forms of human culture are associated with the birth of fundamentally new technologies. A. I. Rakitov notes in this connection: “... technology in the usual ... understanding is a set of various operations and skills that are implemented in a fixed sequence in the appropriate space-time intervals and based on a well-defined technique to achieve the chosen goals." During the development of society, “technology is included in the system of social relations and activity structures ... technology becomes a factor in various social modifications and transformations, affecting various social structures and subsystems of society” (Rakitov, 1991).

Modern information and communication technologies, in contrast to other technologies that are implemented exclusively in the field of material production and subject activity, and only indirectly affecting spiritual activity, are a means that penetrates mainly into the sphere of intellectual labor. Modern information and communication technologies are a fundamentally different type of technology, different from all previous ones, they possess "cultural and gnoseogenic functions in addition to the sociogenic function inherent in all of them".

The sociogenic function, which is inherent in all technologies and acts as a factor in various social modifications and transformations, in the case of information and communication technologies (ICT) finds expression in the manifestation of culturogenic and gnoseogenic functions.

1. The culturogenic function of modern ICT. When implementing this function, modern information and communication technologies penetrate "... into all the mechanisms of mass communication, education, upbringing, training, influencing personality formation, lifestyle, and system of interpersonal communication" (Udovik, 2011).

2. The gnoseogenic function of modern ICTs is "... the set of procedures and operations carried out using modern computers and information networks that affect cognition and contribute to the growth of new knowledge ...". Modern ICTs generate intelligent technology, which includes artifacts, software products and knowledge systems that ensure the birth of a fundamentally new phenomenon in the history of technological civilization. This phenomenon consists in the fact that it is possible to produce, transform, carry out super-high-speed transmission and actualize information not only with the help of the human brain and means of communication, but also with the help of completely new technical devices embodying the idea of artificial intelligence.

Consequently, the key vector in the development of modern information and communication technologies is not only to reduce the number of operations performed to collect and process information, but to radically change the entire system of spiritual and practical activity and cultural creativity.

2.3. Communication in the Digital Economy Concept

Today, Software Defined Networking and Network Functions Virtualization automate the provision of services in virtual and physical segments and will become the basis for the construction of a new generation of Internet. The explosive growth in traffic caused by the proliferation of Internet of Things applications and services, video streaming, and corporate "cloud" environments can provide a transition to M2M digital platforms and communication technologies, machine-to-machine communication systems, or "physical object - physical object" (based on analytics, things themselves make decisions or give commands to other things), which will allow the creation of intelligent cities and smart factories of the future.

2.4. Venture capital market for investing information and communication technologies

The amount of capital investment in ICT is high in almost all industrialized countries. The largest investments in this sector are characteristic of the USA, Japan and Western Europe.

An important feature of the ICT sector is their investment attractiveness, due to the high return on investment and growth prospects.

ICT sectors in developed countries have strong employment potential. In the United States alone, the number of people employed in information technology products and services industries amounted to 3.8 million people in 2015, and by 2020 it is expected to grow to 4.1 million people.

A feature of the current stage of technological development in the country is a decrease in the share of already existing high-tech industries that operate using robots, computers, non-traditional energy resources and structural materials (Table 1) (Rating of countries of the world by the level of development of information and communication technologies, 2020).

