Systematic Study of Structural Divisions of Industrial Enterprise Using Queuing Systems

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Abstract
In this article we discuss the use of simulation modeling on the example of several enterprises in various industries. An analysis of the work of enterprises is carried out and a simulation model is built on its basis. The results obtained are also evaluated and options for improving the functio-ning of enterprises are proposed. In other words, the purpose of the work is to study the literature on this topic, analyze and model the work of companies to improve the quality of their functioning.

Keywords: Simulation modeling; Research, Analysis; Conceptual model; Modeling

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1. Introduction

In today's environment, it is very common for companies to heavily rely on information technologies for their management, which are aimed at the effective operation of the company. In addition, the efficiency of work is supported by competent decisions of the head. The work of both a separate branch and the entire enterprise depends on the decisions taken. An important point in making a decision is a clear and correct definition of the problem facing management. To concretize the problem, an analysis of the company's activity indicators of interest is carried out. One of the methods of analyzing and solving the problem is simulation modeling.

Before considering this topic in detail, it is certainly necessary to note the fact that the whole world is moving towards modernization and digitalization. Even once classical industries find benefits in modern technological solutions (Razmanova, S. V., & Andrukhova, O. V., 2020), whether it is a system analysis of a particular activity or an assessment of the feasibility of implementing projects. Thanks to new technologies, it turns out, for example, the need to build scenarios for the future. It would seem that the already boring topic of sustainable development cannot be neglected, since there is a divergence of goals and interests of countries, which entails a kind of stagnation, not development (Yurak, V. V., Dushin, A.V., & Mochalova, L. A., 2020). But it is also worth noting that in the mining industry, the ability to find and manage ESG or other types of risks, using the resource potential, as well as the use of the latest CS strategies – this can be called corporate sustainability (Blinova, E., Ponomarenko, T., & Knysh, V., 2022). Technologies that help automate the process receive a strong variety. For example, it is possible to make edits based on mathematical modeling and make conclusions about the possibility of optimizing temperature conditions in the control system under consideration, using Nvidia CUDA (Ilyushin, A. N., Kovalev, D. A., & Afanasev, P. M., 2019).

The main idea and part of this article is necessary to develop an optimal solution in order to obtain economic benefits from the risk assessment of the projects under consideration, but we understand that there are other economic assessments that are applicable in a variety of activities. So there is a DCF model for economic evaluation of projects in the oil and gas sector. But it has conceptual limitations, one of the reasons for which is the lack of consideration of the risks of specific projects (Ponomarenko, T., Marin, E., & Galevskiy, S., 2022). In turn, the topic of modeling situations to form an idea of what can be expected in the future is well revealed in mathematical modeling, which is able to describe both geophysical processes and others. Solving scalar equations reflecting the behavior of real objects, this helps to evaluate the dynamics of the process (Kazankov, V. K., Peregudin, S. I., & Kholodova, S. E., 2023).

In principle, today, modeling is tightly integrated into the modern technological process. Thus, for example, it is possible to visualize the distribution of the solid phase when modeling the flow of a heterogeneous flow and evaluate the efficiency of work. It is clear that with such technologies it is possible to describe the physical state of a substance at all points (Vasilyeva, M. A., & Faith, S., 2017). If we move from this sphere to the sphere of hydrodynamic models, then we can observe a large variety of different programs that are suitable for use – these are Plast, ModTech, Topaz and so on. There is also a certain imbalance that occurs during the construction of the model. It is caused by the fact that there is a need for a qualitative model that will include a large amount of data, taking into account many factors, but it is very important not to forget that the possibility of implementing this entire model may suffer because of this (Martirosyan, A. V., & Ilyushin, Y. V., 2022). As mentioned earlier, digital technologies have tightly entered many areas, even in the oil and gas industry. It is noted that there is an urgent need to improve efficiency in managing business processes, the solution, of course, is digitalization, in particular digitalization of the oil and gas sector (Samylovskaya, E., Makhovikov, A., Lutonin, A., Medvedev, D., & Kudryavtseva, R. E., 2022).

