

## METHODS FOR ASSESSING THE PROBABILITY OF DELAYS IN THE IMPLEMENTATION OF LONG-TERM PROJECTS

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The article is devoted to the problem of effective management of long-term projects, in which there are high risks of untimely execution of individual stages, which may lead to the disruption of the entire project. The authors propose an approach to estimating the probability of project delays, using an adequate distribution law, which is implemented in EXCEL. The article presents the results obtained on the statistical model of the project.

*Keywords:* project management, project delays, probability measure of future events, scenario-probability distributions

**T**oday's trends of fast speed of changes make companies pay special attention to strategic goals and leadership position. The strategy involves large-scale milestones in the development of the company, which should provide a leading position in the market. By these milestones are meant large projects, the implementation of which requires long-term participation. According to Hirschman, projects are privileged particles of the development process. However, the longer the time period of the project and

the larger the scale, the more difficult it is to implement it in accordance with the original plan formulated at the initiation of the project. Management cannot predict the probability of future events that will occur in a few years. Nevertheless, management is obliged to adapt the current state of the project, make forecasts and develop scenarios for the near future, and build operational plans according to the strategic plan.

The strengthening of economic stability in different countries is developing with distinction. Many

countries have not yet adapted to the crisis conditions, such as the financial crisis in 2008, the European sovereign debt crisis in 2010 and the crisis due to global changes in commodity prices in 2014. However, the global economy shows growth of 2,4 % compared to last year and is expected to grow by 3 % in 2019. Investment activity has more favorable conditions compared to last year, but the increase in the riskiness of investments is the main barrier to business development. The uncertainty of the political situation, trade policy, adjustment of Central banks' rates leads to an increase in risk when investing especially for a long period [9]. For example, the risk of a recession of the yield curve is high. That is, the investor has the same risk when investing in short-term assets and long-term; although, in the normal state of the yield curve long-term assets should have a higher yield [1,4]. Thus, long-term projects are primarily costly.

As noted by Albert Waterson, a World Bank employee, most projects have limitations in the administration of the project implementation process [8]. Planning and management are the most common problems. The dynamics of change are diverse and large-scale, so traditional project management methods need to be revised. Special attention should be paid to the skills of managers such as resource mobilization, decision-making and coordination according to the changing environment. The probability of occurrence of adverse events is high, and it is necessary to take into account these values.

Rondelli identified several resistances that are obstacles to the successful implementation of projects. The reasons may be related to the obtaining of appropriate permits for activities in the project, inter-organizational rivalry, the lack of priority rules in the allocation of resources, the lack of planned scenarios, lack of flexibility in the action plan and the rules of priority of work. The author also emphasized the reasons associated with the increase in the project budget related to delays. For example, the lack of systematic analysis of the current activities of the project, the reliability and availability of information about the project for all participants, and the inability to anticipate delays in the fulfillment of obligations of suppliers and contractors to perform other tasks with the least losses in the most optimal sequence [8].

Multitasking and complex projects, which have several performers located in different territories, require high attention in the analysis of the implementation of the project plan. Project management should take into account unforeseen delays, failure to meet the requirements of various project participants, coordination at several levels of the stages of work, as well as control the budget within non-critical limits due to deviation from the schedule. An example of such a complex project is large-scale construction, for the implementation of which the Irkutsk Company is responsible. The project has several levels of coordination: between the parent company and the subsidiary, coordination between subsidiaries and between the subsidiary and

contractors. According to the work schedule, half of the work should have already been completed, but there are 5 % of overdue tasks on the schedule. There are a number of reasons why these delays are possible. In order not to reduce the percentage of deviations from the action plan, a frequency analysis of causes was used to determine the level of risk of a specific cause and consequences in the form of delays.

