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FORMATION OF A MINIMUM VIABLE IT PROJECT TEAM USING THE GENETIC ALGORITHM

The object of research is the process of forming an IT project team, in which the development technology is based on the technology of creating a minimum viable product (MVP) and design thinking (DT) technology. Such IT projects usually have a high content of innovation and require a special management technique, as well as a special approach to the properties of the project team.

The application of design thinking technology will require project team members to master the property of empathy for the customer's problems. Empathy is a property of the human representational system and cannot be acquired through education or training. If it exists, then this property can be developed thanks to special training. Therefore, there is a problem regarding the formation of the IT project team. The manager who is responsible for forming the team needs to make a decision to choose between the availability of technical competencies of the applicants, the ability to work in a team, and the presence of empathy. In addition to the outlined requirements for applicants, such a team must be self-managed and self-organized. This also adds a whole series of requirements to applicants for the IT project team. Usually, applicants possessing all the necessary properties in full do not exist. Therefore, the manager (expert) will need to make decisions about compromises in meeting all the project's requirements. In addition, the need for labor resources will change during the project life cycle (PLC). It is for this purpose that it is proposed to use a genetic algorithm (GA), which will allow finding a local extremum that will be optimal under the current conditions of the project to solve a multi-criteria problem. This will reduce the subjective component in the process of making project decisions, which in turn will increase the probability of successful completion of IT projects in conditions of uncertainty and dynamic changes.

The proposed method of forming an IT project team can be applied in practice in the form of information technology, to which in the form of a template it will be necessary to enter information about project requirements and the competency map of applicants. As a result, the GA will propose a decision regarding the quantitative and competent composition of the project team.

Keywords: *IT project, minimal viable product creation technology, design thinking technology, minimal viable team, empathy, genetic algorithm.*

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1. Introduction

In team management, as a complex system, there is a scientific and technical contradiction. It manifests itself in the fact that it is necessary to apply means of automating the management of complex dynamic objects, on the other hand, there are no universal methods and tools that would minimize the influence of the level of qualification and experience of experts on management processes. This contradiction should be resolved by reducing the subjective influence of expert knowledge on the process of formation and management of the IT project team [1]. This should increase the robustness of the control system. The previous formalization of team formation processes revealed the multi-criteria nature of such a task [2], and the management function will have not one, but several extrema, which cannot be reduced to one – integral. In addition, the management function is complex and dynamic, i. e. it will change over time during the project life cycle (PLC).

The IT project team formation method developed in [2] aims to create a minimally viable team, which by definition should provide a list of all necessary competencies and skills of team members, with a minimum number of its members. Moreover, such a minimum composition should not become a limitation in the possibility of communication both within the team and externally (with the customer, end users of the project's product). Another limitation may be the availability of financial resources to pay the corresponding categories of employees [3].

It should be noted that the use of intelligent management tools, such as neural networks, genetic algorithm, intelligent data analysis, machine learning and other artificial intelligence systems is becoming increasingly widespread in project management.

Thus, in [4], a genetic algorithm was used to automate HR processes – as an adaptive heuristic search method, which is based on the mechanism of optimal selection at each stage of project team formation, which made it possible to significantly increase the number of functional tasks in human resource management.

In [5], the necessity of using intelligent information technologies in the management of large pools of resources, finances, and personnel of complex distributed systems is shown. To optimize the management of such systems in the context of the criterion of minimizing the cost of the expenditure part of the budget, the author suggests using hybrid genetic algorithms, the theory of fuzzy sets, and the method of group consideration of arguments.

The application of the genetic approach to solving project management problems, namely to finding the best project manager for a specific project, is proposed in [6]. The developed models should improve the procedure for determining the relevant project manager, its relationship between managers in the project office, the flexibility of projects to the surrounding environment.

The authors in [7] use a genetic algorithm to achieve conflicting goals that are usually present in every IT project, namely to reduce their duration and cost. With the help of a genetic algorithm, the entire available pool of project scenarios is analyzed and through structured studies of the influence of the most important attributes of the problems, the optimal solution for the current conditions is proposed.

Continuous development of projects throughout their life cycle (LC) requires project managers to make both optimal and near-optimal project decisions. Such decisions require constant review for their compliance with changing conditions. As mentioned above, it is necessary to reduce the subjective component of expert decisions. Most existing project management methods [8] offer only passive project tracking and reporting assistance. Project managers must make all important decisions based on their individual understanding and experience.

