Modeling Business Processes Technology in the Information Service of Interaction

Marina Medvedeva[a], Vladimir Timokhin[b], Helen Iskra[b], Vladimir Belousov[b] and Vladislav Indykov[a]

[a] *Ural Federal University, Mira str. 19, 620002, Russia*
[b] *Donetsk National Technical University, Artem 58, Donetsk, 283015, Ukraine*

Abstract
The aim of the article is to develop a model for managing business processes in the information service based on behavior of the company. The main business processes of the company were identified, and their main interrelationships were reflected at the conceptual level. A model in the Powersim Studio 7 simulation environment is presented, which allows regulating the interaction between companies in the information service, identifying bottlenecks in the company's business processes, and predicting the total income of an enterprise depending on various market conditions.

Keywords 1
Business processes, modeling, system-dynamic model, information service of interaction.

1. Introduction

In the modern world, in the context of growing informatization and general globalization, the economy has received new opportunities on the Internet. Thanks to the latest information technology, economic activity becomes more efficient and profitable. In the context of digitalization of business processes, the issue of interaction between companies using information services and, as a result, the emergence of cloud resources for collecting, processing, and storing data (Data Processing Centers - DPC) is becoming increasingly important.

Such centers are a promising area of business development and a convenient tool for companies to interact with users. Business process management of such data centers is based on business analysis and technical specifications, which are not related to each other. Therefore, an approach is needed that would be based on an assessment of the entire architecture of the company, and not on its individual levels. It is system-dynamic modeling [1],[2],[3],[4] that can predict the efficiency of interaction in the data center and manage business processes. Examples of the analysis of the effectiveness of the application of system-dynamic modeling of the company's business processes are presented in the works [5],[6],[7].

This article proposes to use the system-dynamic approach for the analysis of activities of an information service on the example of the Data Processing Center (DPC) of Mail Ru Group (Russia).

2. Methods and results

Interaction information services refer to the B2B e-business model focused on the business of corporations that act as both sellers and buyers. They cover a wide range of applications that help businesses build electronic relationships between distributors, resellers, suppliers, and partners. These

IVUS2021: Information Society and University Studies 2021, April 23, 2021, Kaunas, Lithuania.
EMAIL: marmed55@yandex.ru (A. 1); volodya.timokhin@gmail.com (A. 2); iskra_helen@mail.ru (A. 3); sorealvladimirbel@gmail.com (A. 4); vladind@list.ru (A. 5).
ORCID: 0000-0003-2729-7046 (A. 2).

services give businesses access to information about a product, customer, supplier, transportation, storage, supply chain, competitors, marketing, and sales. Using the toolkit of B2B applications it is possible to re-engineer the supply chain and partnerships. However, the presence of many partners / customers in the chain of business processes of such information services does not make it possible to clearly define or predict the effect of interaction in advance.

This work for the first time proposes to use the system dynamics method for analyzing and predicting the data in information interaction services that allows, during experiments, to identify hidden factors affecting business performance, and helps to improve the decision-making process.

The article examines the activities of an information service using the example of the Data Processing Center (DPC) of Mail Ru Group, which implements its services through e-business tools. The company has partnered with other e-commerce businesses that are building next-generation data center software. Interaction with other electrical parts engaged in other activities is seen as an important role in the transport sector.

Mail Ru Group's business process model is based on the e-business customer service model. The conceptual diagram of the future model is shown in Figure 1: Mail Ru Group service delivery diagram.

