METODOLOGICAL BASES OF IT PROJECT MANAGEMENT WITH SIMULATION MODELLING TOOLS

Maryna Chaikovska
Associate Professor PhD, Odessa I. I. Mechnikov National University,
e-mail: chmp@ukr.net, Ukraine

Abstract. The article deals with the problematic aspects of the IT projects' management and the systematized methodologies and modelling tools of the IT projects' risk managements.

It is proved that the problems of management requirements and team collaboration are critical and require the use of simulation models at all stages of the development in order to reduce the project risks.

The author proves the feasibility of using the agent-dynamic modelling approach at different levels of the hierarchy to improve the implementation of the IT projects.

Keywords: IT project, process modelling, the agent-dynamic modelling approach.

DOI: http://dx.doi.org/10.23856/2106

Introduction

The implementation effectiveness of the modern IT projects is the creation foundation of an integrated management model based on a new type of the information flows' analysis, business processes' reengineering, ensuring continuity and integrity of the enterprise systems' operation.

However, the development and the implementation of the information systems today are complex, lengthy and costly projects, related to the large risk exposures. One of the features of the modern IT projects is the availability of changes that can be applied not only to the conditions of the project, but also to the purpose of the project itself or its qualitative characteristics. It requires an adequate methodology for modelling as a prerequisite for good governance of the term, costs and risks of the IT projects, the increased manageability and predictability of the project.

The problem of the project management at the theoretical level is examined in the works of I.I. Mazur, V.D. Shapiro, S.Voropaeva, S. Paipe, K. Kucherenko; management of the software projects - in the works of R. Fatrella, F. Donald Schafer, K. Larmana, A.V. Matvienko.

Plenty of standard methodologies for the process of the software manufacturing are developed: ISO9001, ISO12207, ISO15504, CMM (Capability Maturity Model), MSF (Microsoft Solution Framework), RUP (Rational Unified Process), SCRUM, XP (eXtremal Programming) (Beck K., 1999), Crystal Clear, ASD (Adaptive Software Development), Lean Development (Schwalbe K., 2011). However all attempts of formalization have failed, the uniqueness of the software projects highlights the choice problem of methods, practices and rules of the project risks' reduction.

The integration problems of the system dynamics and the agent-based modelling were noted by N. Shyrits, A. Hrosler, A. Borshchiv, V. Veykland, G. Fihuredo, William Aikelin

and others. The features of an IT project were examined in the works of K. Schwalbe, John Sodhi, E. Turban, L. Volonino and McKinsey & Company.

The problems of the collaboration improvement between business and IT were paid attention by B. Brown, David M. Kaplan, T. Weber, J. Laarts, E. and A. Monnuaye Sherdin. The problems of the project life cycle and a system development were focused in the works of Kerznera G., J. Rothman, R.D Archibald, A. Koubern.

At the same time, these works are not considering a number of the methodological problems, reflecting the specific behaviour of agents within a complex system-dynamic IT project environment. We can attribute an un-formalized approach in determining the integration mode of the system dynamics and the agent-based modelling, the lack of a unified methodology to integrate the approaches to the modelling systems and the lack of the applied character of the process modelling for the systems' management, to these problems.

The study is an analysis of the characteristics and risks of today's IT projects and a systematization of the methodologies and modelling tools for the management of the IT projects, the formation of the theoretical and methodological framework and elements of the integrated methodologies to create the models of the IT project on the basis of the process, system and agent-dynamic approach of simulation.

The task of the IT project management in general follows the methodology of the project management, but it has some significant differences that are generated by the task

The differences in the ways of the problem solvation require a special methodology for the IT project management and project risks. There are various international, industry and large IT companies standards in the world, but they are all rather a recommendation, summing up the successful experience in the IT projects' implementation. Unfortunately, the statistical analysis of the projects' success in the IT field within 10 years with the small fluctuations has been stable in the range of 20-30%. The successful projects are those projects which accomplished all the planned scope of work on time and in the frames of the budget.

In Ukraine, according to the researchers, only 4% of IT projects are completed on time, which is one of the lowest indicators in Europe. The leaders here are Sweden (44%), Switzerland (22%), Czech Republic (20%), Germany (19%) and Denmark (16%). Only 16.2% of the projects, completed on time, did not exceed the planned budget and implemented all necessary features and capabilities; 52.7% of the projects ,completed late, exceeded the cost of the planned budget, the required features were not implemented in full; 31.1% of projects were cancelled before the completion. For the projects, completed late or cancelled, the average project budget was exceeded by 89%, and the deadline - by 122% (Chaikovska, Zharova, 2014).

