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APPLYING OPTIMIZATION MODELS FOR THE FORMATION OF THE MANAGEMENT SYSTEM OF BUSINESS PROCESSES

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Abstract: *The purpose of this paper is to build a model for the optimization of the management system of business processes of enterprises, taking into account the time factor. Additional limitations in the model allow the influence of the quarantine restrictions on enterprises' economic activity in the context of the COVID-19 pandemic to be identified.*

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The methods used in this paper are: analysis; synthesis; systematization; theoretical generalization; the method of Charnes and Cooper; the synergistic approach; and modelling. The negative impact of the COVID-19 pandemic on the economic activity of enterprises in Ukraine, in particular in the engineering services sector, is discussed. The economic-mathematical model of the rational formation of the management system of the business processes of enterprises in the engineering services sector, taking into account the time factor, is developed. This allows business processes to be optimized and economic activity to be improved in terms of the global pandemic. The results of using the optimization model for the management system of the business processes of project design, electrical maintenance, manufacture of electrical equipment, starting-up and adjustment works, and consulting are presented. The economic-mathematical model is an effective tool for the improvement of quality management systems and the activity of enterprises as a whole. The scientific novelty of this research may be considered from the prospects of two aspects of the optimization of business process systems: 1) the value of the financial resources in time; and 2) the impact of quarantine measures related to restrictions on carrying out economic activities in time. The application of the economic-mathematical model of the optimal organization of business process systems to enterprises in the engineering services sector will allow top-level managers to receive important information for managerial decision-making, which is aimed at improving the quality of the management system, achieving the key business objectives, and maximizing profit.

Keywords: *optimization, system of business processes management, economic-mathematical model, engineering services, ISO 9001:2015.*

JEL Codes: *C61, M11, M21*

1. Introduction

The contemporary circumstances of the competitive environment in internal and international markets require any enterprise to orient towards business processes, which directly affect its activity and need to be adjusted constantly under the influence of an ever-changing external environment. Meanwhile, an efficient business process management system is a crucial component of an enterprise's quality management system in the context of the requirements of international standards – particularly ISO 9001:2015 (Trachenko & Weis, 2019). In the context of the global COVID-19 pandemic, the introduction of quarantine restrictions caused a significant negative impact on the economic activity of businesses and companies in Ukraine. The majority of enterprises which carry out their activities on contracts concluded in advance have been forced to abandon these contracts and their counterparties, and have suffered losses as a result. This also concerns enterprises in the engineering services sector. Suspension and postponement of the implementation of business processes leads to losses that, above all, are related to the loss of monetary value based on the economic law of the decreasing value of money. However, even in crisis situations any enterprise tries to maximize its financial performance. This is why, for enterprises in the engineering sector, the necessity of the application of the modern toolkit of planning, modelling, and optimizing business processes is obvious. The construction and application of economic-mathematical models which take into account the time factor will allow enterprises not only to improve the efficiency of the management of business processes, but also to minimize the consequences of negative economic situations at these enterprises. In addition, it is possible to consider the optimization of business processes in accordance with the requirements of environmentally safe activities to ensure sustainable development (Kovshun et al., 2021; Latysheva, 2020; Filipishyna, 2020).

2. Literature review

A significant number of scientists have studied the problems of optimizing the business processes system by means of different methods (Glover et al., 2003; Barnett, 2003; April et al., 2004). Korzachenko (2013) argued that it is advisable to optimize business processes. This optimization contributes to the improvement of the efficiency of the enterprise's activity, increasing profits, productivity, and growth, reducing costs, and improving the quality of goods and services. Meško and Meško (1994) investigated the problem of choosing the best combination of investment projects which maximize return on investment. The authors associated investment in certain business processes with an increase in incomes and costs, and applied the proposed fractional-linear optimization model to the example of metallurgy. Munsamy and Telukdarie (2021) modelled the business processes system by estimating energy demand within it, with the aim of identifying the possibility to predict the influence of changes in the energy sector on business. Waszkowski and Nowicki (2020) proposed a model of business processes in the area of contract management for enterprises in the service sector. Models designed in the ARIS software environment with the usage of dynamic analysis allowed for the identification and optimization of a number of processes for the studied enterprise. In the research of Trachenko et al. (2021) and Yankovyi and Trachenko (2019), the optimization of the business processes system in the engineering services sector was conducted, which was focused on the maximization of enterprises' profit. The main limitations were the costs of the implementation of the business process and the number of personnel. Vergidisa et al. (2007) focused their attention on studying multi-objective optimization in building business processes, which allowed alternative options to be obtained for the optimized systems. Yankovyi et al. (2019) considered the production business process and carried out the optimization of the capital-labor ratio within the framework of two-factor production functions. Chukurna et al. (2019) studied the influence of the time factor on the price of engineering enterprises' products. The problems of the optimization of business processes at enterprises in terms of crises were studied in the publication of Gurova and Sadekova (2016), where the stages of this optimization in order to maintain and increase an enterprise's position in the market were highlighted.