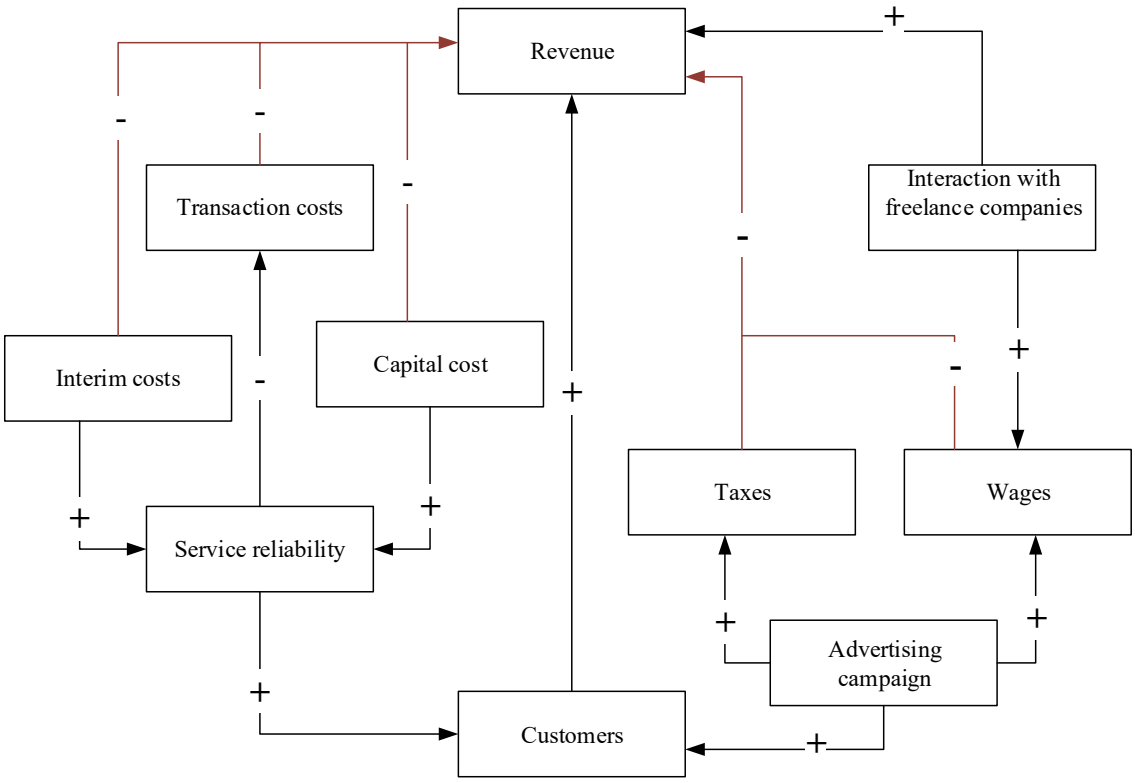

Figure 1: Mail Ru Group service delivery diagram

While building a model on this basis some of additional factors must be fulfilled. Due to the specifics of the market in question, there is a serious competition between a small number of competitors, which necessitates significant marketing costs, which can vary depending on the circumstances. Also, due to the fact that the company operates mainly in the B2B sector, the issue of partnership with other enterprises engaged in the production of software products in the field of e-commerce is extremely relevant for it. And, due to the high requirements for the operation and maintenance of equipment, Mail Ru Group is forced to allocate a large amount of funds for the reproduction of fixed and circulating assets. An important factor in the market for the provision of data center services is the degree of customer confidence, which is due to the degree of security of access to stored information, and uninterrupted access to it [8],[9],[10].

Having considered the specifics of the subject area and building a diagram of cause-and-effect relationships, you can immediately start developing a model of the company's business processes using

the Powersim 7.0 software product and system dynamics tools, taking into account the interaction of companies [11].

The task of this model will be to determine the volume of the company's total income, depending on various factors, such as interaction with freelancers, abandonment rates and changes in tax rates.

Let's look at the main blocks of the model.

2.1. Block 1: Data center business model

The general view of the block is shown in Figure 2: General view of the block "Data Center Business Model".

Consider the equations of the elements of this block of the model.

The total profit (PROFIT) is determined by the formula:

$$PRF(t) = PRF(t_0) + \int_{t0}^{t} INF(t)d\tau - \int_{t0}^{t} OUTF(t)d\tau \text{ , t} = \overline{t_0..t_k}, \quad (1)$$

The total volume (INFLOW) defined by the formula:

$$INF = PFC + ADDF + ROUF, \quad (2)$$

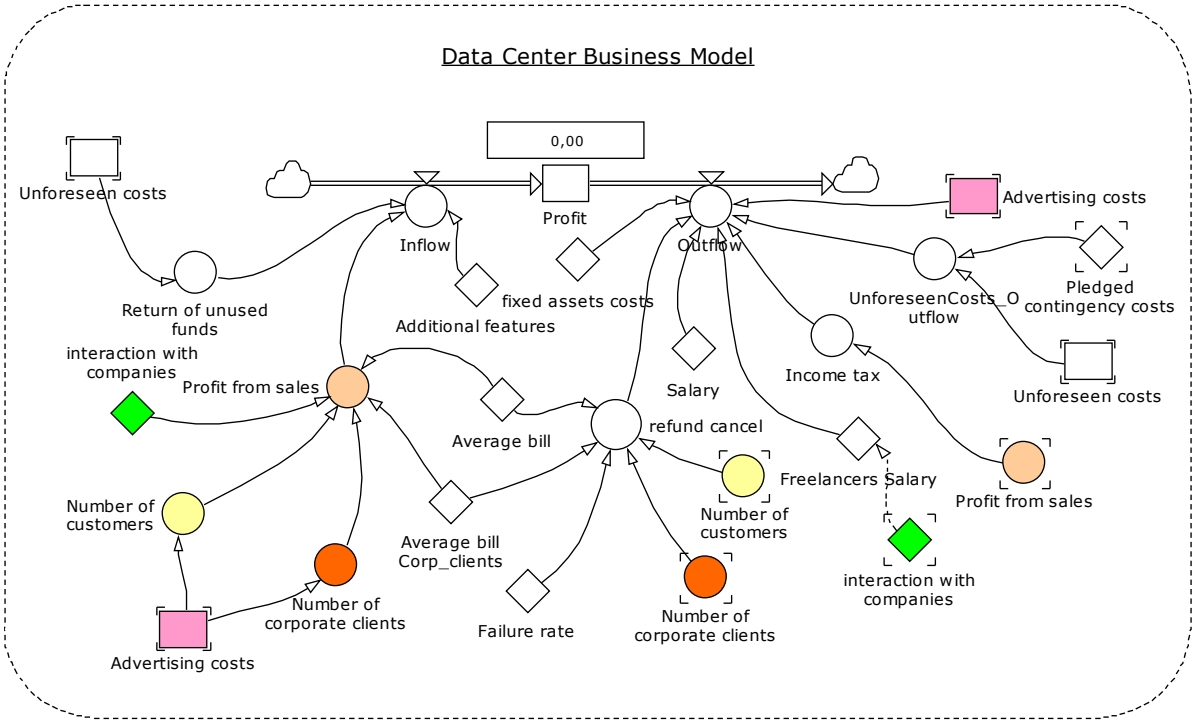

Figure 2: General view of the block "Data Center Business Model"

Return of unused funds is determined by the formula:

$$ROUF = \begin{cases} ROUF, ROUF > 0 \\ 0, ROUF \leq 0 \end{cases}, \quad (3)$$

Profit from sales is determined by the formula:

$$PFS = (NOC * AB + NOCC * ABCC) * INWC, \quad (4)$$

Number of customers is determined by the formula:

$$NOC = 5000 + ADC/30000, \quad (5)$$

Number of corporate clients is determined by the formula:

$$NOCC = 1000 + 0{,}1 * ADC/50000), \quad (6)$$

Refunds in connection with the cancellation of services are determined by the formula:

$$REFCAN = FR * (0{,}25 * NOC * AB + NOCC * ABCC), \quad (7)$$

Unforeseen Costs determined as:

$$UCO = \begin{cases} PCC, USC > 0 \\ PCC + |USC|, USC < 0' \end{cases} \quad (8)$$

2.2. Block 2: Unforeseen costs

The "Unforeseen costs" block is shown in Figure 3: Diagram of the block "Unforeseen costs".

Consider the equations of the elements of this block of the model.

Pledged contingency costs are determined by the formula:

$$USC(t) = USC(t_0) + \int_{t0}^{t} UCIN(t)d\tau - \int_{t0}^{t} UCOUT(t)d\tau \ , \mathrm{t} = \overline{t_0..t_k}, \quad (9)$$

The receipt of costs for solving non-staff problems with the data center (UC Inflow) is determined by the formula:

$$UCIN = PCC, \quad (10)$$

Outflow of funds (UC Outflow) is determined by the formula:

$$UCOUT = INTC + GENC, \quad (11)$$

The costs incurred during the overhaul of the data center (General Costs) is determined by the formula:

$$GENC = \begin{cases} 0, SF > 15\% \\ BEC, SF \leq 15\%' \end{cases} \quad (12)$$