The main reasons for this situation are the following general trends:

1. Inconsistency of the created software and requirements of business objectives.
2. Selection of an inappropriate technology for the project.
3. The problem of understanding the project participants (especially the internal and the external ones for the organization).
4. Violation of the interaction processes in the project team.
5. Failure to follow roles and acceptable functional compatibility of the project team members.
6. The use of inflexible processes at the creation of IP.

7. Insufficient affordance of such risk categories as political risks, which, along with the main risks of IT projects, have a significant impact on results.

The features of IT projects are directly concentrated in the field of high uncertainty and weak demands of clarity. The requirements have different stakeholders, their requirements are not always accurate and often contradictory, not ranked. In addition, the requirements may change during the project, it is difficult to adequately assess the scope and the cost of the project at the early stage (estimated difference is up to 4-5 times), causing difficulty in rating of the resulting products (functional specifications and ready modules) (Chaikovska, 2015).

The product competence, directly attributable to the problem, has the following structure:

- Evaluation process; knowledge of standard processes;
- Definition of products;
- Evaluation of alternative processes;
- Management requirements;
- Management of subcontractors;
- Initial assessment;
- Selection of methods and tools;
- Fitting processes; tracking the quality of products;
- Understanding of actions for the product development.

The analysis of the project management competencies demonstrated that the technical difficulties are not a priority, giving up to the human factor. To implement a system in the company, three functionally important groups are formed: a group of developers, an implementation team and a group of users. The success of the project is determined primarily by the chosen methodology of interaction, skills of the development team and only then by the tool which they use.

The model and parameters of the software industry are largely dependent on the type of the projects that can be classified as:

- Product design writing on demand;
- Continuous customer service project;
- Making replicable product;
- Outsourcing.

The most sensitive type of the project is the first one because of the need in constant searching for new customers. The risks are critical due to the high dependence on the number of contracts.

Among the reasons, causing the failure of the first group of projects at the competence development in tracking quality is the paramount belonging to the Initial Level, which increases the following factors, specific to the domestic projects:

- Lack of discipline and interest of the project participants in the final result (due to the poor motivation of the intended project participants);
- The lack of consideration of the developer values' specific local scale, which does not directly apply to the Western standards;
- Weak documentation of development (which is the reverse side of the spiral model of the information system life cycle);
- Piecemeal development process (due to the need in the implementation of complex projects in a short time);
- Incorrect methods of communication; instability of teams;

- Problems at testing (as opposed to the Western standards, adopting the ratio of 1: 2 of the developer-tester, in the Ukrainian projects the situation is reversed: 2 to 1, which reduces the quality of the product significantly).

To reduce the risk of this group, a process approach and a system-dynamic approach simulation should be used; to monitor the requirements of the management process, the UML models should be created by using variants and attracting the customers for the models' discussion, clearly defining the scope of the project to formulate criteria for a project.

Figure1 gives a piece of the discrete simulation model of the IT enterprise that was built, according to the system-dynamic principle and implemented in iThink. It is a decision support system as it allows to combine several functional spaces into one organization and provide the organizational and quantitative basis for the development of the more effective management policies.

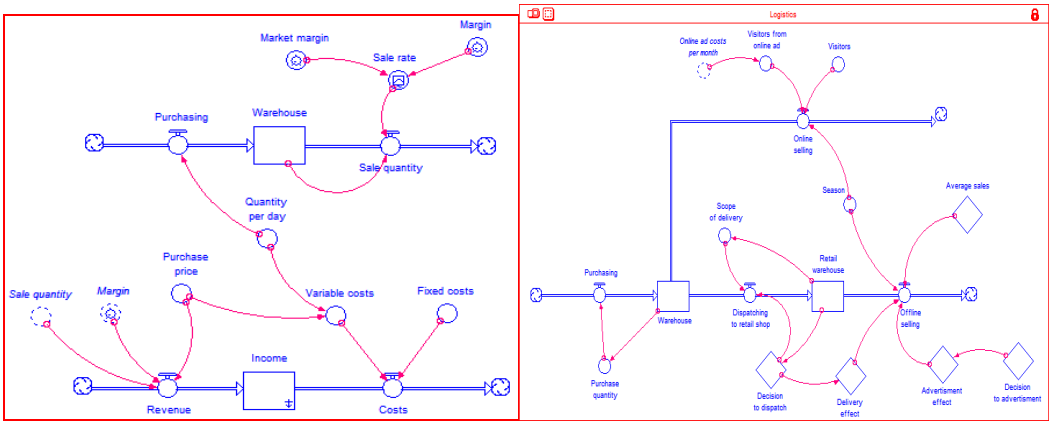


Fig. 1. The Model of Financial and Product Blocks of IT Company
(Compiled by the Author)

