An analysis of the impact of new global trends, such as Industry 4.0, on project-oriented companies was performed. Based on the analysis, the research problem is formulated, which consists in the need to create project management systems in accordance with the concepts, ideas, principles and methods of digital transformation of project-oriented companies. Project management processes in the conditions of digital transformation of project-oriented companies are defined as the object of research.

An approach to the creation of project management systems is proposed, which is based on the need to adapt the organizational, methodological and technological components of these systems to the specifics of a project-oriented company and the conditions of digital transformation. Based on this approach, the methodological, organizational and technological components of project management systems were improved. As part of the organizational component, a structural and functional model of project management is proposed, which takes into account the conditions of digital transformation of a project-oriented company. Within the framework of the methodological component, it is proposed to use management meta-methodology to create a project management methodology specific to the company's conditions and digital transformation processes. A digital interpretation of matrix information technologies for the technological component is proposed.

An organizational and technological model of implementation of project management systems in the conditions of digital transformation of companies was developed.

The conditions for the practical use of the concept are given: the systematic organization of the digital space and the availability of qualified specialists in the creation of project management systems. The implementation of the concept made it possible to reduce the project execution time by 5–20 %, as well as project cost due to more rhythmic work performance

Keywords: project management systems, organization, methodology, project management technology, digital transformation

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DEVELOPMENT OF THE CONCEPT OF BUILDING PROJECT MANAGEMENT SYSTEMS IN THE CONTEXT OF DIGITAL TRANSFORMATION OF PROJECT-ORIENTED COMPANIES

Iurii Teslia
Doctor of Technical Sciences, Professor
Department of Information Technology Design*
Iulia Khlevna
Corresponding author
Doctor of Technical Sciences, Associate Professor**
E-mail: yuliya.khlevna@gmail.com
Oleksii Yehorchenkov
Doctor of Technical Sciences, Associate Professor**
Nataliia Yehorchenkova
Doctor of Technical Sciences, Professor
Institute of Management***
Oleg Grigor
Doctor of Political Sciences, Professor
Department of Economics and Management*
Yevheniia Kataieva
PhD, Associate Professor, Researcher
Faculty of Informatics and Information Systems***
Tatiana Latysheva
PhD, Assistant**
Tetiana Prokopenko
Doctor of Technical Sciences, Professor
Department of Information Technology Design*
Yuriy Tryus
Doctor of Pedagogical Sciences, PhD, Professor
Department of Computer Sciences and System Analysis*
Andrii Khlevnyi
PhD, Assistant**
*Cherkasy State Technological University
Shevchenka ave., 460, Cherkassy, Ukraine, 18006
**Department of Technology Management
Taras Shevchenko National University of Kyiv
Volodymyrska str., 60, Kyiv, Ukraine, 01033
***Slovak University of Technology in Bratislava
Vazovova str., 5, Bratislava, Slovakia, 811 07

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1. Introduction

Digital transformation of society, economy, companies, the fourth industrial revolution (Industry 4.0) require changes and development of management tools in various spheres of human activity [1, 2]. The emergence of agile project management methodologies, the updating of the body of knowledge of the project management institute in

PMBOK 7.0, the development of a project management meta-methodology (PMMM) indicate that the science of project management does not stand still. It is developing in accordance with global trends of human development. This, in turn, requires the development of project management tools, expanding the use of digital technologies, methods of collective problem solving based on flexible management tools and remote interaction of project team members.

A large-scale increase in companies' interest in developing practical methods of effective project management in the conditions of Industry 4.0 leads to the need for individualization (to meet the conditions of companies), and also improvement of organizational management structures, enrichment of methodology and information technology of project management with models, methods and means of management and development of enterprises in integration with digital transformation processes.

The activities of most companies are project-oriented. If there are many projects, if organizational structures of project activities are created, and projects are distributed among portfolios, if there is a significant volume of project support activities, there is a need to create project management systems [3]. In particular, systems that would combine the organizational, methodological and technological components of the company's project-oriented activities, as well as take into account the processes of digital transformation of project-oriented companies.

Therefore, bringing the scientific and methodological foundations for creating project management systems to the conditions of digital transformation is an urgent scientific task. The solution of this problem will provide tools for creating project management systems that would meet the requirements of the time and be effective in various sectors of the world economy.

2. Literature review and problem statement

The efficiency of project-oriented companies can be increased through:

a) digital transformation of their activities;

b) application of project management methodology.

In practice, project management methodology is applied in two directions – project-oriented activity management and enterprise development management [4]. But sometimes there is a huge gap between the management ideal prescribed in the project management methodology and the practice of its implementation. You can often hear from project managers that "the methodology does not work" [5]. The reason for this is that it is impossible to create a single methodology for all occasions. Therefore, thousands of different methodologies have already been created (the most popular among them are PMBOK, P2M, OPM3, the Scrum framework) for projects with different specifics.

According to the PMBOK standard [5, 6], the methodology is considered from a practical point of view as a system of practices, methods, procedures and rules used in a certain field of activity. But with the advent of the digital era, specialists at enterprises demand that these methodologies be adapted to the new operating conditions of project-oriented enterprises.

If we consider the most common project management methodologies, we can see that they practically do not take into account the specifics and level of digitalization of enterprises for which they were created.

For example, the most widely used Scrum framework, which is particularly popular in the field of software development, is adapted to customer requirements through the rapid response of a self-organized, multifunctional team to emerging changes [7, 8]. But it is not at all adapted to the technological level (in the sense of digital technologies) of the company. There is no answer to the question of whether and how distributed online interacting project teams can be created; how to implement the processes of planning, development, testing, demonstration through the digital space in the Scrum framework.

Management of innovative projects and programs required the creation of a special methodology. Such a methodology is P2M [9]. It is a good representation of approaches, methods, schemes and principles that can be used in practice. But it does not regulate practical work in projects and programs in the context of the digital transformation of companies.

In [10, 11], methodological foundations at the level of OPM3 model practices were formed. The results show how to convert 456 best practices out of 586 presented by OPM3 into 38 typical best practices. Presentation of methodology as a practical activity is continued in [12, 13]. This is aimed at developing a convergent approach as a mechanism for convergence of existing methodologies of practical activity (PMBOK, OPM3, P2M, PRINCE II, ISO 21500, etc.), but, unfortunately, as in the mentioned methodologies, without taking into account the specifics of implementing management processes in the conditions of digital transformation of project-oriented companies.