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With all this variety of new technologies, do not forget about your own security when working with data and in communication systems. Often at large enterprises that spend a lot of money on the development and modernization of technologies, failures occur caused by carelessness in working with data transmission, even in a corporate environment. To date, it is worth highlighting one of the areas of development of a system that implements the idea of using standard client applications with processing transmitted on the corporation's own server (Matrokhina, K. V., Makhovikov, A. B., & Trofimets, E. N., 2021).

The main need will always be the economic component. In this regard, we should mention the issue of constructing Lorentz curves. This topic is used in various fields, which is connected with modern technologies, science, and economics. These curves can be used to analyze economic inequality with an uneven distribution of profits and incomes. They can also be useful with uneven costs, as well as research detail or certification processes, and so on (Bochkov, A., Pervukhin, D., Grafov, A., & Nikitina, V., 2020). For the planned growth and normal development of the economy through technological progress, it is necessary to turn to the formation of a balanced system of indicators. So, it is necessary to set strategic goals, target values, find programs that contribute to the achievement of these strategic goals, that is, strategic initiatives, determine the main projections of activities (prospects). All this shows the need for strategic planning, which should be, regardless of what field we work in (AL-Saadi, T., Cherepovitsyn, A., & Semenova, T., 2022).

Simulation modeling is one of the modeling methods that allows you to describe all the processes of the object of study in such a way as if they were taking place in reality. Models of this type can be "played" (run) through time countless times. Moreover, the simulation results will be described by the random nature of the processes (Pervukhin D.A., 2020).

Nowadays simulation modeling is used in a variety of fields of human activity: in industry, transport (Krakovskiy Y.M. & Ngo Zui Do, 2015), economics, ecology, information security and services, as well as in public, state and military relations.

Simulation modeling can be of several types: modeling of functioning, modeling of system efficiency, modeling of application conditions, physical modeling. In this article, we will consider in more detail the modeling of the efficiency of the system, since the goal is to optimize the work of enterprises.

When modeling the effectiveness of the system, a preference is given to a certain concept of the system. In addition to the functioning of the system itself, a model of the functioning environment is being designed. By varying the external and internal parameters of the system, you can explore various options for operation and capabilities of the system.

Currently, there are a number of programs that allow you to conduct simulation modeling: Plant Simulation, GPSS World, Scilab, AnyLogical (Panov K.V., 2018), Maxima, Solidworks Simulation, Autodesk Simulation, Matlab.

2. Materials and Methods

Based on the purpose of this work, specifically the study of theoretical materials for the development of simulation models and their visual application in practice, we will form the following tasks:

1. The study of literature on the objects of research
2. Study of theoretical materials on modeling to develop a solution to the problem
3. Development of a simulation model in the GPSS World program for each enterprise
4. Optimization of the company's work
5. Summing up conclusions on the work done with possible recommendations

In this article, we will conduct simulation modeling in a program such as GPSS World. GPSS – General Purpose Systems Simulator is a classic simulation program. It is designed for modeling queuing systems and has special operators as well as syntax. Many areas of life can be described as a queuing system, with their help, it is possible to implement multiple repetition of the same actions over a certain period, but not in real time, which significantly saves a valuable resource. Any system can be calculated and adjusted in advance, so that when implemented in practice, losses and a simple system make up a smaller percentage or there was none at all.

In the simulation modeling (IM) of discrete processes in modern practice, the GPSS World general purpose system, which is the latest modern representative of the GPSS family of modeling languages, has become widely used as a tool. The ideas laid down by GPSS creator Jeffrey Gordon were used in many subsequent specialized languages and environments by HIM. For half a century, undergoing continuous evolution, the GPSS language has found and is finding application in new types of computers and operating systems. By the beginning of the XXI century, about a dozen versions of the GPSS language were created. GPSS World, thanks to its capabilities, the availability of literature and a free student (academic) version, is widely distributed in our country and abroad.