Frequency analysis involves determining the frequency of events related to a certain criterion. On the basis of the data obtained, a risk map is constructed, which displays the range of probabilities of negative consequences. In this case, the risk matrix consists of two criteria: the cause of delay and the probability of occurrence of the event. Probability is calculated by counting the frequency of overdue tasks with a time range. Thus, the management of the organization can determine what causes require more attention and more careful monitoring, and what causes of delays are not require increased attention, but should also be taken into account. However, the risk map formulated by this method can only make sense for the analysis of completed work, reporting and identifying failures. Also, these risk maps have a fairly rough estimate and clear boundaries in the definition of small, medium and high risk. Another drawback is that the sample is limited, for example, for a large project with many tasks for compiling a heat risk map, it is necessary to group the samples, which is not convenient and accurate to determine the probability of occurrence of an event. The Manager, based on this risk map, will not be able to predict future possible problems with deadlines [5]. To perform this task and have a vision of the probability of future delays, management should analyze previous experience of work and set the estimated function, the rules of which will be built scenarios [3].

Any rule that allows you to find the probability of all values of a random variable called the law of distribution of its probabilities. This law is given in the form of a table for a discrete random variable, which lists all its possible values and their probabilities [3]. However, the resulting distribution table may not be suitable or practical because of the scale of the tables. Therefore, for the convenience of the analysis, the distributions of random discrete quantities are approximated by continuous distributions, allowing the use of relatively simple methods of calculation, even with an unlimited number of scenarios. To set such distributions, use the function  $F(x)$  called the distribution function of a random variable or the distribution law. Having defined the distribution function or probability density distribution of a random variable, we can draw conclusions about the degree of reliability of the events that generate it. However, to solve many practically important problems, it is often enough to know the values of only a few characteristics (parameters) of a random variable, which give a less complete but more visual representation of its distribution. The most important of these are the mean, variance, and standard deviation.

The author has chosen several completed tasks related to the delay for one of the reasons. The results of the frequency analysis are shown in red in Figure 1. Further, such measures as the mean deviation and standard deviation were found. This is necessary to specify an array of random numbers formed on the basis of statistical data. After Excel generates a possible outcome of the work, the quantitative

indicators of the number of days overdue were also calculated. This work was carried out to compare real data and randomly generated and check whether it is possible to rely on the given random parameters. The figure shows that the data correlate with each other, so a normal distribution generated with random numbers and parameters of statistical data can be considered valid.

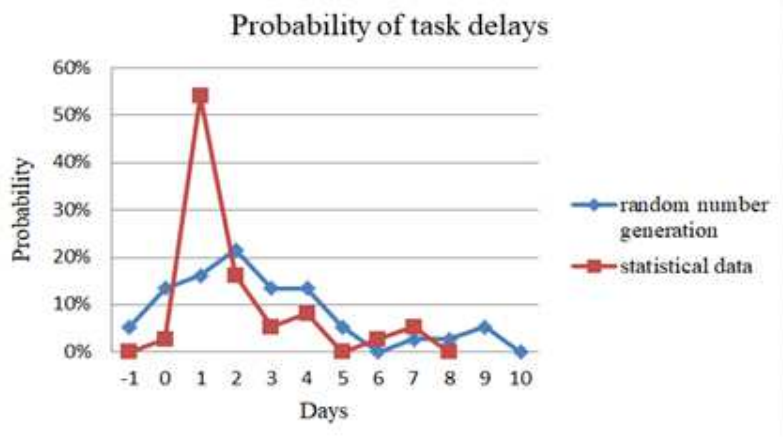


Fig.1. Comparison of the function of normal distribution of statistical and random data

The law of distribution of a random variable includes the calculation of the mean and standard deviation. However, we may assume that it is possible to specify one constant, which will not require these calculations. This method of constructing the predicted probability values is called the Poisson distribution law [6]. On the basis of previous calculations, the author suggested three values of the constant, which

will determine how many tasks will have delays and presumably how many days it will be. The Figure 2 shows the difference in three scenarios: pessimistic, more probable and optimistic. The more probable scenario is as close as possible to the actual frequency data relative to the probability percentage. This confirms that the law of distribution of a discrete random variable can be used in the planning of work.