The results of experiments with the model are shown in Figure 2.

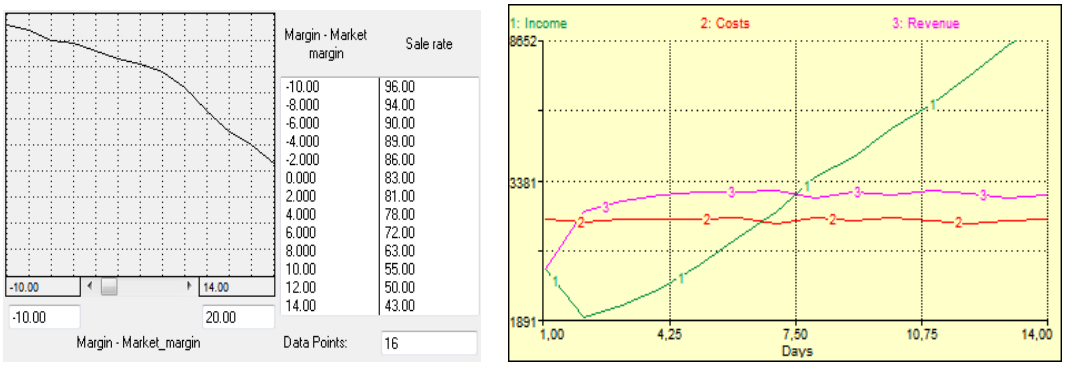


Fig. 2. Dynamics of Changes in Model Parameters (Compiled by the Author)

The simulation experiments with a model with the uniform and the exponential distribution of orders' flow led to the following conclusions:

- On optimization directions of the IT workers' loading.
- On optimization of the production cycle (when increasing the flow of orders by 20%, the production cycle increases).
- On the profitability factors of the IT project (the level of orders' flow, revenues and expenses, profits, wages).

Thus, the most critical risks of the IT projects are the related requirements' risks. The main way to combat these risks is to control the management process requirements, the creation of UML models by using variants and attracting the customers to discuss the models, a clear definition of the project boundary and the concepts of the project quality.

The quality of the IT project is usually seen through the prism of the software quality, which has such attributes as correctness, flexibility, efficiency, community, interaction between operations, opportunities for support, portability, reliability, re-use, testability.

Some researchers replaced the concept of quality with the concept of complexity, highlighting the logical (cyclic) complexity, the complexity of data, the complexity challenges by using a jump, functional complexity. Japanese companies add the time, required to remove defects after the product release, to the overall development time and use it as a key factor in determination of the key factor.

We believe a project can be considered a quality product if it meets the expectations of a customer; satisfies the constraints of the project; meets the needs of users; provides the ability to use it; ensures its smooth deployment.

A necessary condition for the quality performance of the IT projects within the current models is the use of the effective tools for modelling at the early stages of the IT project: determination, formalization and approval of requirements for IP.

The application scenario approach allowed identifying the areas of modelling: the process approach and the simulation modelling, including the agent modelling.

The simulation modelling allows us to study the problems of the complex systems for which there is no analytical solution.

It includes the following four approaches:

- system dynamics (Roberts, 2012),
- dynamical systems (MacCormack, 2013),
- discrete-event (McLeod, Jordan, 2012),
- agent modelling (Eamonn, 2008).

However, when the system that represents the company needs to be examined from a global point of view, or when the disparate elements of the system are to be examined together, the use of only one approach will not work. In this case there is a need for a comprehensive combination model. The most promising area for it, in the author's consideration, is the integration of the system dynamics (SD) and the agent-based modelling (AM) into a single agent-dynamic approach. Unlike the system dynamics, in the agent modelling, an individual group of members, such as firms in the economy or people in a social group, are represented explicitly, not as the aggregate object. The combined CD and AM approach, namely the agent-dynamic modelling (ADM) is a more versatile approach to the business modelling that takes into account the structure of a high level with a lot of active objects and the complex behaviour that meets the specifics of the IT projects (Chaikovska, 2014).