Table 1
Competitiveness of countries and their equipment ICT

Country competitiveness rating		Country	Specific gross national product, USD/person	ICT equipment indicators			
prospective	current			Phones (Smartphones), pcs/1000 people	Cost of 3 minutes of local communication	Personal Computers, pcs./1000 people	Number of Internet users, thousand people
1	22	Finland	47750	732	0,13	562,1	5098
2	16	USA	62850	925	0,10	671,4	312322
3	18	Singapore	58770	5219	0,02	638,8	4600
4	14	Australia	53190	812	0,16	829,4	20268
5	8	Norway	80790	890	0,08	746,8	5044
6	11	Sweden	83580	931	-	690,3	8861
7	13	New Zealand	40820	814	0,01	533,0	3995
8	5	Great Britain	41340	942	0,19	480,6	62091
9	4	Denmark	60190	854	0,12	561,0	5461
10	3	Switzerland	83580	728	0,13	741,5	7300
11	12	Germany	47180	780	0,11	756,0	72290
12	21	Austria	49260	742	0,17	415,6	7171
13	15	France	14080	713	0,12	512,1	56367
14	10	Japan	41340	914	0,09	657,2	117528
15	27	Spain	29450	769	0,09	384,4	40148
16	2	South Korea	30600	861	0,04	319,8	47013
17	38	Greece	19600	778	0,07	211,8	7322
18	45	Russia	10230	550	0,02	180,4	109552

The speed and quality of investment processes in the sector of information and communication technologies is largely determined by the ability of domestic industrial producers to provide all spheres with modern means of processing and transmitting information, otherwise the percentage of imports of ICT technologies is significant.

According to a review by the Russian Association of Venture Investments (Market Review. Direct and venture capital investments in Russia, 2018) at the end of 2018, the information and communication technology (ICT) sector remains the focus of attention of venture investors. About 70% of venture capital investments - both in volume and in number - fell on the ICT sector. An analysis of the trend dynamics taking into account the industry preferences of new players does not yet allow us to talk about a significant change in the situation: investors are in no hurry to increase their presence in the market of real technologies that is more resource-intensive, with a long investment cycle.

It is advisable to use the discrete financing method as the main method for selecting venture financing facilities. This method allows you to take into account the cost of financial flows over time, as well as the strategic value of the project, taking into account the ability of the investor to take an active part in the management of the company during the implementation of the project, and quickly respond to a number of negative changes and minimize losses (Lozhkina et al., 2020).

3. Materials and methods

Factor analysis method

When determining the effectiveness of investing resources in information and communication technologies, it is advisable to use the factor analysis method, which allows determining the influence of various factors on the effective indicator.

The presence of a systematic approach to investing in ICT of a modern enterprise allows for the effective management of information and communication processes and the rational distribution of information and

communication resources (ICR). These resources include the following elements: information, time, material, energy and labor.

It is difficult to determine a quantitative indicator of the effectiveness of the use of these resources in the process of investing in ICT. In practice, the process of organizing investments is traditionally influenced by the following processes:

1) uneven provision of resources;
2) their non-optimal use.

Thus, the availability of resources is a necessary but insufficient condition for the effectiveness of investing in ICT.

Information and communication resources (ICRs) of an organization acquire value only upon receipt of a consumer assessment, that is, with their full participation in the functioning of the information and communication system.

4. Results

To conduct factor analysis, it is necessary to derive a formula that determines the influence of various factors (information and communication resources (ICR) and information and communication factor (ICF)) on the effective indicator - the information and communication potential of the enterprise:

$$P_i = R_i - F_i$$

where: R_i is enterprise resources that are an element of the information and communication system;

F_i is information and communication factor; it is a component of the information and communication resources of the organization, which is partially or fully involved in the system and brings the result.

P_i is information and communication potential of the i-th factor of the enterprise. The following options for the effective indicator are possible:

