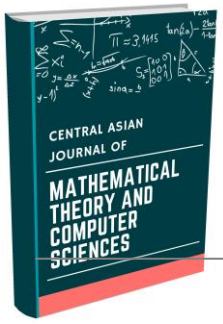

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REALIZATION OF ECONOMIC AND MATHEMATICAL MODELING OF INFORMATION SYSTEMS

Inomjon Yarashov, Dadanur Shukurov

Teacher of Computer Engineering Department of Tashkent University of Applied Sciences

Kamoljon Xudoyqulov

Senior lecturer of Computer Engineering Department of Tashkent University of Applied Sciences

Abstract

The research describes the points of project of information systems of organizations, describes the results of the implementation of the method of information system design in the case of the local fund of a compulsory medical organization. Mathematical modeling is used to select the optimal option of an information system from various options. An optimal solution was obtained using mathematical modeling. Conclusions and recommendations are formed based on the imitation results.

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Introduction

A modern organization is a complex dynamic system focused on the performance of specific tasks, the totality of which characterizes the effectiveness of the information system. Improving the functioning of the corporative system can be ensured by using information technology's items, algorithms and mathematical modelling and optimization methods [1-6].

Informatization of production sectors in countries is a natural continuation of the objective process of social development and the collection, storage, transmission, processing and presentation of necessary information. Increasing the quality of work, labor productivity and efficiency in the fields of economy, production, communication, research, education, medicine and business is connected with the most modern information and communication technologies applied in them. Modern information and communication technologies deliver collected information products to people at a rapid pace, while reducing the level of labor, creating wide opportunities to solve existing problems. Therefore, effective use of information and communication technologies[7-15] in all sectors of the economy serves as an indicator of technological and economic development of the country.

Achieving high results in the economic and social spheres of the state, taking the place of a full-fledged partner in the world economic system, depends on the high level of application of modern digital and information technologies in all aspects of human activity. And it depends on the role of techniques and technologies in increasing the efficiency of social work. The information society creates a great ground for

economic and scientific-technical progress, the quality of products produced in the country and the improvement of labor productivity, the improvement of macro- and micro-level management of the economy, and the development of promising scientific areas. Building a comprehensively perfect society is closely connected with the achievements of scientific and technical development and the application of information[16-21], communication and digital technologies in the fields of advanced production, materials and raw materials. Informatization processes[22-29] serve as the main basis for the improvement of man and society, which is the main social productive force of modern society.

It gives people a great opportunity to improve their skills in the wide application of the most modern computer equipment[30-32] and technologies and to test their inexhaustible abilities in practice.

Arming a person with modern digital technologies that strengthen the capabilities of information processing and systematic analysis is the most important scientific, technical, technological and economic task that requires rapid development of the information industry.

The use of information technologies in the economy ensures the quality of economic information, system analysis, reliability, its accuracy, objectivity, speed, and as a result, the ability to make management decisions on time with the help of complex algorithms.

Therefore, the formation and organization of a complex information system is one of the most urgent tasks of today and is the main factor of the development of society. The main criterion for the introduction of information and digital technologies should be the orientation of each person, as well as society in any market economy and state management. Information technologies include an information system that is used in all spheres of human activity and has an organizational, economic and social structure. Information systems and digital technologies are being used more and more widely in various spheres of personal activity from year to year. The purpose of their creation, implementation and widespread use is to solve the problems of society and the entire life activity of a person in terms of information.

The indicated measures allow the active role of telecommunications, computer and information technologies to increase in the growth of the efficiency of the country's economy. It makes it possible to ensure that people's activities and life are equipped with the most modern types of technical devices and services. It enables successful integration of the state into world processes. Therefore, it is necessary for students studying economic specialties to be educated as mature specialists and perfect people who can meet the demands of the times. It is important to use modern information technologies in the formation of the state system of information, in all spheres of economic and social life. It is of great importance in the mass introduction and use of computer equipment and telecommunication equipment.

