МАТЕМАТИЧНЕ ТА КОМП'ЮТЕРНЕ МОДЕЛЮВАННЯ

MATHEMATICAL AND COMPUTER MODELING

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DECISION-MAKING MODELS AND THEIR APPLICATION IN TRANSPORT DELIVERY OF BUILDING MATERIALS

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ABSTRACT

Context. The task of determining a generalized parameter characterizing a comprehensive assessment of the action of criteria affecting the sequence of execution of orders for the manufacture and delivery of products to the customer.

Objective. The purpose of the work is to develop an algorithm for calculating priorities when solving the problem of transport services in conditions of uncertainty of choice.

Method. When considering the problem of the efficiency of order fulfillment, the reasons are given that affect the efficiency of the tasks being solved for the delivery of paving slabs to the customer in the shortest possible time. In order to select a scheme that reflects the main stages of decision-making, a justification was carried out and a comparative analysis of existing models was carried out. The criteria for the requirements for describing such models have been determined. It is indicated that the objective function depends on a group of reasons, i.e. represents a composite indicator. The stochastic nature of such factors led to the use of statistical analysis methods for their assessment. The limits of variation of the parameters used in the calculations are established. The solution to the multicriteria problem consists in bringing the role of the acting factors to one unconditional indicator, grouping and subsequent ranking of their values. The decision-making and the choice of the indicator will depend on the set threshold and the priority level of the factor. The indices that form the priority of the factor are determined analytically or expertly. The sequence of actions performed is presented in the form of an algorithm, which allows automating the selection of a model and the calculation of indicators. To assess the adequacy of the proposed solutions, tables of comparative results for the selection of the priority of the executed orders are given.

Results. The method allows a comprehensive approach to taking into account the heterogeneous factors that determine the order in which the order is selected when making managerial decisions, ensuring the achievement of a useful effect (streamlining the schedule for the delivery of paving slabs to the customer) by ranking the values of priority indices.

Conclusions. The proposed scheme for the transition to a complex unconditional indicator (priority index) makes it possible to quantitatively substantiate the procedure for choosing the next order when performing work. A special feature is that the list of operating factors can be changed (reduced or supplemented with new criteria). The values of these parameters will improve and have a higher reliability with the expansion of the experimental design, depending on the retrospective of their receipt, the accuracy of the data. As a prospect of the proposed method, the optimization of the process of selecting applications using queuing methods (for the type of the corresponding flow – homogeneous, without consequences, stationary, gamma flow, etc.) can be considered.

KEYWORDS: decision making model, factor, priority, ranking, order sequence, algorithm.

ABBREVIATIONS

MM – mathematical model;

MED – multidimensional experimental data.

NOMENCLATURE

\$ – cost of the order;

t – time of delivery of a tile to the consumer;

t_{day} – delivery within a day;

t_{2week} – order delivery within 2 weeks;

L – the distance of the location of the object from the supplier;

L_0 – minimum delivery distance (self-pickup);

L_{del} – distance traveled by transport when delivering the goods;

p – type of work;

s – terms of performance of work (order);

w – weight of the delivered tile;

w_{carry} – carrying capacity of the transport unit;

g – work schedule;

m – weather conditions at the time of the order;

e – availability of products in stock;

$I_{general}$ – priority factor;

Z – number of calls / orders for the accounting period of time;

f – frequency of customer appeals;

$I_\$$ – order value index;

I_t – product delivery time index;

I_l – index of remoteness of the customer's location;

I_p – index of the type of work, which may include only delivery, or delivery and installation of tiles;

I_w – order volume index;

I_s – index, taking into account the urgency of the order (delivery);

I_g – index, which provides for coordination with other works;

D – priority coefficient;

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I_m – index determined by the action of meteorological conditions;

I_e – index, taking into account the availability of goods (tiles) in stock;

j – number of customers for the reporting period (for example, a year);

r – correlation coefficient;

σ_r – error rate;

χ^2 – Pearson distribution with f degrees of freedom;

N – sample size;

V – number of sample elements where the sign matches;

W – number of sample elements where the sign does not matches;

v – number of sample rows;

n – number of parameters;

$C_{conting}$ – contingency coefficient.

INTRODUCTION

The efficiency of the production and related processes depends on many factors. Among them are the availability of a financial backlog, and the provision of the necessary means of production, technological and raw material base, the solution of personnel problems, and supply issues.