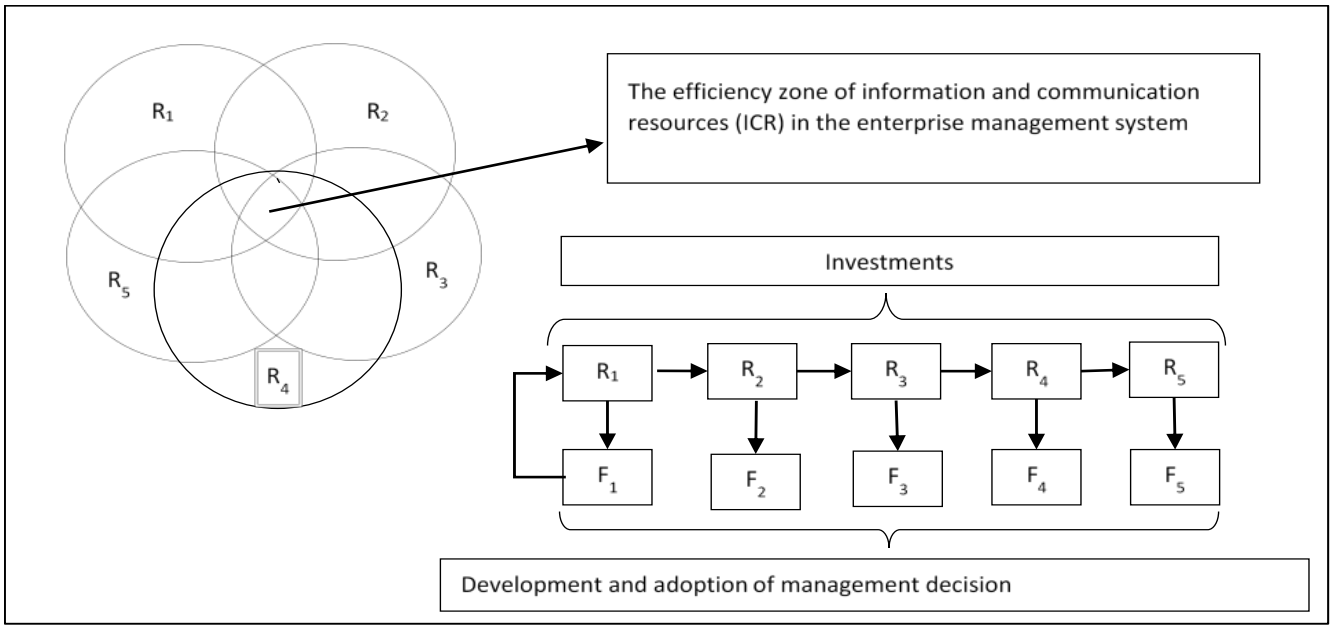
- $P_i > 0$ - the organization has stocks of i - resource;
- $P_i = 0$ - the optimal state of the i-resource and i - factor;
- $P_i < 0$ - investments in the i-th resource are necessary.

Therefore, with an ideal enterprise informatization system, the sum of all factors will have to strive for the sum of all resources, which will characterize the maximum efficiency of their use, that is

$$\sum_{i=1}^{m} F_i \Rightarrow \sum_{i=1}^{m} R_i$$

Figure 3 clearly demonstrates the interpretation of the theoretical model for managing the efficiency of investment in ICT.

Figure 3
ICT Investment Performance Management Model



Source: compiled by the authors

If ideal conditions are met, then the sum of all factors (Fi) should tend to the sum of all resources (Ri). Graphically, such a zone of effectiveness will be represented as a circle (Figure 2).

At the same time, the management of the efficiency of investments in ICT on the basis of a systematic approach should be carried out using a feedback mechanism that takes into account the efficiency of the implementation of factors and information and communication resources, after which the most optimal investment management decision is made.

Information and communication resources (ICR) of an organization (Ri) consist of information, time, material, energy and labour resources. The effectiveness of their use when investing in information and communication technologies (ICT) is difficult to determine. Information and communication factor (Fi) is a component of the ICR that is partially or fully involved and yielding results.

Traditionally, the effectiveness of investment in ICT is influenced by two situations: uneven provision of resources and suboptimal use of them.

Table 2 shows the functional (F) and resource (R) criteria that ensure the fulfillment of the given equation in the organizations of the business sector of the Kaluga region. The criteria were assessed in points on a 10-point scale. The maximum score (10 points) is assigned to a criterion that is fully met at the enterprises of the region. After summing up the scores by functional criteria, they were compared with each other (using the formula Pi = Ri - Fi) in order to determine the information and communication potential of the i-th factor (Pi).