Project management meta-methodology is closer to solving the problem of adapting project management methodologies to the conditions of digital transformation of companies, taking into account the specifics of various enterprises [3, 14]. It is used to create specific (under the conditions of enterprises) project management methodologies. And such specification may also include conditions related to the digital transformation of companies.

This approach is also associated with the idea of creating software and information add-ons for project management tools that reflect the operating conditions and needs of enterprises for certain information [15]. But the ideas of applying meta-methodologies and software and information add-ons in the organizational structures of project management are not combined into a single methodological, organizational and technological project management system (MOT PMS), specified by the conditions of the digital transformation of companies.

There are a number of works on the creation and implementation of corporate project management systems (CPMS) [16, 17]. However, in contrast to the analyzed three-component structure of the MOT PMS, the main issue in the creation of CPMS is the means of automation. And the methodological and organizational component of managing the company's project activities either remains outside the framework of the CPMS, or is considered as a derivative part of the information technology solution. Therefore, this approach also needs to be adapted to creating an organizational structure specific to the enterprise conditions, as reflected in [18]. However, the issue of methodology and information technology for managing project and program portfolios is not presented in the work. In addition, CPMS are focused on managing projects and programs, but do not reflect the specifics of project and program portfolio management at

the level of project management of the company in the conditions of its digital transformation [19, 20].

As the analysis showed, despite the scientific and practical results in the field of project management, the issue of creating project management systems focused on digital transformation was not sufficiently reflected in publications. The presence of an unsolved part of the problem, namely the lack of tools for adjusting the organizational, methodological and technological components of project management systems to the conditions of digital transformation of project-oriented companies, calls for the development of a new concept for building such systems.

3. The aim and objectives of the study

The aim of the study is to create a concept for building project management systems in the conditions of digital transformation of companies, which would allow transferring project management processes to the digital space and thereby increase management efficiency.

To achieve the aim, the following objectives were set:

– to develop an MOT approach to the creation of project management systems in the conditions of digital transformation of companies;

– to improve methodological, organizational and technological components of project management systems;

– to develop an organizational and technological model for implementing project management systems in the conditions of digital transformation of companies.

4. Materials and methods

The object of the study is project management processes in the conditions of digital transformation of project-oriented companies. The subject of the study is building project management systems in the conditions of digital transformation of project-oriented companies.

The concept of building project management systems in the conditions of digital transformation of project-oriented companies did not consider the impact of the company's field of activity on such a system. Only the impact of project specifics on the specified project management methodology (SPMM) was considered. Scientific and methodical tools of specified project management methodologies were also not developed. Since these issues are resolved in the project management meta-methodology, the issues of applying the meta-methodology in project management systems should be reflected in the concept being developed.

The assumption of the work is that companies that will use the proposed concept have specialists capable of carrying out the digital transformation of their company, know how to apply meta-methodology and matrix information technology to create project management systems.

The research hypothesis is that taking into account the processes of digital transformation of project-oriented companies, when creating project management systems, requires the use of methods of structural and functional analysis, meta-methodology and matrix information technology of project management. It is these methods that operate with entities that are closest to setting up organizational, methodological and technological tools for different conditions of digital transformation of project-oriented companies. Thus, the methods of project management meta-methodology allow you to "collect" the tools of basic methodologies into a single SPMM, focused specifically on the conditions of a particular company, including the features of digital transformation. The methods of matrix information technology allow you to adjust management processes to the specifics of the company's project and operational activities in various conditions (including conditions of digital transformation of companies). And the methods of functional analysis make it possible to create organizational structures for the specifics of the company's managers and specialists' activities in project management processes. All this will allow creating project management systems in the digital space of project-oriented companies.

A natural experiment was used as an experimental research method. Because it is impossible to create a model of an operating enterprise to test the proposed concept even on modern computers. Therefore, experimental studies were conducted in the conditions of existing companies engaged in the construction of real estate objects. This made it possible to verify in practice the adequacy of the proposed concept and the effectiveness of the meta-methodology and matrix information technology of project management in the conditions of digital transformation. The proposed concept was used to create development project management systems for ICD Investments (Ukraine), EASTONE (real estate business) (Ukraine) and an aircraft building enterprise [3, 4, 21]. The concept is also used to build reflex project planning systems, in which the component of forming the information resource of such systems is assigned to the digital space [22].

The key element that affects the structure of the project management system being created in the conditions of digital transformation of companies is the digital space. The digital space refers to information presented in digital format, which is used in the company's activities and placed in modern computer tools. The digital space creates new opportunities for project management, for example, makes it possible to create electronic project management tools. When considering the issues of digital transformation of project-oriented companies, there was no task to offer technical and software means of placing the digital space. Since this issue does not affect the concept of building project management systems in the context of the digital transformation of project-oriented companies. It is important for the concept how to use the digital space to introduce elements of electronic project management into the practice of companies. Therefore, the paper examined the question of what should be the structure of the digital space (in the sense of the information component needed for project management) and what tools could display this information component in some technical environment (cloud services, server or distributed computer network of the company). In the work, such mapping was based on the use of enterprise and project information management tools, in particular the PrimaDoc system [15].

5. Results of studying the concept of building project management systems in the conditions of digital transformation of companies

5. 1. MOT approach to the creation of project management systems in the conditions of digital transformation of companies

Methodological, organizational and technological components of project management systems should integrate

the functions and tools of project management into a single whole. In fact, such a system should become a clear organization of activity management based on the professionalism of managers. They act in accordance with the company-oriented project management methodology and use information created in the information technology implemented in the company to make decisions. Thus, the organizational, methodological and technological components will be functional subsystems in the MOT PMS.

Therefore, in order to achieve the formulated goals and build an effective MOT PMS in the conditions of digital transformation of project management, an MOT approach is proposed, which will use:

1. To build the organizational component of the MOT PMS, a structural and functional analysis of project management processes, methods for building organizational structures of project management ("for the project", matrix, functional) and methods of responsibility management in projects (responsibility matrix).