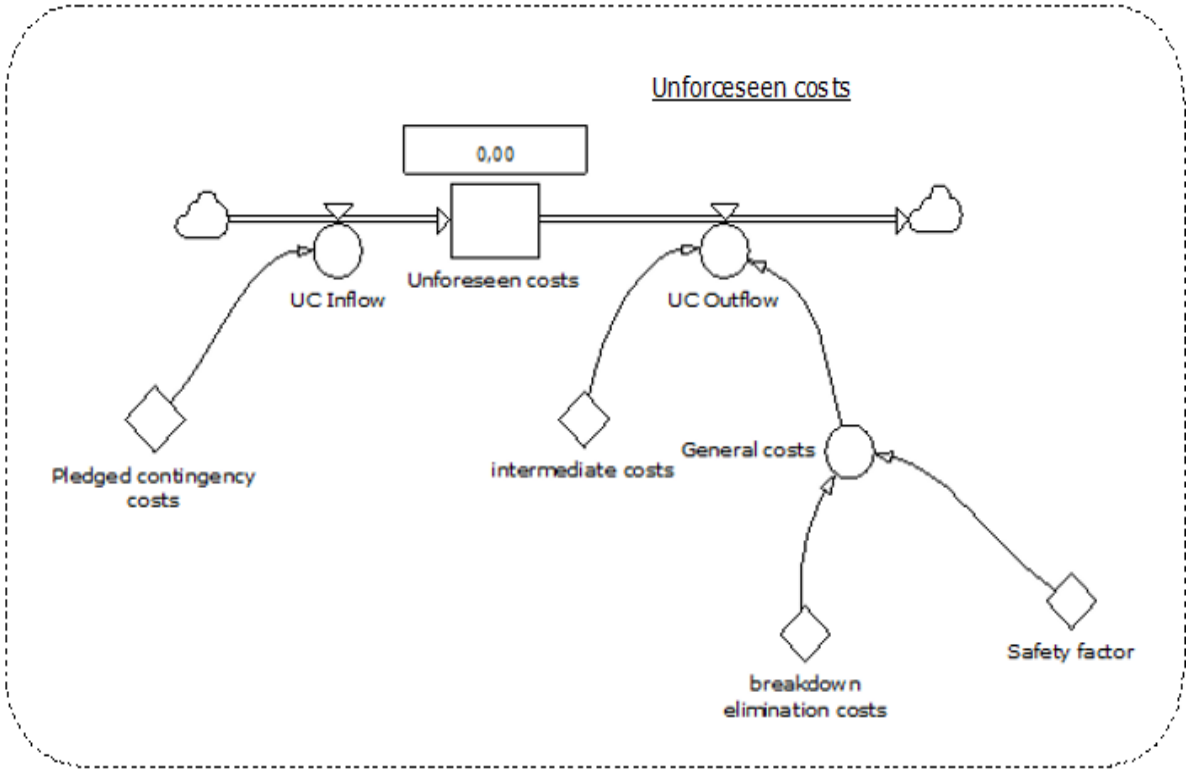

Figure 3: Diagram of the block "Unforeseen costs"

2.3. Block 3: Advertising

The " Advertising" block is shown in Figure 4: Diagram of the "Advertising" block.

Consider the equations of the elements of this block of the model.

The total costs incurred for an advertising campaign (Advertising costs) are determined by the formula:

$$ADC(t) = ADC(t_0) + \int_{t0}^{t} ADVIN(t)d\tau - \int_{t0}^{t} ADVOUT(t)d\tau \ , \mathrm{t} = \overline{t_0..t_k}, \quad (13)$$

The outflow of funds spent on an advertising campaign (Adv_outflow) is calculated using the formula:

$$ADVOUT = (1 - ADT) * (ASC + MMAC + IAC), \quad (14)$$

Thus, having identified all the elements of the model and developing its mathematical model, one can proceed to the system-dynamic modeling of the process of functioning of the data center Mail Ru Group.

3. Simulation

The simulation period is 12 months, since it is not feasible to simulate for more than one year in today's constantly changing conditions in a dynamic e-commerce market. The modeling step is 1 month.