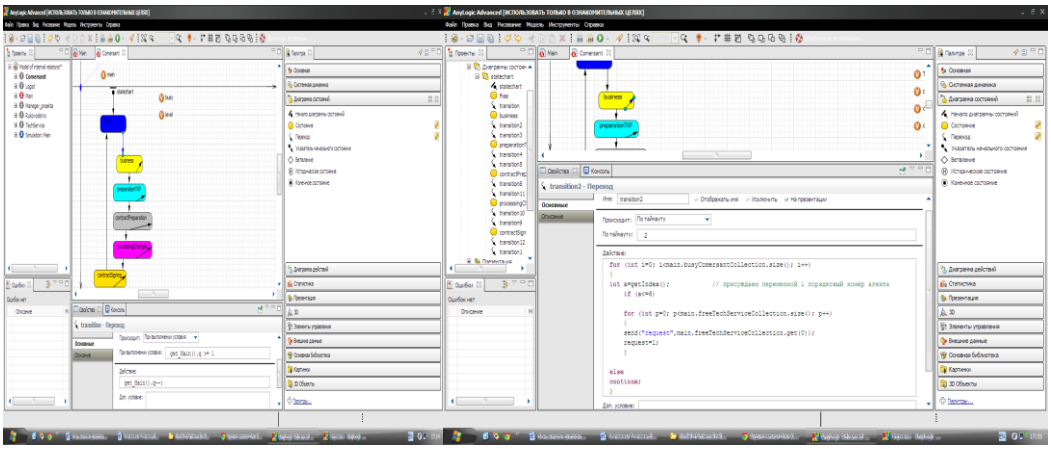
The agent-dynamic models can be used at different levels of the company hierarchy: strategic, tactical and operational.

At the strategic level the model can be established for the preliminary testing of different strategies or global solutions and policies. The advantages of this simulation are as follows. Firstly, it reduces the risk of the disastrous decisions that have led to the negative consequences of the company. Secondly, the management of the company improves the understanding of the relationship of individual units and processes in the company and the operation of the company as a whole.

At the tactical and operational levels, the employees' awareness of the importance of their particular executable process, the importance of their work in the areas of processes throughout the company occurs. As a result, the personal motivation of the employees, the corporate responsibility and the productivity of the whole company increase too.

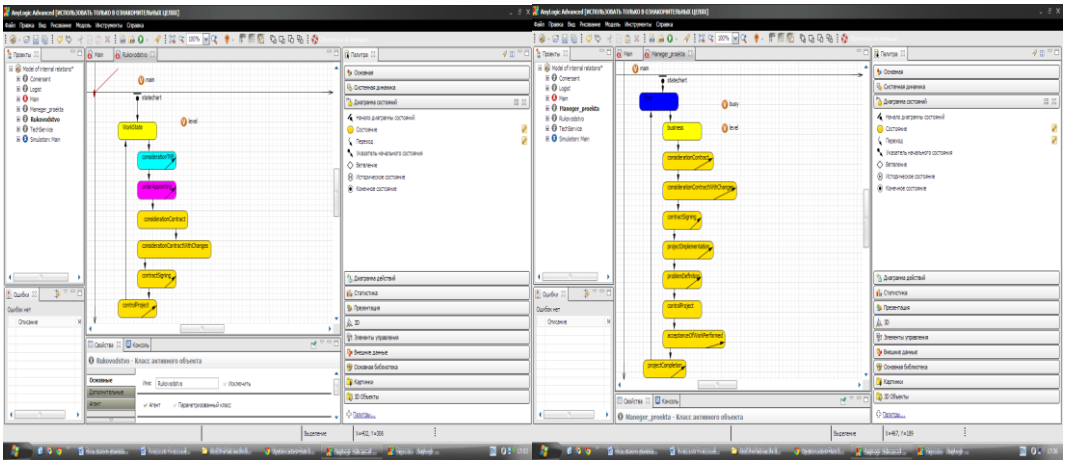
To create a simulation model, it is advisable to model the IT project team consisting of such agents as: a project manager, a project management team (the Management Team, which helps project manager), analytical and technical experts. The analytical professionals include business analysts and system analysts. The technical experts include developers, programmers, testers, etc. This group is made for the easy modelling of project participants as replicated agents and does not necessarily imply at combining the roles of the participants (Chaikovska, Hmelevska, 2015). To build a model of the IT project's internal relations, AnyLogic is used, being a tool for the simulation modelling (IM), which supports all approaches to the development of simulation models,- the process-oriented (discrete-Event), the system dynamics, the agent-based, - and any combination approach of the agent-based modelling.