Despite the fact that there are a significant number of scientific studies on issues concerning the optimization of business processes at enterprises of different industries and sectors, the application of optimization modeling methods in order to take into account the time factor has not been given sufficient attention. Moreover, while building optimization models, the current challenges related to the COVID-19 pandemic should be taken into account.

The purpose of this article is to build an optimization model for the management system of business processes at an enterprise, taking into account the time factor. The introduction of additional limitations into the model will allow for changes in the system which relate to the influence of quarantine restrictions in the processes of enterprises' economic activity in the context of the COVID-19 pandemic to be identified.

3. Methodology

The methods of analysis and synthesis, systematization, and theoretical generalization were used for studying approaches to the optimization of enterprises' business processes. The method of Charnes and Cooper was used for aligning towards a linear programming problem by means of introducing new variables. The synergistic approach was used for the formation of the synergistic economic effect of the management system of business processes of an enterprise in the engineering services sector. Modelling was employed for the creation of an economic-mathematical model of the optimal organization of business processes, taking into account the time factor and reducing cost and profit to the present value by means of the depreciation coefficient. The approbation of the developed model at an enterprise in the engineering services sector was also conducted.

In the authors' opinion, it is advisable to build a mathematical model for the rational formation of the management system of business processes at an enterprise in the engineering services sector, taking into account the time factor. This approach may be substantiated in the following way: an enterprise's success, particularly in the engineering services sector, depends significantly on the ability of the company's top-level management to react to changes in the internal and external business environment. In order to reduce the risks caused by possible environmental changes, an enterprise should form and adapt a management system of business processes for them.

To achieve this goal, it is advisable to develop a mathematical model for the rational formation of the management system of business processes at an enterprise in the engineering services sector taking into account the time factor. The application of a modern methodological toolkit is due to the current stage of existence of the information economy (Kholiavko et al., 2020; Vdovenko et al., 2019). Let us formulate the following basic assumptions to compose an economic-mathematical problem statement (Bolshakov, 2002; Berezhnaya & Berezhnoy, 2002; Fomin, 2001):

- we will consider that, while formulating this system, it is possible to identify n main business processes (i – type of activity) which correspond to respective activities;
- the realization of each type of activity is carried out during the discrete period $[1,T]$, where t represents the number of intervals;

- the size of the economic effect from the implementation of business process i in the management system is directly proportional to the investment in this direction during the whole period $[1,T]$, that is:

$$E_i = a_i \sum_{t=1}^{T} x_{it}, i = \overline{1,n}, \quad (1),$$

where x_{it} represents funding for the direction i during the interval of time t in the analyzed period, and a_i represents proportionality ratio, that is, volume of the economic effect from the investment of the unit of financial resources in the direction (business process);
- for each interval of time t, for investment in the formation of the enterprise quality management system, the financial resources of the total volume F_t are allocated.

Therefore, the problem statement for the formation of the management system of business processes at enterprises in the engineering services sector may have the following meaning: it is necessary to distribute the available financial resources between identified directions in each interval of time in order to maximize the total economic effect from their implementation.