It is important to more fully satisfy the growing information needs of citizens. Complex information systems are of great importance in entering the world information community and expanding the enjoyment of world information resources.

The daily increase in the amount of information and knowledge requires effective use of information and communication technologies in all areas of the state economy, including education. Information has become a resource that can be searched and distributed just like traditional resources. There is a strong reason to say that the total volume of this resource will determine the strategic capabilities of the states in the future, as well as their defense capabilities.

Digital information, digitization, computerization, algorithmization, computing techniques represent the most important features of information and digitization of society. Scientific concepts such as modern information technology, modeling, database and databank, programming, personal computers, software supply also represent digitization and information. Digital information is a set of knowledge and digital information, which is a result of the development of social, economic and natural sciences, the science of thought, and the experience of people during their practical activities. As a person lives in the flow of digital information, it is possible to see the digital connection of various events, phenomena and processes. In order

to systematically and algorithmically analyze the essence of the interaction, it refers to a lot of evidence and numbers. Thanks to digital information, theoretical knowledge merges with practice.

Academician V. Q. Kabulov noted, "Economic cybernetics, based on the political-economic analysis of social production, sees information and materials as part of the economic system of radical transformation." Management errors due to lack of information are very costly. Meanwhile, the system with the most information on management and production efficiency, development and use of advanced technologies is winning. Experts consider, first of all, the free access of economists to information as one of the main conditions for the efficiency of the market economy in the context of industrial development. The main spheres of their activity and social production are related to information in one way or another, and make up 40-60% of the employed. Information services make up 10% of the world gross social product and national income. 90% of it corresponds to the USA, Japan and Western Europe. Information is an important product of intellectual activity. In all industrialized countries, the development and introduction of "methods and means" of delivering these products to their users is being carried out at a rapid pace, which is reflected in the creation of the information systems and technologies industry.

Research of information processing technologies

A information system is a set of technical and software supplies, algorithmic supplies and organizational measures designed to automate digital information processes in professional activities.

An automated information system provides the introduction of some modern information technologies for processing digital data in the course of professional activity.

In order to improve the efficiency and quality of object management, as well as to analyze the activity of the enterprise, it is necessary to create a comprehensive complex information system based on the use of modern digital and/or information technologies to prepare, receive, process, transmit, record, and control information. The purpose of the study is to automate the data processing system.

The information system requires solving the following tasks:

- It is necessary to determine the purpose of the automated system of information processing;
- It is necessary to consider the requirements and structure of systems of information processing;
- It is necessary to determine the general structure of the object;
- It is necessary to create a database;
- The domain model should be described.

Purpose of automated information processing system. When considering the issues of automation of control systems, first of all, it is necessary to clarify the automation, that is, it is necessary to determine the objects of automation. In order to identify the objects of automation, it is necessary to analyze the operation process of the enterprise. As a result of the analysis, a description of the data processing process in the management system should be obtained, the elements of the information process should be determined. Analyzing the process of information processing in solving any management task, which includes the implementation of a specific mechanism for processing the information entered into it to a certain result, and is an interdependent process carried out individually by officials. allows to extract three types of information. A person's daily work activity is related to receiving and collecting information about the external environment, identifying and processing information necessary for solving various issues. For this reason, the above complex of actions, the means of their implementation serve as the basis for creating information systems (IS).

The activity of AIS is related to the collection and processing of information. The information entered into the system and given to the user is formed in the form of documents. For this reason, a document is a material object and consists of a set of information formalized on the basis of a certain procedure. If people and technical tools are considered as sources of information in AIS, different users as consumers can be

divided into three groups: system administration, programmers and end users. Users' appeal to AIS is done on demand basis. A request is a seasoned message, which specifies the conditions for searching for relevant information and the tasks that must be performed on them. Accepting and entering requirements, performing specified actions, preparing relevant information and presenting it to the user in document view are the main steps of any AIS operation. Currently, AISs are used in various fields of human activity, for example, in the management of national economic sectors, in the management of research and development, and in planning in the field of education. In this case, one of the following two methods is used: autonomous use of AIS. In this case, AIS is not part of another system, but works independently. Examples of this are, for example, systems for selling ready and railway tickets ("Sirena", "Express"), information-search systems that prepare relevant documents on demand, etc. Using AIS as a component of a higher level management system. In this case, the generated output data is used in the operation of other elements of the system. Examples of such AIS are, for example, information - training systems, automated design systems, automated control systems. Documented information retrieval system (DIRS) stores and processes documented information. An example of an automated system of library activity is an example of a library.