The model includes a population of agents, "Management", "Project Manager", "Logistician" and "Technical Service" (Figures 3, 4):

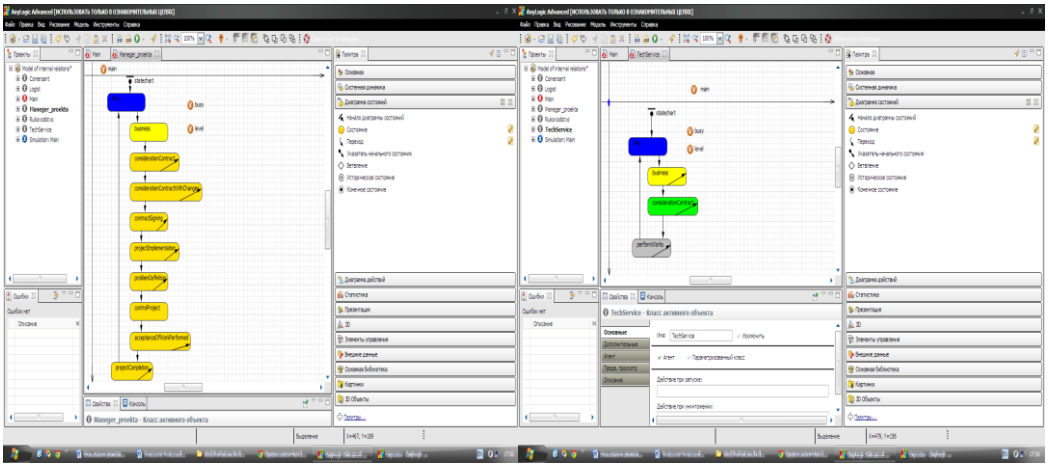


Figures 3, 4. Transition from the Free State to the State of Business
(Compiled by the Author)

Figures 5, 6, 7, 8 show the diagrams filled with class agents:



Figures 5, 6. The Model Diagram of the Class IT-Project Manager
(Compiled by the Author)



Figures 7, 8. The Model Diagram of the Class Technical Service and Logistician
(Compiled by the Author)

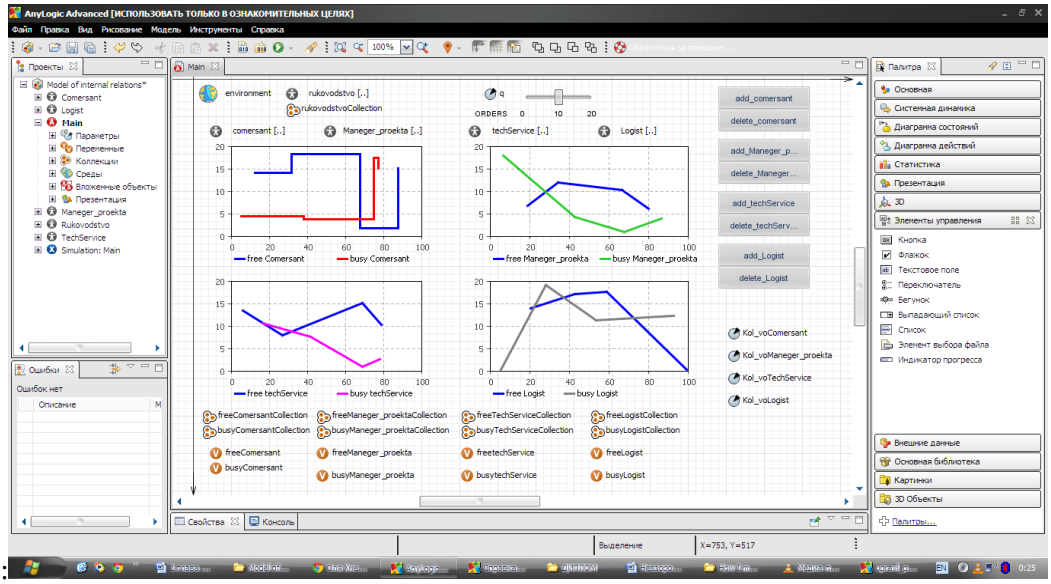


Fig. 9. The Interface Model of the IT Project Internal Relationships
(Compiled by the Author)

Figure 10 presents the model simulation's results with default settings.