Then, the target function of the relative economic-mathematical statement of this problem will be presented as follows:

$$E_0 = \sum_{i=1}^{n} E_i = \sum_{i=1}^{n} (a_i \sum_{t=1}^{T} x_{it}) \rightarrow max. \quad (2)$$

The necessary limitations, which define the requirements for the searched variables x_{it}, may be written in the following way:

$$\sum_{i=1}^{n} x_{it} \leq F_t, \quad t = \overline{1,T}, \quad (3)$$

$$E_i = a_i \sum_{t=1}^{T} x_{it} \geq \underline{E_i}, \quad i = \overline{1,n}, \quad (4)$$

$$e_i = \frac{a_i \sum_{t=1}^{T} x_{it}}{\sum_{t=1}^{T} x_{it}} \geq \underline{e_i}, \quad i = \overline{1,n}, \quad (5)$$

$$R = \frac{\sum_{i=1}^{n} (a_i \sum_{t=1}^{T} x_{it})}{\sum_{i=1}^{n} \sum_{t=1}^{T} x_{it}} \geq \underline{R}. \quad (6)$$

$$x_{it} \geq 0, \quad i = \overline{1,n}, \quad t = \overline{1,T}, \quad (7),$$

where e_i and R represent the indicators of the efficiency of the implementation of the separate direction and the entire management system of business processes at the enterprise, respectively; and represent their minimal allowable values; and represents the lower limit of the economic effect value from the implementation of direction i in the formation of the management system of business processes at an enterprise in the engineering services sector.

Limitation (3) of the optimization problem (2)–(7) describes the financial capabilities of the formation of the management system of business processes at an enterprise in the engineering services sector during all intervals of time in the researched period $[1, T]$. Inequations (4)–(6) set the requirements for the main economic parameters of the management system of business processes which are being formed (the relevant indicators of economic effects and efficiency). Inequation (7) is a natural condition of the non-negativity of variables x_{it}.

Ultimately, the linear programming model (2)–(7) allows for the identification of the structure of the management system of business processes at the engineering enterprise that maximizes the total economic effect (2) from its implementation. Traditionally, effect E is presented as a simple sum of effects from separate directions E_i. Such an approach is possible in the case of a relatively simple economic system (in this case, for the management system of business processes at an engineering enterprise). However, while becoming more complex, this system may demonstrate synergistic characteristics (Myhaylovska, 2011). It is important to form a register of synergies in order to achieve certain strategic results (Hutsaliuk et al., 2020).

For this management system of business processes at an enterprise in the engineering services sector, this means that a certain synergistic effect, E_c, may be formed in this system from the interrelation of separate directions of this system's creation. In the simplest case, this may be given by means of a monotonically increasing function of separate (disaggregate) economic effects, E_i:

$$E_c = \Psi(E_1, E_2, \dots, E_n). \tag{8}$$

The identification of the specific type of this function requires separate and specific studies [25].

In the problem (2)–(7), the target function is a total economic effect. One limitation is the requirement of the efficiency of the management system of business processes at the engineering enterprise which is being formed (6). However, in some sense the inverse problem is of interest, in which it is necessary to maximize its efficiency, in some requirements, to the volume of obtained economic effect in the process of the formation of the management system of business processes. In this case, the target function of the relevant optimization model should be presented as follows:

$$R = \frac{\sum_{i=1}^{n}(a_i \sum_{t=1}^{T} x_{it})}{\sum_{i=1}^{n}\sum_{t=1}^{T} x_{it}} \to max. \tag{9}$$

Moreover, it is necessary to replace limitation (6) with the inequation:

$$\sum_{i=1}^{n} E_i = \sum_{i=1}^{n}(a_i \sum_{t=1}^{T} x_{it}) \geq E_0. \tag{10}$$

The obtained model with the target function (9) and limitations (3)–(5), (7), and (10) is a problem not of linear but of fractional-linear programming. However, it is well-known that problems of this type may be kept to the problem of linear programming by using the method of Charnes and Cooper by means of the introduction of new variables, which for the target function (9) will be presented as:

$$y_0 = \frac{1}{\sum_{i=1}^{n}\sum_{t=1}^{T} x_{it}}, \quad y_{it} = y_0 x_{it}. \tag{11}$$

Next, let us take into account the time factor in the built models, namely the influence of inflation processes, which lead to a loss of the purchasing power of financial resources with time. In order to do this, we will calculate the depreciation of money in the interval of time t according to the following formula:

$$k_{it} = \frac{1}{1+r_{it}}, \quad i = \overline{1,n}, \quad t = \overline{1,T}, \tag{12}$$

where r_{it} represents inflation rate in the interval of time t for the direction i of the management system of business processes at an enterprise in the engineering services sector (in general, all r_{it} may have different values).