2. To create a methodological component of the MOT PMS, ideas and methods that are embedded in the scientific foundations of the project management meta-methodology. The meta-methodology of project management is used to create project management methodologies specific to the companies' conditions.

3. To implement the technological component of the MOT PMS, methods of building matrix information technologies, as technologies that allow digitizing documents used in both project and operational activities of companies as a single information resource.

5. 2. Methodological, organizational and technological components of project management systems in conditions of digital transformation

5. 2. 1. Organizational component of project management systems in conditions of digital transformation of companies

Since project-oriented companies implement projects that differ in the scope of implementation, terms of execution, volume of investments, type of products, this requires a combined approach to project management. Therefore, the life cycle models will differ in scope and purpose of projects and, accordingly, different management functions need to be implemented. Functions in project management are usually assigned not to positions, but to roles that can be performed by different officials. The resource of project managers at all stages of the project life cycle will be: company managers, department heads, department employees, as well as outsourced specialists forming the project team.

To build the organizational component of the MOT PMS, it is necessary to determine the functional dependencies of the system elements in the organizational plane. We use elements of structural and functional analysis to solve this issue. In general, the structural and functional analysis includes the study of functional dependencies of system elements, unity, compliance of their action (functioning) with the needs of projects, identification of how needs change in the process of project implementation and changes in the environment. Since, in the organizational sense, any project is part of a social system, we use the ideas of T. Parsons' structural and functional analysis [23] to build the organizational component of the MOT PMS.

The structural functionalism of T. Parsons is based on the selection of structural components in the system and the determination of their functions relative to each other. His theory uses functional-system concepts borrowed mainly from biologists, which highlight such functions of living organisms, the implementation of which is mandatory for the organism-system to preserve its integrity. In the works of T. Parsons, there are four functions that are common to any social system:

a) adaptation function;

b) goal achievement function;

c) integration function;

d) latency function (structure reproduction).

Digital transformation of project-oriented companies requires the implementation of these functions in one form or another in relation to project management systems:

a) the adaptation function consists in adjusting the company's digital space to the specifics of a particular project. Based on the information that is available in the digital space about the competencies of employees, their employment in projects, the team of a new project is formed so that its composition corresponds to the project and does not harm others. This is possible only if performers are assigned to all tasks of all project plans. If these plans are digitized, this task is solved automatically;

b) the goal achievement function is a key function for project teams. Only if all members of the project team accept the system of goals defined in the project, it is possible to move towards their implementation. For this purpose, each goal must be represented in the digital space as a system model based on the goal; tasks that need to be solved in order to achieve them; technologies that need to be implemented to solve problems; means and resources for implementing technologies. Methods of building such system models should be presented in the specific project management methodology adopted by the company, and the models themselves should form the basis of the structural and functional model of the project management system;

c) the integration function can be implemented on the basis of the PMBOK methodology, which contains the relevant field of knowledge [5]. In the digital space, the integration function is implemented through project plans and a structural-functional model. Integration is based on knowledge of who and what should do (structural and functional model), and on the terms and types of function provision defined in the plan. But in the conditions of digital transformation, integration does not take place in the physical world, but in the virtual one, based on the information interactions among project team members who may be geographically distributed and even unfamiliar with each other;

d) the latency function is relevant for companies that implement complex projects (multi-projects) or programs. In this case, new functions arise in the course of project execution as a result of changes in the digital space, project environment and the state of its implementation. It is quite difficult to predict such functions, but due to the existence of the digital space, information on new functions can become part of the company's information standard and be used in the distribution of functions among team members in new projects.

The difference of the structural and functional model of project management in the conditions of digital transformation of a project-oriented company from traditional management models ("for the project", matrix, functional) with the formation of project management groups is:

a) the need to introduce the role of an information interaction manager who integrates and coordinates project teams in the digital space;

b) recognizing that the management functions of project team members are determined through the digital space of the company.

Based on the tasks of project management within the framework of the MOT PMS and taking into account the need to implement the groups of functions shown above, the following should be created in a project-oriented company:

1. At the company management level:

– a group of methodologists to develop and implement a specific project management methodology;

– a group of development and implementation of project management information technology;

– digital transformation office;

– project management office.

At the project management level:

– project teams;

– project and program management groups of the company;

– groups of information support for projects and programs.

2. In the organizational component, a project management office (PMO).

3. In the methodological component, a unit responsible for the development and implementation of a specific project management methodology and training the company's employees in professional project management.

4. In the technological component, a division responsible for implementing project management information technology.

5. 2. 2. Methodological component of project management systems in conditions of digital transformation of project-oriented companies

It is clear that digital transformation in different companies will lead to the creation of different digital spaces with different organizational components. Therefore, taking into account the specifics of the company, the specifics of projects and the structure of the digital space, it will be necessary to implement project management methodologies that take these specifics into account. In other words, each company should develop a specific project management methodology (SPMM), which will be part of the MOT PMS. As is known from [14], a specific project management methodology is a product of meta-methodology. The meta-methodology integrates the relevant tools of various methodologies into the project management methodology specific to the company's conditions and projects. This allows you to optimize the company's management processes.

Taking into account the digital transformation, the SPMM should be based on the following principles:

– Comprehensiveness of project models. Project management is always based on the manager's foresight of the results of his decisions. Intuitively (in his imagination) or formally (for example, a project plan), the manager always builds a model of what will happen to the project if he makes a particular decision. Since there are many decisions made by managers of the management group in accordance with their area of responsibility, it is difficult to predict what will happen to the project when all these decisions are made and implemented. Digital transformation will allow the MOT PMS not only to build project development models based on decisions made, but also to demonstrate them to all project participants. This will allow predicting not only its results, but also problems, risks, deviations, etc., and increase the effectiveness of managing risks, problems, and changes.

– Administration through the digital space. It is known that project management should have a clear distribution of key functions: the project manager makes a decision, and the project administrator conveys it to the performers. The implementation of the MOT PMS allows administration functions to be transferred to the digital space, through which decisions are brought to the performers, and the status of project implementation is checked. In this case, the administrator functions will be changed. In most cases, he does not interact with performers directly, but through the digital space (for example, online).