Principles of information processing base organization

information is a set of modified and processed data that reflects the status and progress of processes.

The variety of requirements for information, the ever-increasing range of issues, etc. place a number of demands on modern IT.

These requirements include: Accuracy of information processing base. It is known that the database forms the information model of the relevant field. For this reason, the information stored in the database should be fully and clearly expressed as to the state, characteristics and relationships between the objects. A DB created otherwise can be dangerous and cause damage.

Speed and performance. The speed of the system is determined by the response time to the set request. In this case, it is necessary to take into account not only the speed of the computer, but also the location of the data, search methods, the difficulty of the request and other factors. Productivity of the system is determined by the amount of requirements fulfilled within a unit of time.

Simplicity and ease of use of DB. This requirement is imposed by all users of the system. Therefore, it is important to create easy, simple and convenient ways to use DB.

Data protection. The system should ensure the protection of information and programs stored in the database from external influences and foreign users.

System development. The content of the system must always be estimated with new elements, programs, information arrays should be changed and updated.

A DB that meets the above requirements can be organized based on the following principles: The principle of data integration. According to the essence of this principle, unrelated information is combined into a single database.

As a result, data is presented to the user and his application programs in the form of information arrays. When using information arrays, it becomes easier to search for the necessary information, manage the processing processes, reduce the redundancy of data, and simplify the maintenance of the DB.

The principle of data integrity. Through this principle, the accuracy of the information stored in the DB increases, that is, their characteristics and descriptions are fully represented by the relevant field objects. The integrity of the data may be violated as a result of entering the wrong information or deleting a certain part of it from the memory. That is why it is possible to ensure the integrity of the DB by controlling the entered information, constantly checking the stored information, restoring it using a special system, and other measures.

Data relevance is principled. According to the essence of this principle, all information in DB is interconnected and represents the relationship between objects. Types of information and the set of relationships between them make up the logical structure of information.

Principle of data sufficiency. According to the essence of this principle, the relevant information is stored in a single copy in the DB, and they are interconnected and sufficient to solve any problem. For example, in AIS, which consists of autonomous files, some information is repeated, but in DB, their repetition is completely eliminated.

The principle of centralizing DB management. According to this principle, all functions of data management are assigned to a single control program - database management system (DBMS). From IS based on adherence to this principle

efficiency of use, all processes are carried out through the DBMS.

The principle of separating the presentation of the information processing base from their processing processes. According to this principle, the data representation is prepared outside the application programs and stored in the DB. This, in turn, simplifies the programming process, reduces the amount of information required for the program. Improves DB maintenance and etc.

Thus, on the basis of the above-mentioned principles, the composition of the DB was created, that is, the interconnection between the logical, physical and software elements of the IS is developed.

Implementation of mathematical modeling of information system in the digital economy.

The mathematical model is constructed as follows: among companies providing Internet services in the Republic of Uzbekistan, it is required to choose an Internet provider that meets the maximum value of the net current effect (the largest total cost of capital) and demand. restrictions.

The mathematical model includes two stages:

1. Companies providing the Internet on the territory of the Republic of Uzbekistan are selected according to the method of expert assessment.
2. Using the methods of mathematical programming, the optimal option is selected from among the Internet providers selected at the first stage.

The peer review method is based on the experience and intuition of experts. A group of experts is developing a list of factors that characterize an Internet provider. Each factor is assigned a weight. Next, experts evaluate the project under consideration for each factor, after which these estimates are summed up, taking into account predetermined weights, and then averaged over the number of experts.