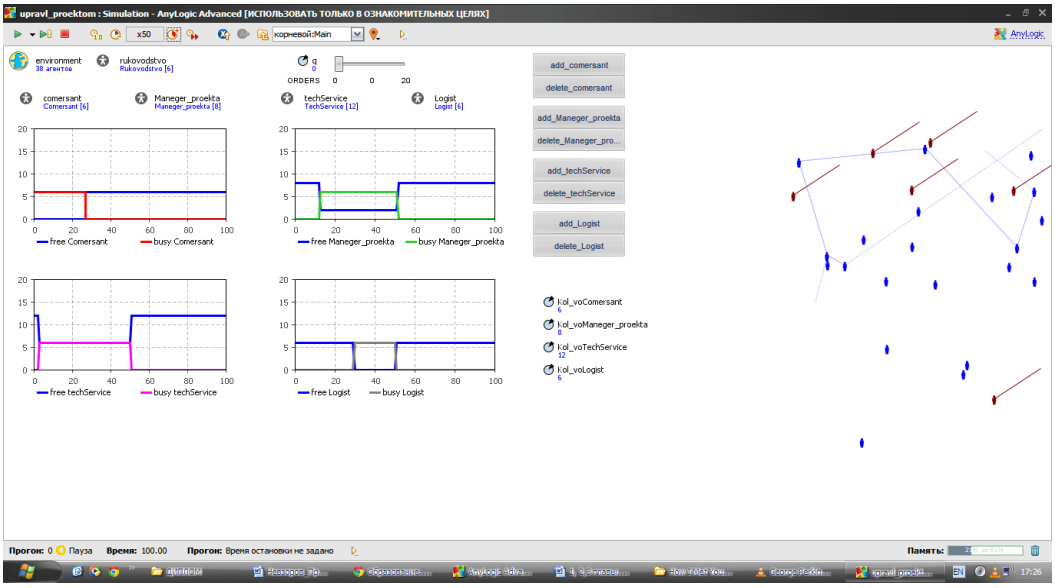


Fig. 10. The Simulation Process Running with the Standard Parameters
(Compiled by the Author)

The results of the model simulation allowed analysing the dynamics of changes in the number of employees in the IT projects, costs, profit performance and execution of orders.

The results of model experiments with changing the number of employees are represented in Figures 11, 12:

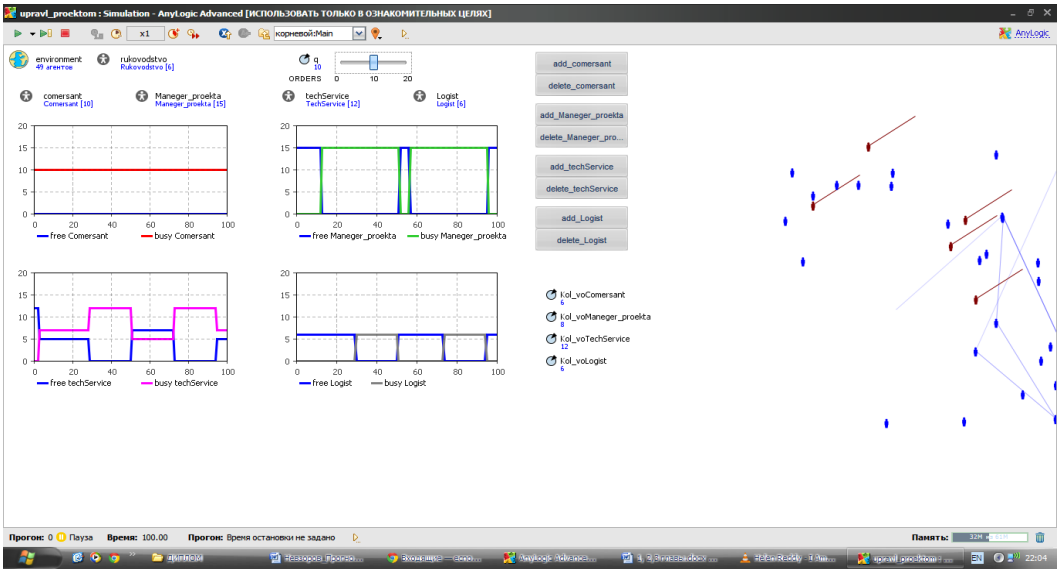


Fig. 11: Model Experiment with the Orders' Number Increase
(Compiled by the Author)