– Soft management – management through information. It is implemented by agreeing on project decisions through the digital space. Before making and approving a decision, it is placed in the digital space for approval by performers. It is best to do this through the information management system of enterprises and projects (or through the electronic document management system). This does not mean that the performers immediately agree on the decision but interact as partner managers to reach a realistic decision that satisfies everyone. Because, as the experience of implementing projects shows, most of them are implemented with a disruption of deadlines, overspending of funds. This is not only because performers don't work well. More often, this is due to poor planning, which does not take into account all the conditions and possibilities for performing work in a given time with limited resources.

– Awareness of collective responsibility for the project. As soon as all information on the project becomes available to all managers and performers, everyone can monitor the progress of the project and the results of their activities. In this case, performers monitor the impact of the result of their work on the project as a whole. In fact, the digital space forms a kind of "board of shame" or "board of honor" depending on the results of the performers' work, and this somewhat changes the emphasis in views on responsibility in projects. Usually, only managers can be responsible, but the use of digital space forces performers to realize their responsibility for the project to a greater extent than in traditional methodologies.

– Physical presence is nothing, information interactions are everything. It is not so much the physical presence of the manager in the teams of project performers that is important, as his informational influence on performance. The fact that the manager personally shows the performers what they need to do will not increase the quality and efficiency of the work. Especially if they wait for him from some meeting and do nothing without his instructions. The physical presence of the manager is only required to control the performance of work.

– Learn, learn, and learn again. The central area of knowledge of SPMM in the conditions of digital transformation should be the area of knowledge on project information management. The main capital of any company is the knowledge of its employees. Knowledge and ability to implement this knowledge in the field of professional activity. For this, it is necessary to "learn, learn and learn again". Therefore, training of company managers and specialists should be carried out in the project of creating the MOT PMS.

SPMM should describe and regulate management actions in projects, which are necessary for the implementation of the listed principles. Moreover, the PMMM should ensure the creation of relevant regulations, rules, methods and algorithms for implementing the above principles in the SPMM. Based on this, the project management meta-methodology should increasingly implement an algorithmic approach to project management. When the implementation of manage-

ment functions is presented in an algorithmic form and becomes available for implementation in the digital space [15].

The main thing that follows from the above principles is the understanding that in order to build project management systems in the conditions of digital transformation of project-oriented companies, it is necessary to develop electronic project management. Under electronic project management, management functions are gradually moving to the digital space, where they are implemented with minimum human involvement.

5. 2. 3. Technological component of project management systems in conditions of digital transformation of project-oriented companies

MOT PMS is a tool that standardizes the processes and functions of information use both at the level of project management of the company and at the level of management of the entire company. Therefore, there is a need to integrate both information processes in project management and information processes of company management in one information technology. This technology is called matrix technology [24]. Matrix information technology solves the following tasks: planning; administration; budgeting; monitoring; management of labor resources (responsible and performers); management of material resources; creation of the company's information standard, etc. and all in a complex with the tasks of company management [25, 26].

In the conditions of digital transformation, the basis of such technology will be the company's digital space. Traditionally, project management information technology is focused on solving functional problems and, most often, with various software tools (Fig. 1).

Traditional information technology is characterized by the fact that:

1. There is no integral digital environment.

2. Information processing technology, database management system, and knowledge bases are autonomous and not linked to one system.

3. All primary documentation and information do not undergo pre-basic processing, but are immediately entered into software tools for solving functional problems.

4. Databases can be created under different database management systems (DBMS).

In any case, the tools used in such technology may be different. Most often, they reflect the vision of the company's IT specialists and, in fact, such technology implements a local (task-specific) approach to solving project management problems.

Digital transformation allows creating a single digital environment that can be used in project management tools (Fig. 2). For example, the work [22] provides a project planning system that fills the digital space with information received from managers, from documents and information standards and is used to generate project calendar and network schedules.

The matrix information technology of project management through the digital space has a number of advantages, in particular:

1. The task of creating a digital space is separated from the functional tasks of project management and company management, which are subject to automation and act as an independent system-forming component of a project-oriented company.

2. All necessary primary documentation and information available in units and used in project or company management software are first digitized. They are then entered into digital space databases for further use in software tools.

3. Digital space is used to solve functional project management tasks – analysis, document management, planning, etc.

4. Databases are created under a single DBMS.

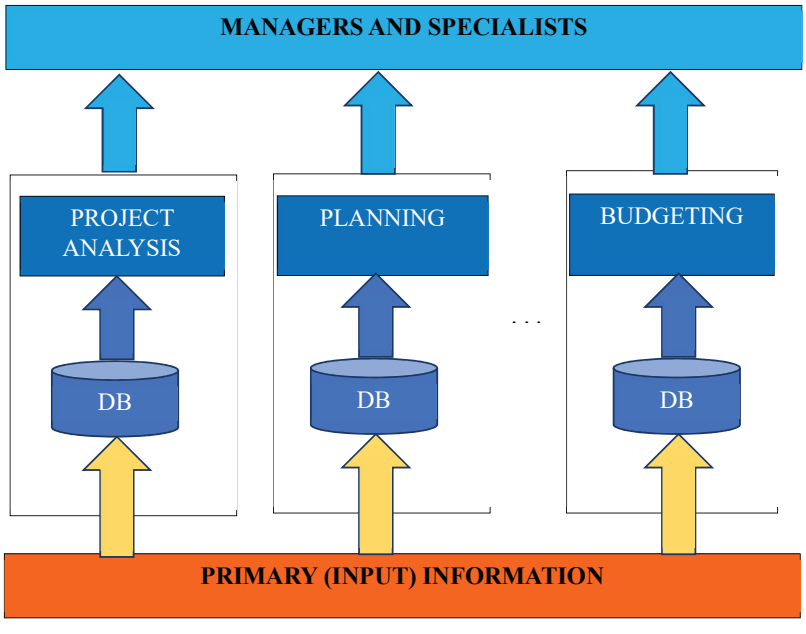

Fig. 1. Structure of traditional (task-specific) project management information technology