The research in the article was carried out on real objects in several stages, to demonstrate the universality of the methods and tools used. The performance indicators of the system under study were determined and a simplified algorithmic description of the system under study was given. Then a modeling algorithm was developed and a software implementation of the model was described, which allowed a number of experiments to be carried out on objects by varying various internal and external indicators of the system (Afanasyev, M.P., 2020). All the results obtained during the study were interpreted and based on them, recommendations were made for optimizing or modifying the systems that were studied.

3. Results

Simulation model of an energy industry enterprise

JSC «Concern Rosenergoatom» is a company that uses nuclear power plants as power generation. It consists of various branches scattered throughout Russia. Take a closer look at the branch of the Kalinin Nuclear Power Plant (KNPP), in particular, the department of organization of entrance control and conformity assessment. This department is divided into two groups – the entrance control group and the conformity assessment group (Official website of JSC «Concern Rosenergoatom», n.d.).

Based on the practical experience of the employees, the following information was obtained on the functioning of their department: there are seven employees in the conformity assessment group (call it the first one), each of whom can simultaneously work with five applications (incoming letters or requests for the purchase of equipment). In the entrance control group (in the second group), there are four employees, each of whom can simultaneously work with two applications for input control. On average, 5.5 applications per hour can be received, while the average working time of the staff of the first group with one application varies from 8 to 10 hours, in the second group – from 3 to 5 hours. For convenience, we present these data in Table 1.

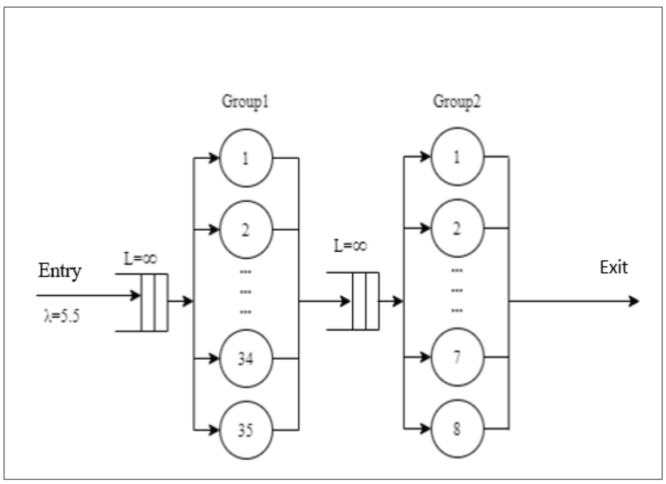
Table 1. Initial data.

T_{lab}, hour	λ, units/hour	n_1, units	n_2, units	$\bar{t_1}$, hour	$\bar{t_2}$, hour	DL
1976	5,5	35	8	8-10	3-5	Uniform

Source: «Compiled by the authors».

This model is presented in the form of a multi-channel queuing system with waiting. The input is a simple flow (Exponential) and a uniform distribution law, respectively, will describe the service process. Let us model the work of the department for one working year in hours, which equates to 1976 hours. Before we start writing the program, we will make a schematic representation of the functioning of the department (Pic. 1).

Picture 1. Conceptual model of the system.



Source: "Compiled by the authors".

Based on the conceptual model (Pic. 1), we will write a program in GPSS World, the listing of the program is shown in Pic. 2.

Picture 2. The model program in GPSS World.

```
GROUP1    STORAGE   35
GROUP2    STORAGE   8
GENERATE  (EXPONENTIAL(1,0,1/5.5))
QUEUE     OCH1
ENTER     GROUP1
DEPART    OCH1
ADVANCE   (UNIFORM(1,8,10))
LEAVE     GROUP1
QUEUE     OCH2
ENTER     GROUP2
DEPART    OCH2
ADVANCE   (UNIFORM(1,3,5))
LEAVE     GROUP2
TERMINATE 0
GENERATE  1976
TERMINATE   1
```

Рис. 3.2. Программа модели в GPSS World

Source: "Compiled by the authors".

After the simulation of the program, a report with all the simulation results is displayed in GPSS World, for convenience, we will enter all the decrypted data from the report in Table 2.

Table 2. Explanation of the report parameters.