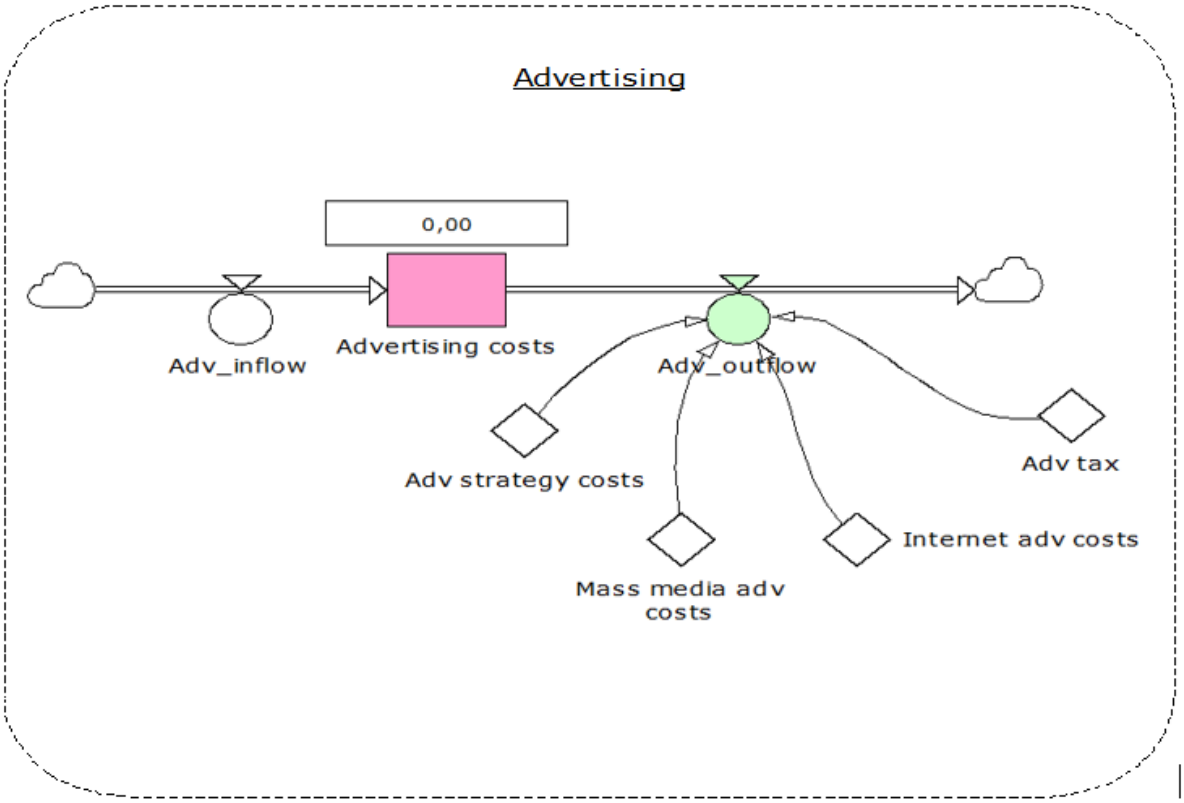

Figure 4: Diagram of the "Advertising" block

The modeling considers interactions with other companies and freelancers.

Two cases are considered:

1) when working with freelancers, sales profit increases, but the company pays salaries;

2) the company does not interact with freelancers and do not receive addition income from sales.

The interaction switch is shows in Figure 5: Switch "Interaction with companies", and the "Return percentage" slider with a value of 0.01, or 1% is shows in Figure 6: "Percentage of Return" regulator.

Figure 6 shows. In most cases, a customer placing an order for the use of a data center is firmly convinced of his intentions, and he can only cancel the order under unforeseen circumstances. In addition, this indicator also takes into account the return of the order associated with the inadequate quality of the data center.

The forecasting using this model is carried out based on the analysis of the dynamics of changes in key indicators.

We can consider several states of business, setting different conditions of interaction, presented in Table 1, and the results of the experiments 1-4 in: Table 2, Table 3, Table 4, Table 5.

Modelling has shown that the system is not homogeneous, and it is difficult to find a single solution for problems arising under different conditions.

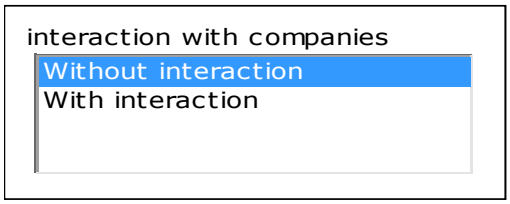

Figure 5: Switch "Interaction with companies"