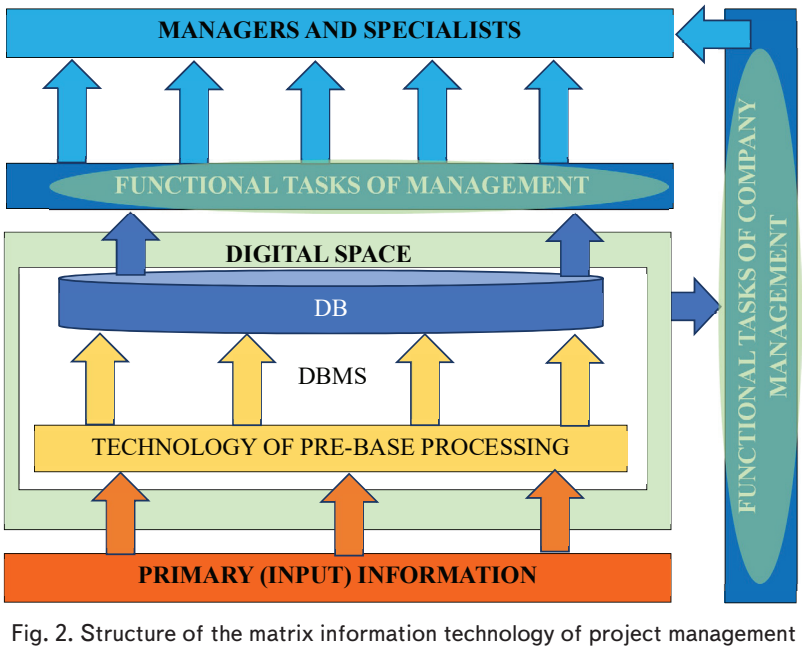

Fig. 2. Structure of the matrix information technology of project management based on the digital space of a project-oriented company

Thus, a systematic approach to project management is implemented through the digital transformation of the company – a single digital space. It is used to solve all functional problems, in contrast to the traditional local approach when the database (DB) is created within the framework of project management tools.

Each MOT PMS is a complex unique system, and its creation can take even more than one year [3]. Therefore, the creation and implementation of the MOT PMS should be considered as a development project of the organization and a project approach should be used for its implementation.

5. 3. Organizational and technological model of creation and implementation of project management systems in the conditions of digital transformation of companies

As follows from the above, the MOT PMS is people (roles), rules (methodology) and information (digital space). Moreover, these components are largely unique in each company. Therefore, MOT PMS cannot be bought or borrowed from another company. It must be created and implemented. The creation and implementation of such a system is a complex project of the company's development. Its implementation imposes specific features both on the process of creating the MOT PMS and on the MOT PMS itself. The essence of the organizational and technological model of the project of creation and implementation of the MOT PMS is presented below.

In the creation and implementation of the MOT, it is necessary to solve a number of interrelated problems:

1. Initiation of the project of creation and implementation of the MOT PMS.

The company's management decides to implement the project approach in management. The position of deputy head of the company for project management is introduced into the organizational structure.

2. Start of the sub-project of the formation of an administrative group of the company's project management.

An administrative group of the company's project management means the group that will create a project team for the creation and implementation of the MOT PMS. In mandatory order, this is the company's deputy head for project management, HR manager, and administrator. A lawyer, information specialist, financier, etc. can be included.

3. Formation of an administrative group of the company's project management.

The company's deputy head for project management forms an administrative group mainly from the company's employees. Specialists (primarily scientists) may be invited to outsourcing. Upon completion of the task, an administrative group for the creation and implementation of the MOT PMS project should be formed.

4. Formation of a management group for the creation and implementation of the MOT PMS project.

The administrative group of the company's project management develops the organizational structure of the project of creation and implementation of the MOT PMS. The group organizes and conducts the recruitment of managers and specialists. Upon completion of the task, a group of project management, creation and implementation of the MOT PMS should be formed.

5. Conducting training for the company's management employees, which will ensure the necessary level of understanding of the processes of implementing MOT PMS in the company's activities.

6. Creation of a rational organizational structure of project management. The organizational structure should correspond to the developed functions of departments. The optimality criteria of the organizational structure relative to management functions will be the number of information interactions in the process of their implementation. After all, it is known that every informational interaction carries the risk of erroneous determination of the content of information transmitted in the process of interaction, which can lead to erroneous decisions by managers. So,

$$\sum_{S_i}\sum_{S_j} E\left(S_i,S_j\right)\to \min, \tag{1}$$

with restrictions:

$$\forall S_i \exists F_l : \mu\left(S_i,F_l\right)=true,$$

where F_l – management function;

S_i, S_j – company employees;

$E(S_i, S_j)$ – additional project costs associated with errors in the process of information interaction of company employees;

$\mu(S_i, F_l)$ – predicate that determines that the management function F_l is performed by the company employee Si.

In turn,

$$E\left(S_i,S_j\right)=\alpha\cdot d\left(S_i,S_j\right)+\beta\cdot t\left(S_i,S_j\right), \tag{2}$$

where $d(S_i, S_j)$ – amount of information transmitted during the interaction of subjects Si and S_j;

$t(S_i, S_j)$ – duration of interaction between employees S_i and S_j;

α – coefficient that determines the average loss from incorrectly made decisions due to the risk of an error in misunderstanding the content of information during interaction;

β – average cost per unit of time spent on interaction.

Coefficients α and β are determined as follows:

$$\alpha=\frac{E_l}{\sum_{S_i}\sum_{S_j\neq S_i} d\left(S_i,S_j\right)},$$

where E_l – costs of eliminating risks associated with errors in information.

$$\beta=\frac{\sum_{S_i}\sum_{S_j\neq S_i} t\left(S_i,S_j\right)}{2\cdot\sum_{S_i} B\left(S_i\right)}\cdot V,$$

where $B(S_i)$ – working time budget of employee S_i;

V – payment for labor resources.

Let us highlight 3 main classes of information interactions:

– information interactions within the department;

– information interactions among employees of different departments;

– obtaining information from the digital space.