Using, we will write coefficient K_{it} of investment depreciation x_{it} in the time period [1, T]. In doing so, we will assume that the financing (investment) is provided in the beginning of each interval of time in this period. Then, the influence of the inflation processes should be taken into account in the interval of time (t–1) inclusively, and, relatively, the above-mentioned coefficient is calculated with the formula:

$$K_{it} = \frac{1}{\prod_{l=1}^{t-1} k_{it}} = \frac{1}{\prod_{l=1}^{t-1}(1+r_{it})}, \quad i = \overline{1,n}, \quad t = \overline{1,T}. \tag{13}$$

If the inflation rate level for the direction i remains constant during the whole period [1, T] and has value r_i, then (13) may be written in a simpler way:

$$K_{it} = \frac{1}{(1+r_{it})^{t-1}}, \quad i = \overline{1,n}, \quad t = \overline{1,T}. \tag{14}$$

Hence, if we consider the influence of inflation, the real value of investment x_{it} will be defined with value $K_{it}x_{it}$, which is necessary to use while calculating economic effects E_i.

Then, the elements of the formulated economic-mathematical models (1)–(11), taking into account the factor of the depreciation of financial resources over time, acquire the following view:

$$E_i = a_i \sum_{t=1}^{T} K_{it}x_{it}, \quad i = \overline{1,n}, \tag{15}$$

$$E_0 = \sum_{i=1}^{n} E_i = \sum_{i=1}^{n}(a_i \sum_{t=1}^{T} K_{it}x_{it}) \rightarrow max. \tag{16}$$

$$E_i = a_i \sum_{t=1}^{T} K_{it}x_{it} \geq E_i, \quad i = \overline{1,n}, \tag{17}$$

$$e_i = \frac{a_i \sum_{t=1}^{T} K_{it}x_{it}}{\sum_{t=1}^{T} x_{it}} \geq \underline{e_i}, \quad i = \overline{1,n}, \tag{18}$$

$$R = \frac{\sum_{i=1}^{n}(a_i \sum_{t=1}^{T} x_{it})}{\sum_{i=1}^{n}\sum_{t=1}^{T} x_{it}} \geq \underline{R}. \tag{19}$$

$$R = \frac{\sum_{i=1}^{n}(a_i \sum_{t=1}^{T} K_{it}x_{it})}{\sum_{i=1}^{n}\sum_{t=1}^{T} x_{it}} \rightarrow max. \tag{20}$$

$$E_0 = \sum_{i=1}^{n} E_i = \sum_{i=1}^{n}(a_i \sum_{t=1}^{T} K_{it}\, x_{it}) \geq E_0. \tag{21}$$

The optimization models (1)–(11) of the formation of the management system of business processes at enterprises in the engineering services sector, which are built based on ratios (15)–(21), are also problems of linear and fractional-linear programming – the methods of solution for which are well known.

4. Results

Let us apply the presented models to the example of an enterprise which operates in the engineering services sector.

In the models, five processes are considered: x_1 – project design of electricity supply objects; x_2 – electrical maintenance; x_3 – manufacture of electrical equipment; x_4 – starting-up and adjustment works; and x_5 – consulting.

The volume of profit from the implementation of these business processes, the costs of each business process, and the total volume of financial resources which the enterprise may direct to project implementation during the year are presented in Table 1.

The total volume of financial resources of the enterprise is distributed evenly during the project period.

The enterprise's projects on the implementation of business processes are carried out over three years on contracts concluded in advance. In this regard, the purpose of building the proposed models is the identification of the optimal (most profitable for the enterprise) combination of business processes which will be implemented during the given period, and the volume of financial resources, which will be directed in a separate business process.

Table 1. *Annual input data for building an optimization model*

Indicators	x_1	x_2	x_3	x_4	x_5	*Total*
Volume of the economic effect (profit) from the implementation of business process, a_i, EUR	163,900	5,235,900	393,500	370,400	146,800	6,310,500
Costs of the implementation of business processes, EUR	127,200	3 820,500	309,900	289,800	110,900	4,658,300
Total volume of financial resources, F_i, EUR.	1,652,200					

Source: *developed by the authors based on the enterprise's financial report (Chesm LLC, 2021)*

By combining the implemented business processes in a certain way over time, the enterprise will be able to achieve maximum profit at the given target level of efficiency of the separate business processes, as well as across the project as a whole. This will enable the diversification of enterprise activity to reduce risks (Kalinin et al., 2019), and will be related to the production and technical development strategies of the company (Danyliuk et al., 2020).