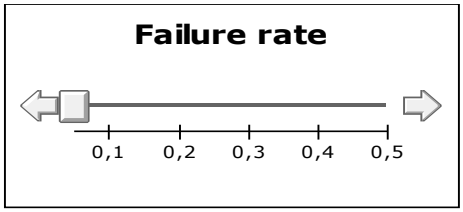

Figure 6: "Percentage of Return" regulator

Table 1

Data for experiments

	Experiment1	Experiment 2	Experiment 3	Experiment 4
Interaction with freelancers	Yes	No	Yes	No
Cancellations, %	5	15	15	50
DPC overhaul	Not Required	Required	Required	Required
Advertising tax, %	5	5	5	20

Table 2

Experiments results: Experiment 1

Time	Inflow	Outflow	Profit
01 Jan 2021	0,00	0,00	0,00
01 Feb 2021	78 250 000,00	18 125 000,00	60 125 000,00
01 Mar 2021	156 968 397,38	37 872 017,33	119 096 380,05
01 Apr 2021	236 155 192,14	59 241 052,00	176 914 140,14
01 May 2021	315 810 384,29	82 232 104,00	233 578 280,29
01 Jun 2021	395 933 973,81	106 845 173,33	289 088 800,48
01 Jul 2021	476 525 960,71	133 080 260,00	343 445 700,71
01 Aug 2021	557 586 345,00	160 937 364,00	396 648 981,00
01 Sep 2021	639 115 126,67	190 416 485,33	448 698 641,33
01 Oct 2021	721 112 305,71	221 517 624,00	499 594 681,71
01 Nov 2021	803 577 882,14	254 240 780,00	549 337 102,14
01 Dec 2021	886 511 855,95	288 585 953,33	597 925 902,62
01 Jan 2022	969 914 227,14	324 553 144,00	645 361 083,14

Table 3

Experiments results: Experiment 2

Time	Inflow	Outflow	Profit
01 Jan 2021	0,00	0,00	0,00
01 Feb 2021	60 250 000,00	18 642 380,72	41 607 619,28
01 Mar 2021	120 859 733,33	38 907 848,44	81 951 884, 90
01 Apr 2021	181 829 200,00	60 796 403,16	121 032 796,84
01 May 2021	243 158 400,00	84 308 044,89	158 850 355,11
01 Jun 2021	304 847 333,33	109 442 773,62	195 404 559,71
01 Jul 2021	366 896 000,00	136 200 589,36	230 695 410,64
01 Aug 2021	429 304 400,00	164 581 492,11	264 722 907,89
01 Sep 2021	492 072 533,33	194 585 481,86	297 484 051,47
01 Oct 2021	555 200 400,00	226 212 558,61	328 987 841,39
01 Nov 2021	618 688 000,00	259 462 722,37	359 255 277,63
01 Dec 2021	682 535 333,33	294 335 973,14	388 199 360,19
01 Jan 2022	746 742 400,00	330 832 310,91	415 910 089,09

The results show that when the company interacts with freelancers, and the share of DPC overhaul costs, taxes, and order returns is reduced, the company's financial performance improves. Experiment 1 is an optimistic scenario for the company's development. But its conditions are too ideal: active interaction with freelancers, no capital repair costs, a low tax rate on advertising (5%), a low percentage of order returns (5%). This situation is practically impossible. Therefore, the best from the point of view of company's development is experiment 3, which provides profit growth. The set values of experiment 3 are: interaction with freelancers, the need for a DPC overhaul, advertising tax - 5%, order return rate - 15%. In the whole, the model showed the significance of each indicator and the nature of its impact on the company's financial performance.

Table 4
Experiments results: Experiment 3

Time	Inflow	Outflow	Profit
01 Jan 2021	0,00	0,00	0,00
01 Feb 2021	78 250 000,00	22 091 931,59	56 158 068,41
01 Mar 2021	156 967 653,33	45 827 709,40	111 139 943,94
01 Apr 2021	236 152 960,00	71 207 333,41	164 945 626,59
01 May 2021	315 805 920,00	98 230 803,62	217 575 116,38
01 Jun 2021	395 926 533,33	126 898 120,05	269 028 413,29
01 Jul 2021	476 514 800,00	157 209 282,68	319 305 517,32
01 Aug 2021	557 570 720,00	189 164 291,52	368 406 428,48
01 Sep 2021	639 094 293,33	222 763 146,57	416 331 146,77
01 Oct 2021	721 085 520,00	258 005 847,82	463 079 672,18
01 Nov 2021	803 544 400,00	294 892 395,28	508 652 004,72
01 Dec 2021	886 470 933,33	333 424 788,95	553 048 144,38
01 Jan 2022	969 865 120,00	373 597 028,83	596 268 091,17