Table 2
The ratio of functional and resource criteria for determining information and communication potential

Resource criteria (R)			Functional criteria (F)	
Criterion name	Score in points (on a 10-point scale)	⟺	Criterion name	Score in points (on a 10-point scale)
Material resources R1 (availability of an up-to-date hardware and software complex necessary for the successful implementation of this ICT)	7,2	<	Chronological characteristics of the information and communication process (ICP) (data transfer rate, memory capacity for storing information, etc.)	8,1
Energy resources R2 (energy requirements for the implementation of the information and communication process (ICP) for this ICT)	8,4	>	The degree of stability of the energy-information infrastructure of the enterprise in relation to internal and external factors of volatility	7,9
Human resources R3 (quantitative and qualitative composition of employees responsible for the implementation of this ICT)	5,4	<	Personnel characteristics demonstrating the degree and quality of information technology training	7,8
Time resources R4 (the amount of time required to implement the ICP for a given ICT)	5,2	<	Optimality characteristics of the time parameters for the implementation of ICP, the quality of communication interaction	7,4
Information resources R5 (a set of competencies demanded in the process of ICT implementation)	6,7	>	Staff readiness to adequately perceive and display the results of ICT implementation (correctness of speech or image recognition, quality of generated graphic information; document reliability, etc.)	6,2
Total	32,9			37,4
Effective indicator Pi = Ri - Fi	P_i = 32,9 - 37,4 = - 4,5 < 0			

Source: Compiled by the authors on the basis of the Ministry of Economic Development of the Kaluga Region, (2020)

As can be seen from the table, the effective indicator Pi shows the discrepancy between the functional and resource criteria that ensure the effectiveness of investment in ICT. In the Kaluga region, the following factors need additional investment: material resources, labour resources, temporary resources.

5. Discussion

Such a systematic approach, based on a combination of resources and factors, makes it possible to form a mechanism for managing the effectiveness of investments in ICTs and make the best investment decision. It allows you to get an estimate of the contribution of info-communication resources to the economic indicators of the enterprise, which can be obtained based on an analysis of the criteria characterizing the production situation. This approach allows obtaining detailed accounting information that unambiguously characterizes both the participation of this type of resources in the main production process at the stages of the technological process, as well as the status of the considered ICTs as the company's main assets.

For quantitative and qualitative assessment of the effectiveness of possible options for designed or available ICTs, it is necessary to determine the criteria for their effectiveness. At the same time, using methods for assessing the effectiveness of ICTs, it is necessary to identify intermediate stages in such a way that they can be described, measured and controlled using quantitative indicators.

When assessing the information technology needs of enterprise management in the course of deciding on the implementation of an ICT project, it is necessary to determine a system of performance indicators. Abroad, quantitative and qualitative assessments are used for this. Since 1988, Computer World magazine annually compares companies by the effectiveness of their information and communication technologies. Enterprises are ranked in accordance with indicators, the totality of which gives an index of the efficiency of ICT use in them. Thus, the process of investing in ICT is important for the successful solution of the following management tasks:

- pre-production;

- production and sale of competitive, informational and knowledge-intensive products;

- selection of investment projects with a high degree of efficiency;

- the use of ICT as the basis of operational management in the field of research and development (R&D).

In the course of justification of the need to invest in information and communication technologies, the following factors must be taken into account:

- the availability of financial benefits of the ICT implementation project;

- the process of the impact of ICTs on other projects that are being implemented as part of the R&D portfolio;

- determination of the degree of influence of the project in question on the economy of the organization as a whole.

6. Conclusions

Thus, investing in information and communication technologies contributes to the successful solution of a number of strategic problems:

a) increasing efficiency through reorganization of the enterprise and diversification of the business;

b) increasing the competitive advantages of the business;

c) increasing customer satisfaction by improving the efficiency of their services;

d) optimizing the customer base and expanding the presence of business in the market.

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