Since this research is aimed at taking into account the time factor for the optimization of the business processes management system, it is necessary during calculations to take into consideration money, which is reduced to its present value by means of the investment depreciation coefficient. In this case, for the calculation of this coefficient it is possible, in addition to the inflation rate, to consider the average return on deposits in Ukraine (8.52%) (Minfin, 2019).

Table 2. *Reduced financial resources while r_{it} = 0.0852 (2019–2024)*

	t_0 (2019)	t_1 (2020)	t_2 (2021)	t_3 (2022)	t_4 (2023)	t_5 (2024)
Depreciation coefficient of money (k_{it})	1.0000	0.9215	0.8491	0.7825	0.7210	0.6644
Total volume of reduced financial resources in a year, F't, EUR	1,652,200	1,522,400	1,402,900	1,292,800	1,191,300	1,097,700

Source: *calculated by authors*

As can be seen from Table 2, the volume of financial resources depreciated to the present moment in time t_0 reduces gradually under the influence of inflation processes. Moreover, it is necessary to take into account that the volume of predicted profits from the implementation of business processes will also reduce gradually in line with its depreciation to the present value (Table 3).

The next step is to perform calculations in accordance with the built models using the MS Excel Solver software package. The first model (2), with limitations (3)–(7), does not provide for the consideration of the time factor during calculations. Instead, it maximizes profits at the given level of finance resources and is based on limitations regarding the minimal level of efficiency for the separate business processes and the implemented project as a whole.

Table 3. *Profit volume of business processes reduced to the present value (2019), EUR*

	t_0 **(2019)**	t_1 **(2020)**	t_2 **(2021)**	t_3 **(2022)**	t_4 **(2023)**	t_5 **(2024)**
x_1	163,900	151,000	139,200	128,300	118,200	108,900
x_2	5,235,900	4,824,800	4,446,000	4,096,900	3,775,300	3,478,900
x_3	393,500	362,600	334,100	307,900	283,700	261,400
x_4	370,400	341,300	314,500	289,800	267,100	246,100
x_5	146,800	135,300	124,700	114,900	105,900	97,600

Source: *calculated by authors*

The results of the optimization of the business processes system of the enterprise due to the target function (2) and limitations (3–7) are presented in Table 4.

Table 4. *The results of optimization of the business processes system of the enterprise in the engineering services sector ignoring the time factor (the period of project implementation is three years), 2019–2021*

<table>
<tr><th>Years</th><th>Business processes</th><th>Costs of business process implementation, EUR</th><th>Profit from business process implementation, EUR</th><th>Total costs of project implementation, EUR</th><th>Total profit from project implementation, EUR</th></tr>
<tr><td rowspan="5">2019</td><td>x_{10}</td><td>-</td><td>-</td><td rowspan="10">4,952,000</td><td rowspan="10">6,686,900</td></tr>
<tr><td>x_{20}</td><td>3,820,500</td><td>5,235,900</td></tr>
<tr><td>x_{30}</td><td>309,900</td><td>393,500</td></tr>
<tr><td>x_{40}</td><td>-</td><td>-</td></tr>
<tr><td>x_{50}</td><td>110,900</td><td>146,800</td></tr>
<tr><td rowspan="5">2020</td><td>x_{11}</td><td>-</td><td>-</td></tr>
<tr><td>x_{21}</td><td>-</td><td>-</td></tr>
<tr><td>x_{31}</td><td>-</td><td>-</td></tr>
<tr><td>x_{41}</td><td>289,800</td><td>370,400</td></tr>
<tr><td>x_{51}</td><td>110,900</td><td>146,800</td></tr>
</table>

Years	Business processes	Costs of business process implementation, EUR	Profit from business process implementation, EUR	Total costs of project implementation, EUR	Total profit from project implementation, EUR
2021	x_{12}	-	-		
	x_{22}	-	-		
	x_{32}	309,900	393,500		
	x_{42}	-	-		
	x_{52}	-	-		

Source: *calculated by authors*

The results of optimization, which are presented in Table 4, demonstrate that in the first year of project implementation (2019) it is advisable to implement the business processes of electrical maintenance, manufacture of electrical equipment, and consulting. In 2020, starting-up and adjustment works should be implemented alongside consulting, and in 2021 work should focus on the manufacture of electrical equipment. This will allow the enterprise to obtain a total profit of EUR 6,686,900, with total costs of project implementation in three years of EUR 4,952,000.