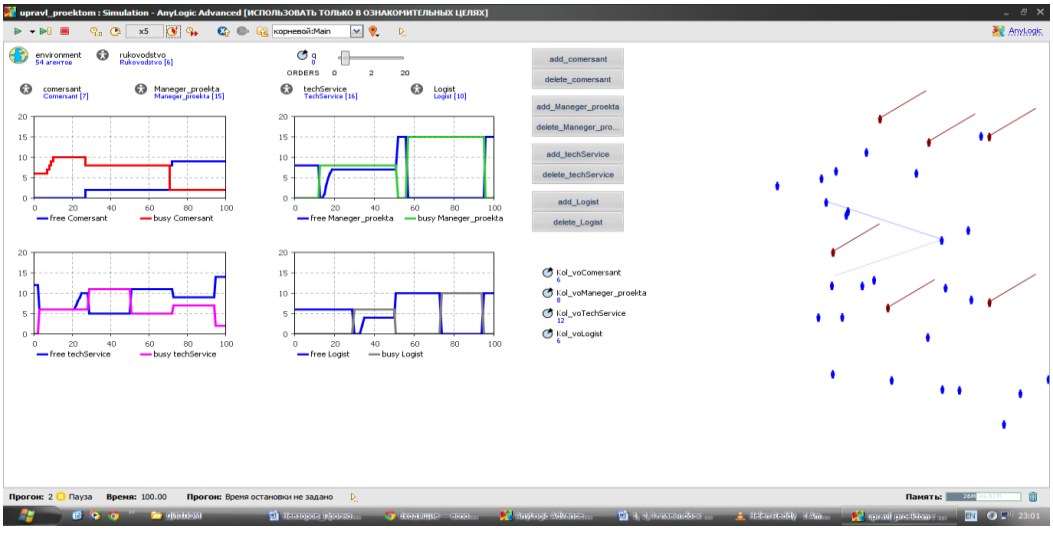


Fig. 12. Model Experiment with the Orders' Number Decrease
(Compiled by the Author)

The interaction of the IT project team with the external agents can also be viewed through the prism of the project life cycle's phases. This chart, giving the opportunity for the agents to display all the relationships in terms of stages, is also useful in the process of modelling, because it allows you to check whether all the relations between the agents are reflected in the created models.

To create an agent-dynamic model of the IT project, providing the IT simulation project for the life cycle of the project, it is necessary to identify the main processes, modelled at each stage.

The evaluation of project boundaries is completed by the project manager and in some cases by the sponsor. But as the future model is be the project manager's auxiliary tool in the project management, then the whole process of modelling should be done in terms of the project manager. Thus, during the project initiation it seems appropriate to create an additional simulation model to assist the project manager in the evaluation of the project boundaries. To solve this problem it was proposed to use the method optimization in software environment AnyLogic with the built-in optimizer OptQuest, which systematically changes the model parameters to minimize or maximize the objective function value.

The goal of the optimization is to find the optimal strategy for the implementation of the IT project to exercise a given content to a certain point of time at the lowest cost to meet a customer demands. To configure the functional optimization, the minimization option is used, as the objective is to minimize the cost and timing of the project. As the target functionality is minimized, such variables as the amount of expenses per a month (InitialMonthlyCost) and the amount of time per a month (InitialMonthlyTime) are used, in which the Project is implemented (InitialScope). The content of the project serves as the limit of the optimization parameters that are checked before starting the experiment. As an additional requirement, presented for the decision search after the experiment running, a customer satisfaction is used, which is expressed as a percentage.

Thus, we can conclude on the relationship of the involved risks and the initial level of work on the project management methodologies, the priority interaction and human factors over the technology. The necessary condition for quality performance of the IT projects is the use of the effective tools for modelling at the initial stages of the IT project definition, formalization and approval requirements for ICs, allocation of relationships and goal-setting of the IT project, according to the business plan of the company.