The authors of the publication [8] proposed a technique for the optimal distribution of resources and the formation of the project schedule, based on genetic algorithms. It automatically determines, with the help of an objective function, the structure of the task and the pool of resources. This made it possible to assign staff tasks and predict the corresponding future status of the project, based on extensive analysis of time and cost variations in the solution space.

Thus, based on the results of the analysis, it can be considered that the development of IT project team management tools using artificial intelligence systems, such as GA [9], is quite relevant. This will reduce the subjective component in making project decisions, which should increase the probability of successful completion of IT projects in conditions of uncertainty and risk.

The aim of the study is to develop a method of forming a minimally viable IT project team.

2. Materials and Methods

The object of research is the process of forming an IT project team, in which the development technology is based on the technology of creating a minimum viable product (MVP) and design thinking (DT) technology.

The algorithm for minimizing the number of team members will take into account not only the characteristics of the project tasks themselves, but also the forecasted needs for new resources or new competences of resources, the cost of these resources with given competences. This algorithm will be based on the conceptual model of managing a creative team of an IT project, which was published and discussed at the VI International Scientific and Practical Conference on Project Management, P3M-2021 [3]. The conceptual model contains elements of the minimum viable product creation technology and design thinking technology [10]. In addition, a mandatory condition of the method is the allocation of time for communication/discussion by team members of the current situation in the project, in order to create opportunities for the manifestation of a synergistic effect and the formation of group empathy in the team [11].

The minimization of the number of team members is carried out under the condition of restrictions on the deadline for the completion of each of the tasks, taking into account the technology of creating a minimum viable product and taking into account the creation of a management team that will be unchanged throughout the life cycle.

The method of forming a minimum viable team (MVT) is based on reducing the number of team members by expanding the range of competencies of each of the selection participants. At the same time, the restrictions are:

1) condition of mandatory possession of empathy [3, 10];

2) availability of additional time (not related to programming):

– on communication within the team and with the customer;

– to trainings/seminars to increase the level of empathy and increase professional competences;

3) condition of having previous experience of joint work and/or experience of working in a team;

4) financial restrictions on the part of the customer for payment of project works.

Then, in order to ensure all the necessary work of the project, it is advisable to choose a small number and types of resources that will be involved in the team. These types of resources should be chosen based on the types of tasks to be solved. Let's refer to the resources as applicants, participants in the competitive selection, before they are recommended for participation in the project. After the recommendation and consent of the applicant to participate in the project team, let's call it a team member.

Further, the selection procedure will be based on the following assumptions: the larger the applicant's type number, the smaller its competence range and the lower its cost, and also, if the task can be effectively solved by the i-th applicant, then it can be performed no worse by applicants with smaller numbers. Another condition for the work and even the existence of the IT project team is that the quantitative composition cannot change much within the scope of the project, especially in a downward direction. It is understood that after the end of the period of loading of this resource, for example, for two weeks or months, it is removed from the team.

With such actions, the synergistic effect will definitely be lost (or it will not have time to form in such conditions) and all the advantages of a self-organized and self-governing minimum viable team will be lost [2].

At the same time, the technology for creating a minimally viable product involves the gradual expansion of the product's functionality in its next prototypes, which will also require an increase in resource provision.

Therefore, the proposed approach to creating a minimally viable team should monitor the moments when there is a need to change the numerical composition of the team, depending on the current conditions, and after their detection – form proposals for decision-making. After that, a self-organized and self-governing team, based on this data, will make the final decision. Considering the complexity and multi-criteria nature of the problem to be solved, it is proposed to solve it using a genetic algorithm [12].

3. Results and Discussion

A project team that uses MVP creation technology and DT technology for development has four possible types of resources.

*R*1 – Reserved Instances – under constant loads.

This numerical composition is on a permanent basis, therefore it cannot change dynamically. At the same time, there may be situations when these resources are not fully used in the planned tasks. In this case, «permanent» resources will be able to perform additional tasks.

Reserved Instances must ensure the availability of all technical competencies required by project works + mandatory ability to empathize with customer problems + psychological compatibility + experience/ability to work in a team.

*R*2 resources with a smaller set of technical competencies are next in priority. However, as before, they are still required to be able to empathize with the customer's problems + psychological compatibility. Experience working in a team is not mandatory.

Its resources have second-order priorities, their value is lower than the value of *R*1 resources.