Using (1), (2) and taking into account the classes of information interactions, we get

$$\sum_{P_i}\sum_{S_i\in P_i}\sum_{S_j\in P_i}\left(\alpha_1\cdot d\left(S_i,S_j\right)+\beta_1\cdot t\left(S_i,S_j\right)\right)+$$
$$+\sum_{P_i}\sum_{S_i\in P_i}\sum_{S_j\notin P_i}\left(\alpha_2\cdot d\left(S_i,S_j\right)+\beta_2\cdot t\left(S_i,S_j\right)\right)+$$
$$\sum_{S_i}\left(\alpha_3\cdot d\left(S_i,W\right)+\beta_3\cdot t\left(S_i,W\right)\right)\to \min, \tag{3}$$

with restrictions:

$$\forall S_i \exists F_l : \mu(S_i, F_l) = \text{true},$$

where P_i – department;

W – digital space;

α_1 – coefficient that determines the average losses from incorrectly made decisions due to the risk of an error in misunderstanding the content of information during the interaction of employees of the same department;

β_1 – average cost per unit of time spent on interaction by employees of the same department;

α_2 – coefficient that determines the average losses from incorrectly made decisions due to the risk of an error in misunderstanding the content of information during the interaction of employees of different departments;

β_2 – average cost per unit of time spent on interaction by employees of different departments;

α_3 – coefficient that determines the average losses from incorrectly made decisions due to the risk of an error in misunderstanding the content of information from the digital space;

β_3 – average cost per unit of time spent interacting with the digital space.

Analyzing the complexity of information interaction among employees of the same department, different departments and with the digital space, we can conclude:

a) Time spent on interaction in one department is less than among employees of different departments (no need to spend time looking for counterparties)

$$\beta_1 < \beta_2.$$

b) Losses from erroneous decisions due to a misunderstanding of the content of information in one department are smaller than among employees of different departments (related functions – better understanding of each other)

$$\alpha_1 < \alpha_2.$$

c) Time spent on obtaining information from the digital space is less and it is less likely to make an error due to a misunderstanding of the content of information formalized in the digital space than obtaining information from employees of other departments

$$\alpha_2 < \alpha_3;$$

$$\beta_3 < \beta_2.$$

From this, we can draw a conclusion. In order to minimize the costs of obtaining information for implementing management functions (3), it is necessary to place information, resulting from the work of one department and used by other departments, in the digital space (Fig. 3).

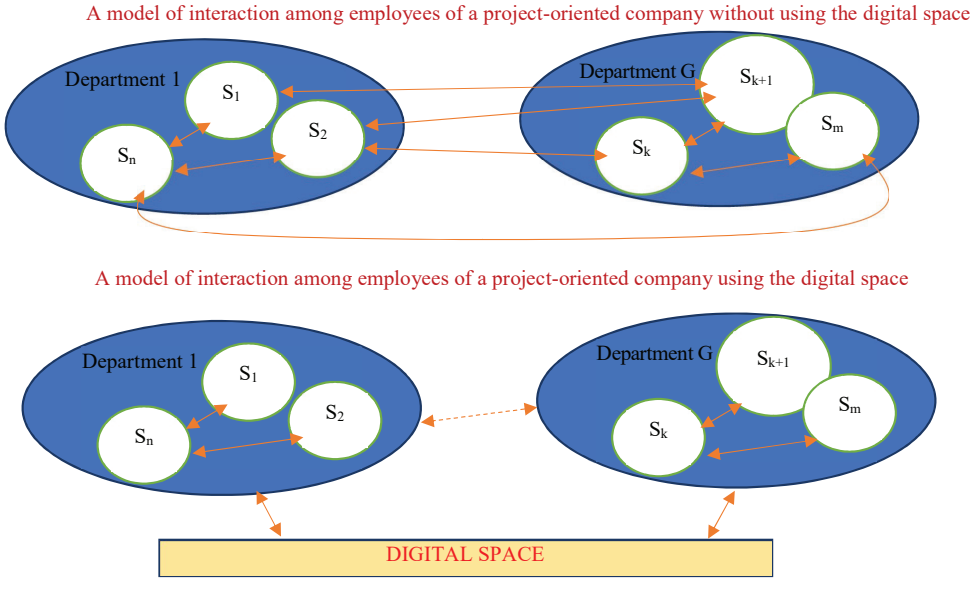

Fig. 3. Models of information interaction among employees of a project-oriented company

From the conclusion, as well as from the structure of information interaction in the project management system, due to the existence of digital space, it was found that:

a) interaction within one department is cheaper and more effective than interaction through the digital space or with other departments when implementing functions that require the same competencies of employees (they understand each other);

b) interaction through the digital space is cheaper and more effective than with other departments.

Then the following crucial function can be used to build the organizational structure of a project-oriented company:

$$S_i \in P_r, \text{ if } \forall P_k \neq P_r,$$

$$\begin{aligned}
&\sum_{S_j \in P_r} \left(\alpha_1 \cdot d(S_i, S_j) + \beta_1 \cdot t(S_i, S_j)\right) + \\
&+ \sum_{S_q \notin P_r} \left(\alpha_3 \cdot d(S_i, S_q) + \beta_3 \cdot t(S_i, S_q)\right) \leq \\
&\leq \sum_{S_u \in P_k} \left(\alpha_1 \cdot d(S_i, S_u) + \beta_1 \cdot t(S_i, S_u)\right) + \\
&+ \sum_{S_y \notin P_k} \left(\alpha_3 \cdot d(S_i, S_y) + \beta_3 \cdot t(S_i, S_y)\right),
\end{aligned} \quad (4)$$

with restrictions:

$$\forall S_i \exists F_l : \mu(S_i, F_l) = \text{true}.$$

Using (4) will allow assigning roles for which functions with a minimum number of external (with respect to the department) information interactions are defined to one department.

7. Development of corporate standards for solving project problems. Such standards are developed using the tools of project management meta-methodology. The development is carried out in accordance with the principles developed in the work. SPMM is a product of the project and must provide the necessary quality of management of all projects. That means taking into account the features of the company itself, its production and management structure, strategy, conditions, and operating environment. Project management meta-methodology does not change the existing classic (PMBOK, P2M, PRINCE2, etc.) or agile methodologies. It allows you to choose the principles, approaches, models,

methods appropriate for the implementation of the company's projects and possibly supplement them with new ones. Taking into account the digital transformation of a project-oriented company, such new tools can be:

1) In managing information (communications) in projects.