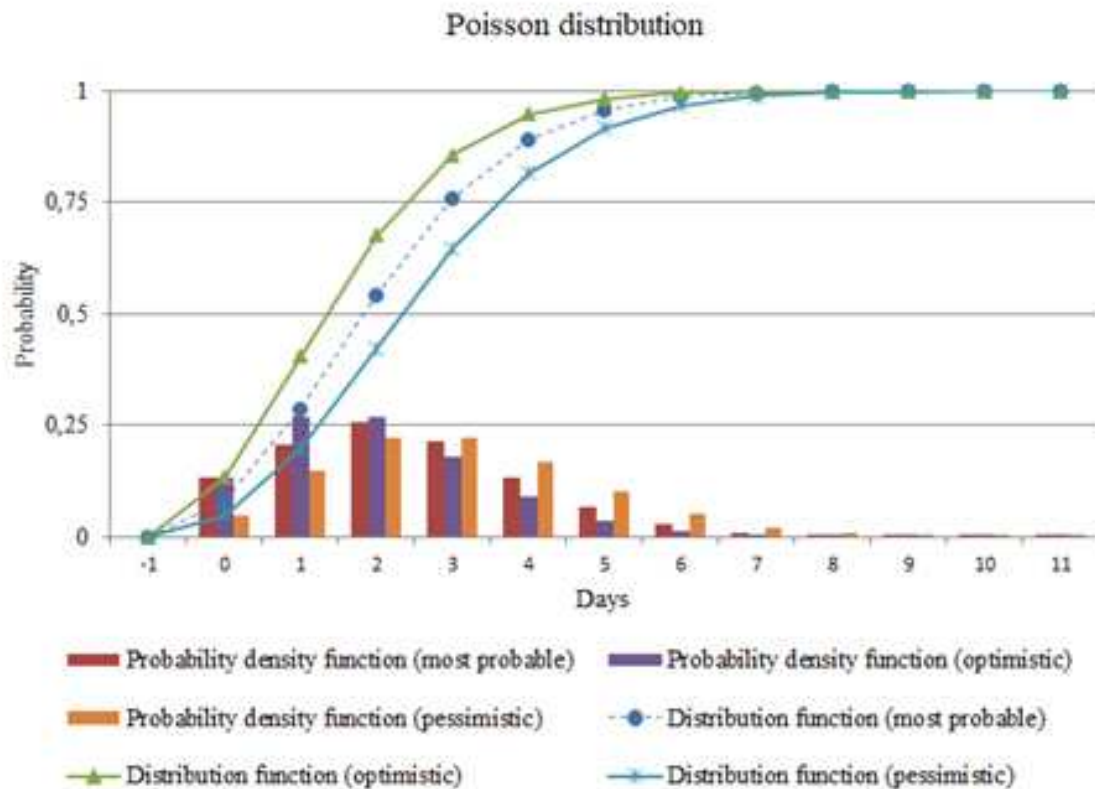


Fig.2. Poisson distribution law as a method of predicting scenarios of future events

The pessimistic forecast illustrates that the task will have a delay of 6 days with a probability of 5 %, while the optimistic forecast shows that the delay of 6 days is probably only 1 %. It is assumed that the consideration of the three scenarios allows more efficient development of plan options, and change of the baseline [2]. It means that managers relying on the data on the three scenarios of work execution can form three scenarios of the network schedule and, if necessary, change the basic plan [7].

Thus, this article analyzes the real data of overdue tasks for various reasons of delay. Based on the frequency analysis of real data, the predicted values of the three scenarios were constructed using the laws of distribution of a random variable. The obtained data were close to the real data, which allows using the forecast values for planning the work of the project. With this data, managers can establish reserves regarding the impact of previous causes of downtime and the resulting probability ratio. There is an additional opportunity to use several scenarios of the action plan to change the baseline in case of delays. In conclusion, project managers can implement the plan with fewer losses and minimize deviation from the schedule. ■

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## Методы оценки вероятности задержек при реализации долгосрочных проектов

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Статья посвящена проблеме эффективного управления долгосрочными проектами, в которых велики риски несвоевременного выполнения отдельных этапов, что может привести к срыву всего проекта. Авторы предлагают подход к оценке вероятности задержек в работе над проектом, используя адекватный закон распределения, который реализован в EXCEL. В статье приводятся результаты, полученные на статистической модели проекта.

*Ключевые слова:* управление проектами, задержки в ходе реализации проекта, сценарии распределения вероятностей

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