The building of the second model (16), with limitations (17–19), provides for taking into account the time factor and reducing costs and profits to the present value by means of the depreciation coefficient. As a result of the application of the optimization algorithm, the combination of business processes which is presented in Table 5 was created.

Hence, taking into account the time factor allows for different results of optimization to be received. In accordance with the built model, in 2019 it is advisable to implement the business processes of: project design of electricity supply objects, electrical maintenance, and manufacture of electrical equipment. In 2020, it is necessary to implement the project design of electricity supply objects, and in 2021 both the project design of electricity supply objects and consulting. Under this option, the total costs of project implementation will be EUR 4,576,900, while the expected profit will be EUR 6,208,200.

Table 5. *The results of the optimization of the business processes system of an enterprise in the engineering services sector taking into account the time factor (the period of project implementation is three years), 2019–2021*

Years	Business processes	Costs of business process implementation, EUR	Profit from business process implementation, EUR	Total costs of project implementation, EUR	Total profit from project implementation, EUR
2019	x_{10}	127,200	163,900	4,576,900	6,208,200
	x_{20}	3,820,500	5,235,900		
	x_{30}	309,900	393,500		
	x_{40}	-	-		
	x_{50}	-	-		
2020	x_{11}	117,200	151,000		
	x_{21}	-	-		
	x_{31}	-	-		
	x_{41}	-	-		
	x_{51}	-	-		
2021	x_{12}	108,000	139,200		
	x_{22}	-	-		
	x_{32}	-	-		
	x_{42}	-	-		
	x_{52}	94,200	124,700		

Source: *calculated by authors*

The COVID-19 pandemic caused serious social and economic changes on a global scale. These changes did not bypass the Ukrainian economy. Quarantine restrictions, the ban on public gatherings, and the introduction of other strict measures in Ukraine made it necessary to reschedule, postpone, and cancel many activities and the implementation of numerous projects.

The COVID-19 pandemic is a source of global economic crises, since businesses face a great number of new prospects and challenges within their systems. Approaches to work and business activities are changing due to the risks of discontinuity of business, strict time limits for decision-making, threats to safety, and decreases in productivity. The current situation has had a significant impact on business processes, which enterprises must develop and manage.

For the studied enterprise in the engineering services sector, the introduction of the quarantine restrictions in 2020 affected them negatively, as they related to the delay of the execution of projects. In accordance with this, 2020 may be considered as a year during which no projects were implemented. This requires modifications in building the optimization model, which means that while calculating the depreciation coefficient of money (k_{it}), the intervals of time $t = 0, 2, 3$ should be used (2019, 2021, and 2022, respectively).

It is possible to use economic models for prediction (Ahmand et al., 2021). If the enterprise had predicted in advance that in 2020 it would be fully unable to conduct its activity, the optimal combination of business processes would have looked as presented in Table 6.

Therefore, taking into account the impact of the quarantine restrictions (the impossibility of implementing planned business processes during 2020) produces the following combination of business processes: in 2019, it is advisable to conduct the project design of electricity supply objects, electrical maintenance, and consulting; in 2020, works are not provided due to the quarantine restrictions; in 2021, the project design of electricity supply objects and consulting are conducted; and in 2022, only consulting (Arsawan et al., 2020; Yankovyi et al., 2021). This will allow a profit of EUR 5,925,400 to be obtained, while the costs of project implementation will be estimated at EUR 4,347,500 during 2019–2022.

Table 6. *The results of the optimization of the business processes system of an enterprise in the engineering services sector taking into account the time factor (the period of project implementation is three years – 2019, 2021, and 2022) and the effect of quarantine restrictions.*

Years	Business processes	Costs of business process implementation, EUR	Profit from business process implementation, EUR	Total costs of project implementation, EUR	Total profit from project implementation, EUR
2019	x_{10}	127,200	163,900	4,347,500	5,925,400
	x_{20}	3,820,500	5,235,900		
	x_{30}	-	-		
	x_{40}	-	-		
	x_{50}	110,900	146,800		
2020	x_{12}	108,000	139,200		
	x_{22}	-	-		
	x_{32}	-	-		
	x_{42}	-	-		
	x_{52}	94,200	124,700		
2021	x_{13}	-	-		
	x_{23}	-	-		
	x_{33}	-	-		
	x_{43}	-	-		
	x_{53}	86,800	114,900		

Source: *calculated by authors*

However, since the enterprise enters into contracts for the implementation of business processes in advance, in 2019 it begins its activity in accordance with the optimized model, the results of which are presented in Table 5 (carry out the processes x_1, x_2, x_3)

(Yankovyi et al., 2021). After the introduction of quarantine restrictions, it should conduct optimization again, the results of which are presented in Table 7.