Показатели	**Значение**
Number of applications created	10727
Number of applications served	3941
Average number of applications in the first queue	1490,412
Average number of applications in the second queue	1848,513
Average waiting time for an application in the first queue	274,546
Average waiting time for an application in the second queue	476,973
Average number of occupied channels of the first group	39,944
Average number of occupied channels of the second group	7,961
Utilization rate of the first group	0,998
Utilization rate of the second group	0,995

Source: «Compiled by the authors».

According to the table, it can be concluded that the service channels of both groups are occupied almost all the time of the simulation, on average, 1490 and 1849 applications were waiting in the queue, which is unacceptable, and the waiting time in them is 275 and 476 seconds. The program is running at the limit, the channels cannot cope with so many applications. Therefore, it is necessary to work on improving the model and determine the nominal mode of operation, i.e., to conduct a number of experiments on the original model.

To determine the nominal mode of operation of the model, it is necessary to select several informative performance indicators by which it will be possible to evaluate the efficiency of the model (Afanasev, P.M., 2020). Let us choose the following indicators: utilization rate, average number of applications in the queue, average waiting time for applications in the queue, average number of busy channels. We will conduct a series of experiments by changing the number of channels in the first and second groups, since it is impossible to change other model indicators taken from Table 1. Let us bring all the performance indicators from the reports into a single table (Table 3).

Table 3. Interpretation of experimental results.

Numbers of channels		**Utilization rate**		**Average numbers of application in queue**		**Average waiting time for applications in the queue**		**Average number of busy channels**	
1 group	2 group	1 group	2 group	1 group	2 group	1 group	2 group	1 group	2 group
35 (7)	8 (4)	0,998	0,995	1490,4	1848,5	274,55	476,97	34,944	7,961
40 (8)	12 (6)	0,998	0,995	971,27	1406,3	179,28	317,76	39,923	11,94
45 (9)	16 (8)	0,998	0,995	398,04	970,58	73,418	195,10	44,894	15,917
50 (10)	20 (10)	0,976	0,994	9,251	388,97	1,701	71,919	48,788	19,873
50 (10)	22 (11)	0,972	0,978	10,647	6,542	1,968	1,215	48,595	21,506
55 (11)	24 (12)	0,902	0,912	1,485	1,644	0,269	0,299	49,59	51,883

Source: «Compiled by the authors».

Analyzing Table 3, we can conclude that with an increase in the number of channels, the values of efficiency indicators decrease, the system works faster and does not make applications wait in queues for a long time during modeling. In addition, the average number of occupied channels shows that the use of 50 and 22 channels is sufficient for the model, because at the next step, when using 55 and 24 channels, the number of occupied channels remains almost the same. Therefore, the nominal operating mode of this system corresponds to the model with and , because the model works as efficiently as possible (Arefiev, I.B. & Afanaseva, O.V., 2022).

Let us summarize the developed simulation model for an energy industry enterprise: during the simulation, it was confirmed that there is an overload of employees' work in the system. The department cannot cope with the number of applications that it receives at the entrance. To improve the quality of work in the department, there should be 10 people in the conformity assessment group and 11 people in the entrance control group. By implementing this recommendation, the company would be able to reduce the downtime of equipment in the warehouse and waiting for its processing. Which would help to reduce the cost of warehousing and increase the productivity of workers.

Simulation model of an oil and gas industry enterprise

LLC "Dalkamneft" is an enterprise that refuels various vessels: commercial and small vessels, tugs, etc. The company is located in the city of Petropavlovsk—Kamchatsky, in this region the industry of fishing and other production related to marine activities is well developed. Due to this, there is a demand for fuel, because in addition to the fact that many ships are assigned to Petropavlovsk itself, ships from other cities also enter the port, which also require refueling. Coordination and interaction with all ships of the enterprise takes place live, that is, online. A tracking system is installed on each vessel, and all data is sent to the operator's computer via satellite. He can find out at any time the course of the vessel, which mission the bunkerer is currently performing. In addition, operators have access to information about ship captains and communication with them. The people in the office and the people on the bunker are constantly in the same information field. They all function together as a single whole (Kholopov K.V. & Sokolova O.V., 2015).