Table 5
Experiments results: Experiment 4

Time	Inflow	Outflow	Profit
01 Jan 2021	0,00	0,00	0,00
01 Feb 2021	60 250 000,00	33 037 500,00	27 212 500,00
01 Mar 2021	120 802 933,33	67 492 559,29	53 310 374,05
01 Apr 2021	181 658 800,00	103 365 177,86	78 293 622,14
01 May 2021	242 817 600,00	140 655 355,71	102 162 244,29
01 Jun 2021	304 279 333,33	179 363 092,86	124 916 240,48
01 Jul 2021	366 044 000,00	219 488 389,29	146 555 610,71
01 Aug 2021	428 111 600,00	261 031 245,00	167 080 355,00
01 Sep 2021	490 482 133,33	303 991 660,00	186 490 473,33
01 Oct 2021	553 155 600,00	348 369 634,29	204 785 965,71
01 Nov 2021	616 132 000,00	394 165 167,86	221 966 832,14
01 Dec 2021	769 411 333,33	441 378 260,71	238 033 072,62
01 Jan 2022	742 993 600,00	490 008 912,86	252 984 687,14

The proposed model makes it possible to search disadvantages in the company's business processes, as well as to forecast the total income of an enterprise depending on various market conditions.

4. Conclusions

The article comprehensively examines the features of business processes of the information service of interaction on the example of the company Mail Ru Group. In current conditions, the use of such

tools can significantly increase the profit of an enterprise, and the specificity of e-business is such that interaction with other enterprises in the same industry can significantly increase the efficiency of the company.

To model of the company's business processes, a system-dynamic approach was applied, and a diagram of the cause-effect relationships of Mail Ru Group was built, and the functional relationships are reflected at the conceptual level. A model of the company's business processes was developed, considering the interaction of companies. With its help, the analysis and interpretation of the simulation results in four different states of the system were carried out. Thus, the proposed system-dynamic model of enterprise business processes is suitable both for finding disadvantages in the company's business processes and for predicting total income depending on various market conditions.

5. References

[1] Jj. Jeng, On developing system dynamics model for business process simulation, Proceedings, Winter Simulation Conference, December 2005, doi: 10.1145/1162708.1163068, source: dblp.

[2] Katalevskiy D.Yu., Fundamentals of simulation and system analysis in management: textbook, 2nd edition, Publishing house "Delo", Moscow, 2015. (In Russian).

[3] V.V. Repin, V.G. Eliferov, Process approach to management. Business Process Modeling, "Mann, Ivanov and Ferber", Moscow, 2013. (In Russian).

[4] V.N. Sidorenko, System-dynamic modeling in the POWERSIM environment, "MAKS Press", Moscow, 2001.(In Russian).

[5] Berg, D.B., Kolomytseva, A.O., Apanasenko, A.V., and Isaichik, K.F., Modeling of the Municipality Entrepreneurial Community Functioning Using the Methods of System Dynamics, IFAC-PapersOnLine, 51 (32), 61-66. doi: 10.1016 / j.ifacol.2018.11.354.

[6] Medvedeva, M.A., Apanasenko, A.V., and Iskra, O.A., An integrated model of efficiency analysis of companies' network interaction, Z. Kalogiratou, T. Monovasilis, and T.E. Simos (Ред.), International Conference of Computational Methods in Sciences and Engineering 2018, ICCMSE 2018 (Том 2040), 050019, American Institute of Physics Inc. doi:10.1063/1.5079117.

[7] Medvedeva, M., Kolomytseva, A., Sychov, I., Ford, V., and Gorbunov, M. (2020), Modeling the target architecture of an entrepreneurial network as a complex system of interaction, CEUR Workshop Proceedings, 2562, 147-152.

[8] Mail.Ru Group announces its financial results for 2018, URL: https://mail.ru/company/press_releases/2019/2019-02-15R.

[9] Mail Ru Group has separated Mail DPC into a separate company, 2019, URL: https://vc.ru/flood/14066-Mail-market-part.

[10] VEB.RF and Mail.ru Group set up a joint venture, 2019. URL: https://www.vedomosti.ru/technology/news/2019/02/14/794100-i.

[11] Forrester J.W., Counterintuitive behavior of social systems, Technology Review, 1971, Vol.73, Issue 3, 52-62.