It is based on the use of digital space. Therefore, information processes in projects are not aimed at directly informing project team members, but at filling the digital space with new information, which is used to provide information to project team members (Fig. 3). This requires the development of a standard and tools for information interaction in the company's digital space in the process of project management.

2) In managing the project content.

It is based on the automatic formation of project content through the use of digital space and intelligent systems. Such systems independently form the content of the project from the information standard of the company, documentation and experience of managers [22]. Therefore, management processes are supplemented by quality control standards for the project content, which, in turn, are based on informational interaction among managers and specialists in the digital space to agree on the project content.

3) In managing integration, time and cost of projects.

It is based on the use of project planning tools. The peculiarity is that digital project management tools can be created in the digital space. In particular, intelligent systems that determine project work parameters from the company's information standard, documentation and managers' experience [22]. The use of such systems requires making changes to traditional planning methods and including elements of digital project management in SPMM. Project management processes are complemented by standards for monitoring project parameters (amount and types of resources, duration, communication). In contrast to changes in the formation of project content, control is performed by managers and specialists competent in project planning. In addition, the budgeting procedure for program and project portfolios should be considered as part of the general budgeting procedure of the company's activities. Therefore, it should reflect the financial capabilities of the company.

4) In resource and procurement management.

It is based on the use of digital space. In the digital space, there is no need to create various applications and tasks for procurement, supply and use of material and technical resources (MTR). The basis of the MTR project provision standard is a digital project plan, which defines the terms of MTR use. Depending on the duration of procurement, production, in the absence of MTR in the warehouse, the dates of procurement initiation, holding of a tender or production of MTR at own facilities are automatically determined.

For procurements:

$$t_0 = t_{plan} - t_{delivery} - t_{tender} - t_\Delta,$$

where t_0 – date of initiation of material resourse delivery;

t_{plan} – date of need for material resourse;

$t_{delivery}$ – duration of material resourse delivery by the supplier;

t_{tender} – duration of the tender procedure and conclusion of the contract with the supplier;

t_Δ – anti-risk time reserve.

For production:

$$t_0 = t_{plan} - t_{acquisition} - t_{production} - t_\Delta,$$

where t_0 – date of initiation of material resourse delivery;

t_{plan} – date of need for material resourse;

$t_{acquisition}$ – duration of obtaining the resources necessary for material resource production;

$t_{production}$ – duration of material resourse production;

t_Δ – anti-risk time reserve.

5) In risk management.

It is based on the use of the company's information standard. In traditional methodologies, risks are determined mainly on the basis of experts' opinions. In the digital space, it is possible to automatically take into account the progress of previous projects, disruptions and delays in the work performance and deliveries of MTR, in financing, etc. Therefore, risks can be determined automatically from the company's information standard. But the SPMM needs a standard for assessing risks and losses from them, which prescribes the actions of experts in working with automatically determined project risks.

Other areas of knowledge and processes of project management (in particular, management of labor resources, stakeholders) are slightly changed when using the digital space of project management.

8. Development of matrix information technology (MIT) for project management.

Such technology is developed using both project management software and software add-ons created in the company, which solve the functions that cannot be implemented by software. In particular, these are the functions of project resource management (and not in projects implemented in software), project administration, logistics management, budgeting (in accordance with the company's operational budgeting standards), etc. The development is carried out in compliance with the developed concept. MIT is based on the digital space of the company and uses not only project information, but also information that characterizes the activities of the entire company. This means that it takes into account the specifics of the company itself, documentation describing production activities, finances, resources, standards and conditions of project implementation. MIT does not reject traditional project management software (MS Project, Oracle Primavera P6, etc.), but complements them with software add-on tools and company management automation tools.

9. Completion of the MOT PMS creation project. Summing up the results. Documenting the experience. Receiving incentives from the company's management.

The given organizational and technological model formed the basis of project management systems implemented in the companies ICD Investments (Ukraine), EASTONE (real estate business) (Ukraine) and an aircraft building enterprise [3, 4, 21]. It made it possible to standardize the process of creating and implementing organizational, methodological and technological components of project management systems, taking into account the specifics of the digital transformation of the named companies. This, in turn, made it possible to reduce the time for creating such systems to 1 year, increase the accuracy of planning (there were, on average, 10 % fewer changes in plans), reduce the time of project implementation by 5–20 %.

6. Discussion of the results of studying the concept of building project management systems in the conditions of digital transformation

Systems for creating project management systems have evolved from corporate project management systems, through

three-component (organization-methodology-technology) systems to systems that use the results of the digital transformation of project-oriented companies. The result is a new concept of building project management systems in the conditions of digital transformation of project-oriented companies.

The concept under study is based on the trinity of key project management components – organization, methodology and information technology. In contrast to traditional approaches, the proposed concept of building these components takes into account the peculiarities of the development period of companies – their digital transformation. After all, the globalization of economic and technical development, the lack of qualified personnel, the inability to obtain complete information about the project, especially in the early stages, require the digital transformation of project-oriented companies and development of project management systems on this basis. If project management systems are not integrated into the digital space (Fig. 1), companies will experience a lack of information during project implementation, or will spend a lot of money to obtain it. This will give rise to many management problems, falling behind the schedule, and overspending. In contrast to such systems, MOT PMS reduce the impact of the above negative factors on project management, which is confirmed by their practical implementation in a number of companies.

The proposed concept underwent practical testing during the creation of the MOT PMS in various project-oriented companies [3, 4, 15, 21]. Project management systems created using the proposed concept have shown high efficiency. Better information provision of all management processes based on the use of the company's digital space allowed reducing project execution time by 5–20 %, and also project cost due to more rhythmic work performance with a decrease in the number of changes, downtimes, rescheduling. First of all, this effect was obtained due to improving the quality of work plans, since the planning process was based on more complete and accurate information about the project. This was achieved by taking into account organizational, methodological and technological features of project management in the structure of the digital space. Due to the clear standardization of project planning actions using the project management meta-methodology to reflect the characteristics of the company itself in the planning regulations. And thanks to the application of matrix information technology tools in the digital space of companies. This made it possible to display the production and management capabilities of the company itself in the project information, including when performing operational tasks.