Let $i = \overline{1,n}$ be the number of options for Internet providers project; j=$\overline{1,m}$ - number of experts evaluating options for Internet providers project; k=$\overline{1,p}$ -number of factors;

β_{jk} - the weight assigned by the j-th expert to the k-th factor, Z_{jk}^{i} - assessment given by the j-th expert to the k-th factor, then the average assessment of the i-th version of the Internet provider project is determined by the formula (1):

$$\bar{Z}_{i}=\frac{1}{m}\sum_{j=1}^{m}\sum_{k=1}^{p}\beta_{jk}*Z_{jk}^{i}$$

Ranking allows you to identify the most suitable options for Internet provider projects. At the second stage, the optimal project is selected from among the projects identified at the first stage. The problem of linear programming of the choice of the optimal project from the investment portfolio is formulated. To solve the problem, a mathematical model of linear integer programming has been developed.

The construction of a mathematical model includes four stages.

Stage 1. Definition of variables.

The variables in the mathematical model are the shares of financing of investment projects, the values of which determine whether the project will be implemented ($X_i = 1$) or not ($X_i = 0$).

Stage 2. Definition of purpose and limits.

The criterion for selecting projects in the optimal investment portfolio can be the maximum net present value cash flows (net present effect), maximum net accounting profit (saved costs), minimum present costs, shortest payback period. Constraints are the means of funding available in the relevant time periods.

Stage 3. Describing the goal through task variables.

Let Z be the total net present value of investment projects, then the mathematical formulation of the objective function is to determine an investment project from among the alternative ones that maximizes the value of the net present value. The target function looks like(2):

$$max \leftarrow Z = \sum_{i=1}^{n} A_i * X_i = A_1 * X_1 + \cdots + A_n * X_n$$

Stage 4. Description of restrictions through task variables. When solving the problem, the limitations on the available funding resources in the relevant time periods and the magnitude of the variables are taken into account.

The mathematical description of the restrictions has the form(3):

$$\begin{cases} B_1^0 * X_1 + B_2^0 * X_2 + \cdots + B_n^0 * X_n \le I^0 \\ B_1^1 * X_1 + B_2^1 * X_2 + \cdots + B_n^1 * X_n \le I^1 \\ \vdots \\ B_1^m * X_1 + B_2^m * X_2 + \cdots + B_n^m * X_n \le I^m \\ X_i \ge 0, integer\ number \end{cases}$$

Thus, the mathematical model of linear integer programming has the form

$$max \leftarrow Z = \sum_{i=1}^{n} A_i * X_i = A_1 * X_1 + \cdots + A_n * X_n$$

under the constraints (4)

$$\begin{cases} B_1^0 * X_1 + B_2^0 * X_2 + \cdots + B_n^0 * X_n \le I^0 \\ B_1^1 * X_1 + B_2^1 * X_2 + \cdots + B_n^1 * X_n \le I^1 \\ \vdots \\ B_1^m * X_1 + B_2^m * X_2 + \cdots + B_n^m * X_n \le I^m \\ X_i \ge 0, integer\ number \end{cases}$$

where A_i is the target indicator, single measure;

B_j^i - investment costs of the i-th project in the j-th period of time, million dollars;

I_j - available funds in the j-th period of time, million dollars;

X_i-share of investment project financing (binary variable, the value of which determines whether the investment project $X_i = 1$ will be implemented or not $X_i = 0$;

$i = \overline{1,n}$ - investment project number;

$j = \overline{1,m}$ - number of time period, year.

The economic and mathematical model for choosing the optimal investment project for Internet provider has the form:

$$\bar{Z}_i = \frac{1}{m}\sum_{j=1}^{m}\sum_{k=1}^{p}\beta_{jk} * Z_{jk}^{i}$$

$$max \leftarrow Z = \sum_{i=1}^{n} A_i * X_i = A_1 * X_1 + \cdots + A_n * X_n$$

under restrictions (5)

$$\begin{cases} B_1^0 * X_1 + B_2^0 * X_2 + \cdots + B_n^0 * X_n \le I^0 \\ B_1^1 * X_1 + B_2^1 * X_2 + \cdots + B_n^1 * X_n \le I^1 \\ \vdots \\ B_1^m * X_1 + B_2^m * X_2 + \cdots + B_n^m * X_n \le I^m \\ X \ge 0, integer\ number \end{cases}$$

Using the economic-mathematical model, we will select the optimal Internet provider project for the territorial compulsory health organization fund.