The third type of resources – *R*3 must possess technical competences of at least two different types and have the ability to empathize. Accordingly, this type of resource has even lower priorities and cost.

Let's assign the lowest priority to *R*4 resources, which have only one technical competence from the range required in the project.

For the dynamic management of the team, at each MVP stage, the following will be indicated:

– the duration of work in discrete time intervals corresponding to the time interval of resource availability;
– the minimum set of competencies that corresponds to this task;
– the deadline for completing the current task;
– availability of financial capabilities of the customer to cover the costs of the formed best set of the project team.

Accordingly, a command state vector is formed for each resource when the task is started. Let's take the current time as Δ, (*k*+1) – the duration of the task, (Δ+*m*+1) – the deadline for completing the task [13, 14].

The start of the state vector corresponds to the stage or task that is executed first. If during Δ, this task or stage (which can correspond, for example, to one sprint) has been completed, then the state vector is reduced by one element. If this stage is not completed in time Δ, then all units are shifted to the right and the vector is shortened by one element to the left.

Structurally, the management system will contain a forecasting unit that will determine the numerical and competent composition of the project team in the near future.

If at the moment of time Δ, the forecasting unit issued a forecast regarding the appearance of a task, the performance of which is possible with the resources available in the team, then all units in the state vector are shifted to the right for the time intervals when the corresponding stages are predicted to be performed by these resources. The cells on the left are filled with zeros, which means that the task is waiting for the above resources to be executed. When canceling the forecast, the state of the vector is restored.

Another possible situation of the state vector can be a composition of one units, which means that there are no free team members. In this case, the applicant is searched for a lower category [15].

The level of the price offered by the customer for the required type of resource is an essential point for forming a team of resource applicants.

Then, in fact, the procedure for forming a minimally viable team will algorithmically correspond to the minimization of the objective function, which calculates the required number of team members according to the required competencies from the current moment in time on *D* forward discretes, which are limited by the PLC:

$$K(\Delta)=K_1(\Delta)+K_2(\Delta)+K_3(\Delta)+K_4(\Delta), \quad (1)$$

where $K(\Delta)$ is the total number of team members covering all the necessary competencies and requirements for the time interval Δ; $K_1(\Delta)$ is the total number of team members who correspond to the resource type *R*1 for the time interval Δ; $K_2(\Delta)$ is the total number of team members who correspond to the resource type *R*2 for the time interval Δ; $K_3(\Delta)$ is the total number of team members who correspond to the resource type *R*3 for the time interval Δ; $K_4(\Delta)$ is the total number of team members who correspond to the resource type *R*4 at the time interval Δ.

The total number of team members of resource type *Ri* per time interval Δ will depend on the following components:

$$K_i(\Delta)=\sum_{n=1}^{N}\sum_{m=1}^{M} s_m^i(\Delta) d_{nm}^i(\Delta) T_{nm}^i(\Delta), \quad (2)$$

where $i=[1,4]$ is the resource type; *N* is the number of project works; *M* is the number of applicants to the project team; $s_m^i(\Delta)=[1,0]$ is the financial availability of provision of the *i*-th type of resource in the discrete time Δ; $d_{nm}^i(\Delta)=[1,0]$ is the planned use of the *m*-th applicant in the *n*-th task in the discrete time Δ; $T_{nm}^i(\Delta)=[1,0]$ is the planned delay in the implementation of the *n*-th task with the *m*-th applicant in the discrete time Δ.

Minimization of the numerical composition of the project team is carried out every current discrete time Δ due to the selection of the appropriate values of the coefficients $d_{nm}^i(\Delta)$ genetic algorithm under the above restrictions.

The length of the chromosome for each calculation is determined by the number of tasks and the number of corresponding types of resources [13, 15]. The number of chromosomes subjected to mutations, as well as the mutation rate, is determined during experiments.

As a result, the proposed method of forming the MVT is based on the genetic algorithm of reducing the numerical composition of the team with full provision of a competent set of resources for the successful completion of the project. The procedure takes into account the dynamics of tasks that are launched [15], as well as the change of competencies and skills of team members within the framework of the PLC [16].

The practical value of the results obtained in the course of research and development is to put the analysis of a large number of multicomponent data of various formats on GA, in order to minimize the risk of not taking into account any of them. The direct application of the developed method will consist in the fact that a person who is authorized by the team and has the role of coordinator, or «servant leader», forms as input data of GA:

– IT project indicators;
– the requirements of the necessary competences required for the implementation of the project;
– real competencies possessed by candidates for the project team.