In total, the company has 3 bunkers. The system with an intensity of 7 ships per day receives applications for bunkering vessels. If all bunkers are busy at the time of the request, then the customer is denied service, since in the open sea in the harsh conditions of the Far East it is impossible to put the ship's crew at risk and wait in line, it is necessary to deliver fuel as early as possible. The bunkering time is determined by the law of uniform distribution with a service time of 0.2 - 0.6 days. We will simulate the operation of the system for one week. The initial data are shown in Table 4.

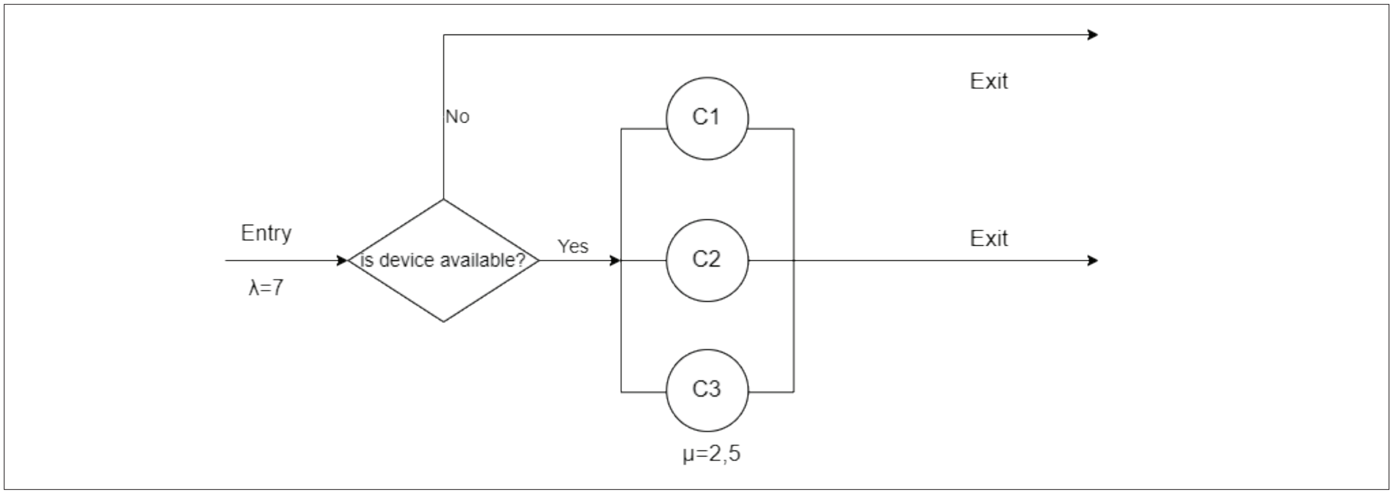
Table 4. Initial data.

T_{lav}, days	λ, units/day	n, units	$\bar{t}_{serv}$, day	DL
7	7	3	0,2÷0,6	uniform

Source: «Compiled by the authors».

Before starting work in the GPSS environment, for the convenience of perception and understanding of the system structure, we will compile a conceptual model of the task. It is shown in Pic. 3.

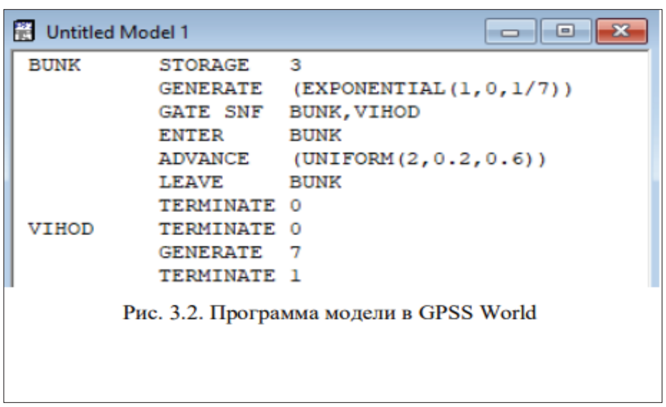
Picture 3. Conceptual model.