However, this kind of data is presented in a different format, does not reflect the presence of connections, the specifics of the work performed, and can vary widely. This makes it difficult not only to control potential costs, but also the very process of planning work. Therefore, modeling of possible situations is of particular importance [16].

The development of such models is a difficult task due to the multi-criteria conditions and the uncertainty of the boundaries of their action. The main thing, probably, will be what models form the basis of such an analysis, how effective they are and how close they are to the working conditions of a real enterprise. If they are logical, thought out from different angles (financial, technical, organizational, etc.), then their implementation will give the desired effect.

All this fully applies to such an area as the production of building materials. In particular, the manufacture of paving slabs and the provision of related services (delivery to the customer and installation work). However, the demand for such materials (as well as services) is unstable and subject to seasonal and temporal fluctuations and changes.

The object of study is the process of a comprehensive assessment of the criteria that affect the manufacture and sale of construction products (paving slabs) by an enterprise.

The subject of study is the task of determining the priority of orders to form the order of their execution. It is planned to implement it based on modeling the change of factors that affect the timing and quality of work performed based on the results of a passive experiment.

The purpose of the work is the development of an algorithm for the complex accounting of parameters based on the analysis of thematically related statistical data.

1 PROBLEM STATEMENT

Operational provision of the customer with building materials has always been distinguished by the complexity of its implementation, which is due to a number of reasons and conditions for the performance of work. This is confirmed, for example, in one of the areas that have been actively developing in recent years – the delivery and laying of paving slabs. Consider what complicates the execution of such orders.

Firstly, this is a variety of operating schemes for the delivery of tiles and bulk materials. Differences depend on the number and type of tiles, the distance of the buyer, the timing of the order.

The heterogeneity of the existing conditions before the fulfillment of orders causes the use of different supply schemes, the choice of different-tonnage freight transport and the variation in schedules for the delivery of raw materials.

Secondly, there are problems in planning shipments that arise due to the limited transport fleet, the presence / absence of a stock of products in the warehouse and the effect of force majeure situations (equipment breakdown, traffic jams, worsening road conditions). This should also be taken into account in delivery planning. In addition, they require the adoption of adequate organizational measures.

Thirdly, seasonality and volumes of work performed. There is no permanent component here. Although initially, especially for large contracts or subcontractors, special conditions are negotiated in advance.

The actions of other manufacturers also affect the planning of work, as they in turn increase competition in the market. Applying sometimes unpopular measures (dumping, anti-advertising) to worsen the reputation of a competitor.

All these factors are important in the choice of management decisions. In addition, no one has canceled the effect of market, sometimes market conditions.

Therefore, at the input we have a number of variable parameters – \$, t, L, p, w, m, e, Z. Depending on the production possibilities, certain limitations apply. For instance: $t_{day} \le t \le t_{2week}$; $L \epsilon [L_0, L_{del}]$; p accepts one of 3 outcomes: pickup, delivery, delivery + laying tiles; $w \epsilon [50, w_{carry}]$; $e \epsilon [1,2,\ldots,10]$ shows the presence of a warehouse stock of products; Z varies widely $Z \epsilon [0,15]$.

It is necessary to find a solution to the objective function, at which the maximum reduction in the order lead-time is achieved, with the achievement of maximum profit and ensuring the schedule.

At the initial stage of solving problems of this kind, it is necessary to single out a number of factors under study. Then the MM of the adopted decision D will have a complex form, and will be determined by the dependence of the form:

$$D = f(\$, t, L, n, s, w, g, m, e) . \qquad (1)$$

Let us add some to the factors given in (1).

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Therefore, the cost of an order, although it is the dominant factor, may lose its original priority if this order is difficult to implement. For example, unrealistic deadlines are set, or the object is far enough from the supplier.

Its implementation can become problematic if a number of conditions are met.

There are time limit, lack of free heavy vehicles to deliver a large batch, violation of the schedule of planned work or lack of the required number of tiles of a given type in the warehouse. No one has canceled the influence of weather conditions, the deterioration of which can violate the terms of the contract.

Thus, the created model should take into account the impact of heterogeneous factors, according to the following conditions:

$$\begin{cases} \$ \to \max \\ T \to \min \\ S \to \min \\ w_{\min} < w \le w_{\max} \\ g \to \text{optimum} \\ e \ne 0 \\ m \to \min. \end{cases} \quad (2)$$

2 REVIEW OF THE LITERATURE

In connection with the action of a number of factors, a comprehensive analysis of their influence is necessary, which will make it possible to establish the order of execution of a particular order. The search for a solution requires taking into account DER and involves a model experiment with the choice of appropriate models. Therefore, we consider which models have been used in practice.