Therefore, in building the optimization model in 2019, the implementation of the three business processes of project design of electricity supply objects, electrical maintenance, and manufacture of electrical equipment was set out (Yankovyi et al., 2021). For 2021–2022, optimization was carried out, the results of which showed that, due to the quarantine restrictions, in order to maximize profit the enterprise will need to conduct the business process of consulting only in 2022. The application of this approach will create a large number of practical measures in order to form an optimal set of business activities at the enterprise to increase its profit (Laurinavičius, 2018).

As a result, the cost of project implementation (reduced to the present value) will be estimated at EUR 4,344,400, and the profit (reduced to the present value) will be EUR 5,908,200. Thus, the enterprise will obtain profit lower than expected by EUR 300,000 (–4.83%).

Table 7. *The results of the optimization of the business processes system of an enterprise in the engineering services sector taking into account the time factor (the period of project implementation is three years – 2019, 2021, and 2022) and effect of quarantine restrictions.*

Years	**Business processes**	**Costs of business process implementation, EUR**	**Profit from business process implementation, EUR**	**Total costs of project implementation, EUR**	**Total profit from project implementation, EUR**
*2019**	x_{10}	127,200	163,900	4,344,400	5,908,200
	x_{20}	3,820,500	5,235,900		
	x_{30}	309,900	393,500		
	x_{40}	-	-		
	x_{50}	-	-		
2021	x_{12}	-	-		
	x_{22}	-	-		
	x_{32}	-	-		
	x_{42}	-	-		
	x_{52}	-	-		
2022	x_{13}	-	-		
	x_{23}	-	-		
	x_{33}	-	-		
	x_{43}	-	-		
	x_{53}	86,800	114,900		

Source: *calculated by authors*

7. Conclusions

The ways of applying mathematical models, which are common to most economic systems, their existing limitations, and their main functions were considered. The necessity of the optimization of business processes system for enterprises in the engineering services sector was substantiated, and the feasibility of using optimization models by managers as one of the most important instruments of operational management for the minimization of the negative impact of external environment factors was proved. The consideration of the time factor when optimizing the management system of business processes enables enterprises to predict costs and financial results, reducing them to the present value. This will also enable enterprises to optimize and improve their activity in terms of the COVID-19 pandemic.

The economic-mathematical model of the rational formation of the management system of business processes was developed, and the optimization calculations for the management system of business processes at an enterprise in the engineering sector (the period of project implementation was three years), in which the time factor and effect of quarantine restrictions were taken into account, was conducted. The results allowed for the prediction of costs and financial results, which were reduced to the present value by means of the depreciation coefficient. In accordance with the developed optimization model, as a result of quarantine restrictions, in 2022 the enterprise will have to implement the business process of consulting only. The costs of project implementation (reduced to the present value) will be EUR 4,344,400, and the profits (reduced to the present value) will be EUR 5,908,200. This demonstrates that the enterprise will obtain profit EUR 300,000 lower than expected (–4.83 %).

This is substantial information for the enterprise's top-level management for the development of corrective measures and appropriate managerial decisions. Moreover, the application of optimization models may become an important instrument of the operational management for the top-level managers of enterprises, as they aim at the minimization of the negative impact of the external environment. The proposed models will allow enterprises in the engineering services sector to ensure the improvement of the efficiency of the decision-making process.

Further research may relate to the minimization of risks while optimizing the business processes systems of enterprises. The introduction of additional limitations to the model will provide the opportunity to develop a comprehensive approach to analyze enterprises' business processes. The application of this approach will create a large number of practical measures in order to form an optimal set of business activities at an enterprise to increase its profit. This is the subject of considerable research interest in terms of the presently unstable economic environment.

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