Source: «Compiled by the authors».

Now let us go directly to the development of this queuing system in the GPSS environment. The listing of the program is shown in Pic. 4. The system receives applications with an intensity of 7 units/day, checks for the availability of a free device. If all devices are busy, the request is sent to the exit; otherwise, the request gets to one of the three service channels, and then goes to the exit.

Picture 4. The model program in GPSS World. *Source*: «Compiled by the authors».



```
Untitled Model 1
BUNK      STORAGE    3
          GENERATE   (EXPONENTIAL(1,0,1/7))
          GATE SNF   BUNK,VIHOD
          ENTER      BUNK
          ADVANCE    (UNIFORM(2,0.2,0.6))
          LEAVE      BUNK
          TERMINATE  0
VIHOD     TERMINATE  0
          GENERATE   7
          TERMINATE  1
```

Рис. 3.2. Программа модели в GPSS World

After modeling, a report is displayed in the program; we will briefly draw conclusions from it: 47 applications were created for the whole week, 31 of them were serviced, and 16 were not serviced. The average number of busy channels was 1.78 and the utilization rate was 0.593. As a result, it turned out that the system, in principle, copes with its task, but the number of lost applications is too large relative to the total number of applications, so 16 ships were forced to use the bunkering services of other companies.

We will observe how the efficiency indicators will change with an increase in the number of bunkering vessels at the enterprise, in other words, we will analyze how the change in the number of channels (the number of bunkering workers) will affect, because the company cannot vary the intensity of the receipt of applications themselves. Let us summarize the data of performance indicators for the experiment in a single table (Table. 5); we will also supplement it with information for the three service channels that were originally.

Table 5. Output of the experiment results.

n	Failure probability	System workload	Average numbers of busy channels
3	0,340	0,593	1,78
4	0,191	0,538	2,15
5	0,085	0,479	2,395
6	0,043	0,418	2,506
7	0	0,379	2,654

Source: «Compiled by the authors».

Conclusion: with an increase in the number of bunkers, the system load decreases and, accordingly, the average number of occupied channels increases. However, since there is no need for such a large number of channels, because of the same 7 bunkers, on average, 4 will be idle. The price of a bunkering truck is approximately 90 million rubles, not counting maintenance costs, fuel, a place in the port, etc. Due to the large expenses for the purchase of new vessels, it is better to focus on the number of 4 bunkers, since the system load is quite low, the probability of denial of service is adequate, and the average number of busy channels is 2.15, which is acceptable. Buying another bunkering machine will reduce the system load to 0.538, although this is not a key value by which to judge, but still the improvement is noticeable. The main thing is that the probability of failure has significantly decreased to 0.191.

Simulation model of a transport industry enterprise

JSC "Russian Railways" is a dynamically developing nationwide transport company, which is among the top 10 largest companies in the field of transport and logistics from the RAEX-600 rating of 2021, and occupies the first place in this list. Its main mission is to carry out the development of transport infrastructure, meet the market demand for high-quality transportation along railway routes and related services (Silichev G.V. & Pyzhyanov N.I., 2015). Let us take a closer look at the branch of JSC "Russian Railways" repair locomotive depot, which is engaged in the repair of traction rolling stock (JSC "Russian Railways", 2018).

Let us imagine the work of the repair shop as a queuing system, find out why this workshop cannot cope with the flow of incoming orders, and how this problem can be solved.

Let us consider the work of the repair shop as a queuing system, find out why this workshop cannot cope with the flow of incoming orders, and how this problem can be solved.

Maintenance of rolling stock repairs is provided by 3 repair teams, each of which performs the repair work specified in the order. Work orders are received with an intensity of 4 orders per hour, while the work time of the team is 7 hours. The execution of works on one side takes 1 hour. The work is carried out according to the principle of "first come first served". The maximum length of the queue is 2 work orders, subsequent orders are sent to a nearby repair shop. The service time is distributed exponentially. Let us present the initial data in Table 6.