As a result, the GA will form a list of decisions regarding the composition of the team that will be optimal for the current project conditions.

The field of application of the proposed developments will be IT companies that have at their disposal a conditionally permanent staff of employees, among whom the selection of applicants for the team of the current IT project will be carried out.

The limitation of the method will be projects with a significant innovative component. Its application to «repetitive» projects, for example, website development projects, will be inappropriate.

The conditions of martial law in Ukraine, namely prolonged blackouts and missile attacks, did not allow the authors to test the method on real projects of the specified type.

The perspective of further research will be the integration of the proposed method into the management of the IT team throughout the entire life cycle, taking into account the requirements for changing the quantitative composition of the team. In addition, automated means of assessing the competencies of applicants and integrating the results into the methods of formation and management of the IT project team will be developed.

4. Conclusions

The article presents the method of forming a minimally viable team of IT projects, for the management of which the technologies of creating a minimally viable product and design thinking should be applied. The method is implemented on the basis of a genetic algorithm, which will determine the quantitative and competent composition of the IT project team, taking into account the following requirements for team members:

– possessing empathy;
– having previous experience of joint work and/or experience of working in a team.

Additional restrictions are:

– the customer's financial ability to pay for the project;
– availability of additional time (not related to programming) for communication within the team and with the customer, as well as time for trainings/seminars to increase the level of empathy and improve professional competencies.

Solving such a multi-criteria problem as the formation of the MVT, the solution of which does not have a single global extremum, will allow to reduce the subjective influence on the processes of project decision-making in conditions of uncertainty, which in turn will allow to increase the probability of successful completion of IT projects [17].

Approbation of the research results is planned to be carried out under the condition of stabilization of the socio-economic situation in Ukraine in IT companies that manage projects with a high degree of innovation.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this study, including financial, personal, authorship, or any other, that could affect the study and its results presented in this article.

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Data availability

Data will be provided upon reasonable request.

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DEVELOPMENT OF A METHOD FOR CHANGING THE SURFACE PROPERTIES OF A THREE-DIMENSIONAL USER AVATAR

The object of study of this research paper is the processes of changing the properties of three-dimensional surfaces of a user avatar in real time. In the course of this work, the research addressed the limitations of existing solutions for synthesizing three-dimensional user avatars, particularly in terms of realism and personalization on mobile devices. Furthermore, the study tackled the challenge of efficiently adjusting color attributes without compromising the underlying texture information, ultimately enhancing user experience across various applications such as gaming, virtual reality, and social media platforms. A method consisting of three key components is proposed: pre-designed 3D models, multi-layer texturing, and software and hardware implementation. The multilayer texturing approach includes different texture maps, such as diffuse and occlusion maps, which contributes to the smooth integration of texture attributes and the overall realism of 3D avatars. The real-time change of surface properties is achieved by mixing the diffusion map with other texture maps using the Metal hardware accelerator, allowing users to efficiently adjust the color attributes of their 3D avatars while preserving the underlying texture information. The paper presents a software algorithm that uses the SceneKit game engine and the Metal framework for rendering 3D avatars on iOS devices. The result of the developed method and tool is a mobile application for the iOS platform that allows users to modify a digital 3D avatar by changing the model's colors. The paper presents the results of testing the proposed methods, means and developed application and compares them with existing solutions in the industry. The developed method can be implemented in areas such as gaming, virtual reality, video conferencing, and social media platforms, offering greater personalization and a more immersive user experience.

Keywords: *digital face, game engine, three-dimensional face modelling, digital avatar, semi-realistic avatar.*

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1. Introduction

In recent years, 3D avatar synthesis has attracted considerable attention from many software developers due to its wide range of applications and the growing demand for realistic digital representations of human faces. Thanks to the rapid development of computer vision, 3D graphics and machine learning technologies, 3D face avatar creation has become an important research area with the potential to revolutionize industries such as gaming, virtual or augmented reality, teleconferencing and social media platforms. The ability to create personalized and expressive 3D face avatars not only provides a more immersive user experience, but also creates a sense of presence in the virtual environment, which is crucial for effective communication. In addition, the development of efficient and accurate methods for generating 3D avatars can contribute to advances in other areas such as facial analysis, emotion recognition, and biometric authentication. The search for new methods and algorithms for creating 3D face avatars remains an active and important topic of modern research, shaping the future of digital human images and interaction.