At the first stage, we will select options for Internet provider projects using the method of expert assessments. In table. 1 shows the selection criteria, factor values and weighting factors. In Table 2 shows the calculated scores for Internet provider projects.

After ranking Internet provider projects for TF OMC, the investment portfolio includes CJSC NTV-Plus (about 199 points), Europe Online Networks (EOL) (about 177 points), Astra Networks (about 157 points), Satpro (about 152 points) and Network Service (about 137 points).

In table 3 shows the costs for the implementation of Internet provider projects selected at the first stage economic and mathematical model.

In table. 4 shows the initial data for choosing the optimal Internet provider project from the investment portfolio. Net Present Value (NPV) is calculated using the formula (6)

$$NPV = \sum_{k=1}^{n} \frac{P_k}{(1+r)^k} - \sum_{j=1}^{m} \frac{IC_j}{(1+i)^k}$$

where kP - annual earnings;

r – discount rate;

IC– investment;

n – duration of the project, years;

m - duration of consistent investment of resources, years;

i – projected average inflation rate.

The net present effect from the implementation of the Internet provider project provided by NTV-Plus CJSC at a discount rate r=25% and a predicted average inflation rate i=14% is determined by formula (6) and is numerically equal to (7):

$$NPV = \frac{3{,}999067}{1{,}25} + \frac{3{,}999067}{1{,}25^2} + \frac{3{,}999067}{1{,}25^3} - \frac{5{,}399907}{1{,}14} - \frac{2{,}00643702}{1{,}14^2} = 1{,}52726999$$

Table 1 Table of expert indicators for choosing a project:

Selection criterion	Вес	Factors					
1. Communication standard	2	analog			Digital		
		1			5		
2. Frequency range, GHz	3	C (3-6		Ku (10-12)		Ka (28-48)	
		3		8		10	
3. Polarization	2	Linear			Circular		
		1			5		
4. Data transfer rate, Mbps	5	до 0,5	0,5-1	1-10	10-20	20-30	30-50
		1	2	4	6	8	10
5. Error (FEC)	3	до 0,2	0,2-0,4	0,4-0,6	0,6-0,8	0,8-1,0	
		8	6	4	2	1	
6. Signal level, dBW	4	до 30	30-35	35-40	40-45	45-50	св. 50
		1	3	6	8	9	10
7. Reliability level	3	Short		Average		High	
		2		4		6	
8. Subscription fee, $	2	volumetric		Hourly		Monthly	
		1		3		5	
9. Equipment cost, thousand $	5	До 0,2	0,2-0,5	0,5-1	1-5	5-10	св. 10
		0	8	6	4	2	1
10. The cost of installation and commissioning	4	До 50	50-100	100-200	200-500	500-1000	св. 1000
		10	8	6	4	2	2

Table 2 Assessment of satellite Internet projects

Provider	Grade scoring	Grade
1. Network Service	1*3+6*4+4*3+5*2+8*3+2*4+5*2+4*5+3*2+4*5	137
2. Омиком	1*2+2*5+2*3+6*4+4*3+5*2+5*2+8*3+2*4+4*5	126
3. SatRro	2*5+2*3+6*4+4*3+5*2+6*5+5*2+8*3+4*4+2*5	152
4. Helios Net	1*3+6*4+2*3+5*2+4*5+4*4+1*2+3*3+5*2+4*5	120
5. Europe Online Networks	4*4+5*2+8*3+1*2+1*3+6*4+6*3+5*2+6*5+8*5	177
6. Astra Network	1*3+3*4+2*4+5*2+8*3+1*2+8*5+6*3+5*2+6*5	157
7.Lucky Net	2*4+5*2+8*3+5*2+4*5+1*3+1*4+2*3+3*2+4*5	111
8. Space Gate	2*4+5*2+8*3+5*2+4*5+1*3+1*4+2*3+3*2+4*5	111
9. Adamant	2*4+5*2+8*3+5*2+4*5+2*3+3*4+2*3+3*2+4*5	118
10. Nordic Sattelite	2*4+5*2+8*3+5*2+4*5+1*3+1*4+6*3+1*2+6*5	129
11. НТВ-Плюс	10*4+5*2+8*3+5*2+2*5+2*3+9*4+4*3+5*2+8*5	199