Table 6. Initial data.

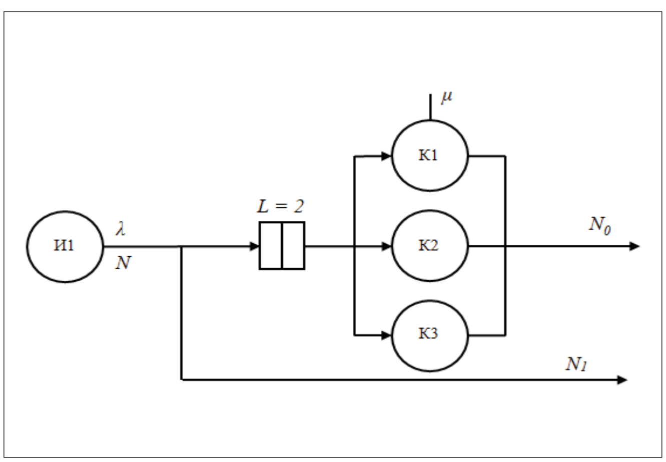
T_{lab}, hour	λ, units/hour	n, units	m, units	$\bar{t}_{serv}$, hour	DL
7	4	3	2	1	Exponential

Source: «Compiled by the authors».

Work orders are received into the system from the source of orders $И_1$ as the simplest flow with intensity λ. After orders get into the storage L, the capacity of which is limited to *m*, if the storage is full, orders leave the system unattended. In the storage, orders are waiting for the release of one of the three service channels K_1, K_2, K_3. After that, they fall into one of the channels in which the service takes place according to the exponential law of time distribution, with an average service time of $\bar{t}$serv. After the service is completed, orders leave the queuing system (Ilyushin, A.N., Shilkina, I.D., Afanasev, P.M., 2019). Also, to understand the results obtained, it is important to enter the following notation: N_1 the number of generated orders; – the number of orders that were denied service; N_0 the number of serviced orders.

The conceptual model for this queuing system is shown in Pic. 5.

Picture 5. The scheme of the queuing system.



Source: «Compiled by the authors».

Let us make a simulation model of the queuing system in GPSS World. This model also calculates the probability of denial of service as a percentage. The probability of failure is calculated as the ratio of the number of orders received on the label «OTKAZ» to the number of orders transferred to the label «SYSTEM».

The GPSS model of the described system is shown in Pic. 6.

Picture 6. Model program.

```
ONT       STORAGE 3
          GENERATE (Exponential(1,0,1/4))
SYSTEM    TEST L Q$Wait,2,OTKAZ
          QUEUE Wait
          ENTER ONT
          DEPART Wait
          ADVANCE (Exponential(1,0,1))
          LEAVE ONT
          TERMINATE
OTKAZ     TERMINATE
          GENERATE 7
          SAVEVALUE Pork,(100#N$OTKAZ/N$SYSTEM)
          TERMINATE 1
```

Source: «Compiled by the authors».

Interpretation of simulation results from the simulation report:

- The numbers of generated applications N = 29 units.
- The numbers of service failures N_1 = 11 units.
- Probability of denial of service P_{fail} = 37,931%
- The numbers of applications served N_0 = 14 units.
- The average number of occupied channels $\bar{k}$ = 2,639 units.
- Utilization rate K_u = 0,88
- The average queue length L = 0,841 units.
- Th average time spent in queue $\bar{t}_{оч}$ = 0,327 hour.

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Analyzing the results of the system, we can note the weak efficiency of servicing incoming orders: the probability of service failure reaches almost 40%, and the utilization factor of the device is 0.88. This index indicates that the system copes with the load, but if we take into account the probability of failure, we can assume that at some points in time the system is idle without orders, and at other times it is overloaded and orders are denied service (Dagaev, A., Pham, V.D., Kirichek, R., Afanaseva, O. & Yakovleva, E., 2022).