The use of the effective agent-based modelling tool at the stage of the IT project harmonization allows to realize the interconnected chain: the development of the management model - the formation of project documents – the confirmation with the developer - the consent of the client - update, which allows the detailed determination of functional requirements of IP, significantly reduces the project cycle timing and lowers the risks, implements the following measures, improving the quality of the IT project:

1. Gives the possibility of changing requirements during the project, as more often the initial targets of the project did not fully reflect the needs of a customer and there is a need to clarify or modify the system of requirements already during the development.

2. Controls the iteration design requirements and permits the system adjusted according to the requirements change. The monitoring compliance at all stages of the project is a part of the quality system.

3. Prototyping of business logics, the functional style and the user interface gives an opportunity to test the system, being not completed yet, to a customer and to identify and

eliminate the non-compliance, which reduces the time and cost of the system development at the early stages of the project.

4. The use of visual modelling, design diagrams, illustrating the functioning of the system that allows the project participants to find the common ground at all stages of the system development.

5. To reduce the period of the system "break-in" at the trial operation stage and during the warranty it is important for the developer to get information on the detected errors.

To reduce the risks associated with the project implementation and to guarantee the quality of execution, along with the experience in development and sufficient resources, a model, based on the agent-based modelling methodology that provides a predictable result of agents, a transparent development process and helps to attract a customer into the process of development, is needed.

Conclusions and Suggestions:

As a result of this study, the theoretical and methodological framework for the agent-dynamic model creation of the IT project management was prepared. It reveals the principles of the agents modelling in the system-dynamic environment as the interaction complex of the internal and the external members of the IT project, according to the certain rules at different life stages of the project, taking into account the life cycle of the system development.

The agent-dynamic model will improve the understanding of the modelled system structure and its dynamic processes as well as the principles of the elements' interaction in the complex. As a result, we may not only improve the quality of management decisions, but also reduce the costs significantly. The agent-dynamic model will also play the different versions of the project, change the main constraints of the project, leverage and see how it will affect the results of the project. Using this tool, the project manager can review the project before its implementation, compare the projected results of the project alternatives with each other or with the results of the similar projects and choose the best of them.

The scientific novelty of the proposed approach is the symbiosis of the process and the agent-dynamic modelling areas that can be shown in the model created by the relationship between the agents. It allows to consider the interaction between the IT project teams and the external agents in the light of the life cycle phases of the project, not only showing the agents' relationship in terms of the stages, but also helping to increase the understanding of the cognitive nature of the IT project, the principles of the elements' interaction in the complex.

The results can be used in all phases of the IT projects, giving the opportunity to realize the interconnected chain: the development of the management model - the formation of project documents - the confirmation with the developer - the consent of the client - update, which allows the detailed determination of functional requirements of IP, significantly reduces the project cycle timing and lowers the risks, implements the measures which improve the quality of the IT project.

References

Beck, K. (1999). Extreme Programming Explained: Emb. Change, Addison.

Chaikovska, M. (2014). Complex modeling approach in managing IT projects. Economic Scientific Letters of National Technical University of Ukraine KPI. Kyiv: KPI, No. 11, 590-597. [in Ukrainian].

Chaikovska, M. (2015). Problems of implementation of IKT-projects in marketing activity of the enterprise. Scientific letters of Academic society of Michal Baludansky. Slovakia, Kosice: ASMB, No. 3, 33-36.

Chaikovska, M., Hmelevska, O. (2015). Simulation of internal relationships companies. Scientific Letters. Economic Science. Khmelnitsky: KNU No. 4, Vol. 2, 286-294. [in Ukrainian].

Chaikovska, M., Zharova, A. (2014). Conceptual approach to the creation of IT-project management simulation modelling. Scientific letters Analele ASEM XII. Kishinev: ASEM, 33-38.

Eamonn, L. (2008). Introduction to Agent-Based Simulation in Flexsim, Flexsim Corporation.

MacCormack, A. (2013). Product-Development Practices That Work – MIT: SMV, Vol. 42.

McLeod, R., Jordan, E. (2012). Systems Development: A Project Management Approach. Wiley, 524.

Roberts, A. (2012). Project management: a distance learning programme: Edinburgh Business School, Edinburgh.

Schwalbe, K. (2011). Information Technology Project Management. Revised Sixth Edition. Course Technology. USA, Boston: Cengage Learning.