Table 3 Similarly, net present effects from the implementation of other projects are calculated.

Project implementation costs

Project	Costs, million dollars			
	Computing technique, software security, etc.	satellite equipment		General
		Number of sets	Price of 1 set, $	
NTV Plus	7,42468399905	87	230	7,984963999051
EOL	7,42468399905	87	250	8,033683999067
Astra Network	7,42468399905	87	260	8,058043999072
Satpro	7,42468399905	87	210	7,936243999058
Network Service	7,42468399905	87	270	8,082403999049

Let's perform the second stage of the economic-mathematical model.

Let

1 X-share of financing of the NTV-Plus project,

2 X-share of financing of the Europe On Line project,

3 X-share of financing of the Astra Network project,

4 X-share of financing of Satpro project,

5 X-share of financing of the Network Service project.

Using the initial data from Table 4, the mathematical model can be written as an objective function and constraints

$$max \leftarrow Z = 1{,}52726999 * X_1 + 0{,}741240001 * X_2 + 1{,}3743999 * X_3 + 0{,}14510999 * X_4 + 0{,}53001 * X_5$$

$$\begin{cases} 5{,}39909 * X_1 + 3{,}1999 * X_2 + 2{,}931003 * X_3 + 6{,}286003 * X_4 + 5{,}901 * X_5 \leq 6{,}499906 \\ 2{,}00643701 * X_1 + 1{,}499901 * X_2 + 3{,}000546999 + 3{,}000574999 * X_4 + 3{,}199903 * X_5 \leq 2{,}99906 \\ 2{,}499908 * X_2 + 1{,}999075 * X_3 + 1{,}6 * X_5 \leq 2{,}99903 \\ 0{,}88183199905 * X_2 + 1{,}186 * X_5 \leq 1{,}499902 \\ X_1, X_2, X_3, X_4, X_5 \geq 0 \\ X_1, X_2, X_3, X_4, X_5 - integer\ number \end{cases}$$

Table 4 Initial data for determining the optimal project

Period time f, years	Investment costs, million dollars					Total investment costs, mln dollars	Available funds funding, mln dollars
	NTV Plus	EOL	Astra Network	Satpro	Network Service		
F=0	-5,4000002	-3,200001	-2,9310002	-6.286001	-5.899902	-23.71699	6,499901
F=1	-2,0064301	-1,500001	-3,0005469	-3,0005749	-3.199901	-12.70756	3
F=2	0,000000	-2,50000	-2,00000	0,000000	-1,6	-6.100000	3
F=3	0,000000	-0,88183	0,000000	0,000000	-1.186532	2.068364	1,499903
NPV	+1.5272699901	+0.74122999	+1,37438999	+0.1451101	+0.5303101		

The problem of mathematical modelling is solved by the methods or branches and bounds. On computer, the problem of mathematical modelling was solved using the add-on "Search for a solution" ("Solver") Microsoft Excel for Windows 10. The optimal investment project for satellite Internet is NTV-Plus. The maximum net present value is $1.5272699901 million.

Conclusion

The results of implementing the method of designing information systems are described using the example of a local fund of a compulsory medical organization; the study describes the points of the project of information systems of organizations. To select the optimal option for an information system from a variety of options, mathematical modeling is used. Using mathematical modeling, an optimal solution was obtained based on the modeling results.

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