To optimize the operation of the system, it is necessary to work with the probability of denial-of-service indicator. Reducing the probability of failure can be achieved in the following ways: by increasing the number of service channels (n=3 to increase to n=4) or by reducing the average service time (decrease from 1 to 0.75). Let's simulate the operation of the system with the changed indicators and compare the simulation results in Table 7.

Table 7. Comparison of simulation results.

Indicator	GPSS World	GPSS World after optimization
Numbers of applications received, units	264	260
Numbers of rejected applications, units	104	23
Probability of denial of service, %	39.394	8,846
Device utilization rate	0.918	0,727
Average queue length, units	1.025	0,321
Average waiting time, hour	0.403	0,085

Source: «Compiled by the authors».

After modeling the work and analyzing the results obtained, it can be concluded that when the indicators changed, such characteristics as: the number of applications that were refused (decreased by 5 times); the probability of denial of service (decreased by 30%); the average queue length (decreased by 3 times) were optimized. At the same time, the load on the system remained optimal, since the utilization rate of the device changed insignificantly.

Discussion

The development and research of this issue has been done before. Each region had its own research centers and scientists dealing with this or that problem.

At the moment, there are a large number of scientific papers that reveal simulation modeling from a theoretical point of view, that is, they give their description, approaches and stages of model development, as well as reveal the software tools with which they can be created. The article focused on the practical application of this instrument, clearly demonstrated how it can be used in real life.

Gorelova N.Y. and Terekhov K.L. in their joint article described the logistics system of the bunkering company, in particular, they disclosed in detail the process of interaction with so-called customers who require refueling services. These two authors set the basis for "solving problems aimed at ensuring the effective functioning of the logistics channel for the provision of bunkering services" (Gorelova N.Y. & Terekhov K.L., 2004).

R.V. Susov in his article optimized the business process of "Attracting a client" by means of simulation modeling. He faced a similar problem in developing the model and, eventually, developed a model of the system. This was achieved thanks to the following methods: "redistribution of the workload coefficients of posts, automation of the performance of certain functions and changing the areas of functional responsibility" (Susov R.V., 2009).

Kholopov K.V., Sokolova O.V. identified the problems of the development of further bunker activities in Russia, including in foreign countries. They described the dynamics of changes in the bunker services market and predicted future indicators of marine fuel turnover. In this scientific article, an explanation was given of the functioning and operation of the fuel supply from the bunker to the ship on the move. Studying their work, it becomes clear that the sphere of business tied to the provision of bunkering services is constantly developing, and the authors themselves describe exactly how and give recommendations for increasing efficiency (Kholopov K.V. & Sokolova O.V., 2015). The result of the research of these works has found its response in our article, and the ideas laid down earlier have been developed and clearly applied in the companies described above. These results were obtained for the purpose of application in real practice.

Another issue discussed in the article related to the railway transport industry is relevant, scientific centers such as the All-Russian Research and Design Institute of Electric Locomotive Engineering are actively developing in order to solve and develop problems, improve technologies in the railway industry. The All-Russian Research Institute of Railway Transport occupies a unique place in the Russian electric locomotive industry, being the only one in its industry.

The results obtained in our study make a small contribution to the general treasury of knowledge. They expand the understanding of the possibility of using simulation modeling methods for a specific industry under consideration. Also, the review and consideration of certain departments helps to clearly and visually present the real work and functioning of the enterprise department, which will help in the future to do a more in-depth analysis, to consider the strengths and weaknesses of departments, which will lead to an understanding of what indicators and improvements can improve the efficiency of work.

Conclusion

In the course of the study, the effectiveness of the use of simulation modeling methods in various industries was shown. It does not matter whether it is an industrial enterprise, an enterprise related to the transport industry or an energy company, its work can be described using the program text and imitate its functioning as in real life. Building a simulation model helps to understand the strengths and weaknesses of the organization, and also allows you to make adjustments to the work and check the correctness of their implementation without compromising real production and wasting the most important resource – time.

The results obtained will help in the future to find and explore improvements that can be made to the workflow, consider all alternative options and check their effectiveness before implementation in practice.

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