Summarizing the above, it can be stated that all this was achieved due to the fact that, within the framework of the studied concept of building the MOT PMS, new tools were developed to adjust the organizational, methodological and technological components of the PMS to the conditions of digital transformation of project-oriented companies. In particular, a new MOT approach to the creation of project management systems is proposed. The MOT approach allows adjusting the tools of the organizational, methodological and technological components of project management systems to the specifics of a project-oriented company and the conditions of its digital transformation.

In the framework of the approach, the development of these components is based on new tools:

– organizational component – on the structural and functional analysis of project management processes;

– methodological component – on project management meta-methodology;

– technological component – on matrix information technologies.

The organizational component of project management systems has been improved by using the ideas of Parsons' structural and functional analysis. The advantage of this approach is the consideration of the organizational component of the PMS as a social system. This made it possible to distinguish four general functions:

a) adaptation function;

b) goal achievement function;

c) integration function;

d) latency function, which allows using the structural and functional analysis to build the organizational component of the MOT PMS.

On this basis, a structural and functional project management model is proposed, within which these functions are integrated into the processes of digital transformation of project-oriented companies (Fig. 2).

The methodological component of the MOT PMS has been improved by using meta-methodology to create a specified project management methodology, which, unlike others, takes into account the conditions and processes of digital transformation of the company. This feature allows you to configure methodological project management tools for the use of digital space in all regulations, templates, rules and methods of implementing project management processes and functions.

The principles of digital project management, which should be used in the MOT PMS in the conditions of digital transformation of companies, are proposed. All this creates significant advantages in practical project management compared to the use of basic methodologies, such as PMBOK, P2M, PRINCE2, Scrum, etc.

A digital interpretation of matrix information technologies is proposed for the technological component. This result makes it possible to expand the scope of project management information technologies to the processes of digital transformation of companies. Fig. 1, 2 show the transition from local (task-specific) to matrix information technology of project management based on the digital space of a project-oriented company. The features of this approach: the digital space is separated from functional tasks; all documentation is digitized and becomes available to everyone; the digital space is used in project management; databases are created under a single DBMS.

The advantages of this approach are that a systematic approach to project management is implemented through the digital transformation of the company – a single digital space that is used to solve all functional tasks. In contrast to the traditional local approach when databases are created as part of project management tools.

A feature of the proposed organizational and technological model for implementing project management systems in the conditions of digital transformation of companies is its integrative nature, which allows considering the implementation of all MOT PMS tools within a single process. The mathematical model represented by formulas (1)–(4) describes the process of structuring the organizational component of the project management system. Unlike traditional models, where interaction is implemented through the exchange of information among system components, the advantage of this model is the interaction in the MOT PMS through the digital space (Fig. 3).

The developed MOT approach offers conceptual tools for the integration of organizational, methodological and technological components into a single project management system. In the organizational component, thanks to the structural and functional analysis, functions were allocated and an organizational and technological model for creating and implementing the MOT PMS was built. The use of tools for adjusting project management methodologies to the conditions of companies, which are contained in the project management meta-methodology, made it possible to develop the concept of building a methodological component of the MOT PMS. Using the tools of matrix information technology, which allow coordinating the project and operational activities of companies, the technological component of the concept of MOT PMS integration with the digital space of the company was developed. Thus, the development of the MOT approach, methodological, organizational and technological components and the creation of an organizational and technological model of the PMS is a solution to the formulated problem – the creation of tools for adjusting project management systems to the conditions of digital transformation of project-oriented companies. The results obtained give reason to talk about creating a concept of building project management systems in the conditions of digital transformation of companies, which made it possible to transfer project management processes to the digital space. This, in turn, made it possible to increase the probability of successful completion of projects due to more rhythmic work performance with a decrease in the number of changes, downtime, rescheduling, as confirmed by practice [3, 4, 15, 21].

A limitation of the study is that the proposed concept is only in the initial stage of its life cycle. This is due to the fact that digital transformation has not yet reached most project-oriented companies. In the companies that implemented the proposed concept, the creation of a digital space of a project-oriented company made it possible to standardize all processes of information interaction, both in company management and in project management. This, in turn, significantly increased the efficiency and quality of management.

The drawback of the study is the high requirements for the company's digital transformation processes. The created digital space should be based on a single data repository, and not be a collection of disparate databases. Only in this case, effective information interactions are realized when solving both company management and project management problems.

Another drawback is the increased requirements for involving qualified methodologists, information technology specialists and managers capable of effectively organizing project management work in the company. These specialists form the organizational, methodological and technological components of the MOT PMS, and their professionalism will determine whether the MOT PMS actually becomes an assistant to project managers and performers.

The listed limitations and shortcomings determine the conditions for the practical use of the developed concept: a systematic organization of the digital space, which would be focused on the comprehensive management of the company's operational and project processes and the availability of qualified specialists in the field of creating project management systems.

The development of this study can be aimed at expanding the scope of MOT PMS to manage programs, multi-projects and project portfolios. That will significantly increase the requirements for the organizational component of the MOT PMS and require the development of new tools.

7. Conclusions

1. The MOT approach to the creation of project management systems in the context of the digital transformation of companies was developed. This approach is based on the development of organizational, methodological and technological components of project management systems due to the digital transformation of project-oriented companies.

2. Methodological, organizational and technological tools for building project management systems based on the use of the digital space of project-oriented companies were improved. The creation of such a space, on the one hand, makes it possible to exclude the information management components from the above tools. On the other hand, it allows them to be supplemented with organizational, methodological and technological features of building a digital space. This is what underlies the development of scientific foundations for creating project management systems.

3. An organizational and technological model of the implementation of MOT PMS was developed through the implementation of a development project specific to a project-oriented company – building a project management system that combines methodological, technological and organizational components of project management. Tasks were identified and a model of their implementation in the project of creating the MOT PMS was built. An analysis of these tasks was carried out in terms of the key functions of the MOT PMS.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

The manuscript has no associated data.

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