As follows from [1], each of the models has its own purpose. The classification is shown in table 1 and is determined by the area of application where they give the greatest effect.

Table 1 – Models in the decision-making

Based on the approach used to obtain data	
descriptive	normative
By the way of data processing	
inductive	deductive
By purpose	
problem-oriented	formal
By way of action	
static	dynamic

Specialists [16] note that the use of descriptor models is justified by the presence of experimental data, i.e. field of observation. Such models [17] are local, selective in nature, since they are formulated because of numerical indications of particular object/objects and are based on identifying patterns in existing data. Possessing high reliability, accuracy, they, however, are not universal. This limits their application in practice.

Normative [18] models, which include those given in [19], are built on the observance of predetermined boundaries, certain rules. Their actions may not be so precise, but they are universal, easily transferable from one object to another. Within the framework of use, they are better prone to automating the control of parameters and their further comparison with the standards.

Now regarding the way data is processed when looking for patterns. There are two approaches here. The first is inductive, which involves obtaining selective readings (they will become key for making generalizing managerial decisions).

Deductive, on the contrary, is built on the collection of the maximum possible information about the object of study. Further, it is analyzed, and certain conclusions are drawn. Then they make the required decisions based on them. Examples of such models are the situations described in [17, 20].

An important aspect at the stage of choosing a model is the determination of its effectiveness (adequacy) taking into accounts the given restrictions. Based on the fact that in some cases it is required to comply with formal conditions, the so-called formal models, examples of which are presented in [6,18].

In another situation (in the presence of specific conditions), the construction of models with high reliability and accuracy is required. They are aimed at solving well-defined, pre-set problems. That is why they are called problem-oriented. Examples of such models used in transport problems are given in [7, 19].

The effectiveness of the constructed model, in addition to its adequacy to the given conditions, also depends on the duration and frequency of practical application.

Therefore, models of this type are those that provide for changes in conditions (therefore, they are not constant). This is the so-called dynamic models.

Others, on the contrary, are based on the processing of a pre-known numerical data array. The construction of such models is based on the statistical processing of indicators that are pre-selected, ordered, normalized.

Regression analysis methods are applied to them, and the models themselves are called static (most of which require the processing of statistical data, i.e. collected and constant for a given period of time data) [5].

3 MATERIALS AND METHODS

Based on the properties listed above, let us consider which models can be used for the tasks set. In addition, given that there are many criteria that affect the fulfillment of orders, and the conditions themselves are subject to change, the goal will be to find the best option when they are taken into account together.

The solution of such a multicriteria problem is seen in the reduction of individual characteristics to unconditional numerical indicators and the grouping of these values in the form of a single parameter [7].

Then they can be ranked, ordered by the degree of decreasing priority. The choice taking into account the rating will serve as the basis for the order of execution of this or that order when working with an array of such applications [8].

Conventionally, the entire process of operations performed can be represented as the following diagram on Figure 1.

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In the practical implementation of the attached model, the question arises of quantifying the factors influencing decision-making under conditions of demand uncertainty [9, 10]. The priority coefficient D can serve as such a criterion. To calculate it, it is proposed to use a dependence that takes into account significance indices and has the form:

$$\mathrm{D} = \mathrm{I}_{\text{general}} = \frac{1}{2}\sum_{i=1} I_{\$} I_t I_l I_p I_s I_w I_g I_m I_e . \qquad (3)$$

1. There are a number of restrictions on:
2. Order cost index ($0.1 \leq I_{\$} < 1$);
3. Product delivery time index ($0.2 < I_t < 1$);
4. remote location of the customer ($0 < I_l < 1$);
5. Index of the type of work, which may include only delivery, or delivery and laying tiles ($0 < I_p < 1$);
6. Order volume index, and $I_w = f(I_{\$})$, therefore ($0.1 \leq I_w < 1$);
7. Index that takes into account the urgency of the order $0 < I_s < 1$;
8. An index that provides for coordination with other works (for example, preparatory ones) $I_g = f(I_s)$. Thus: $0.1 < I_g < 1$;
9. Index from the influence of meteorological conditions on the day of delivery of the order $0 < I_m < 0.5$;
10. An index that takes into account the availability of goods (tiles) in stock. It mostly depends on the size of the order.

So, $I_e = f(I_w)$ and is in the range $0.1 < I_p < 1$.

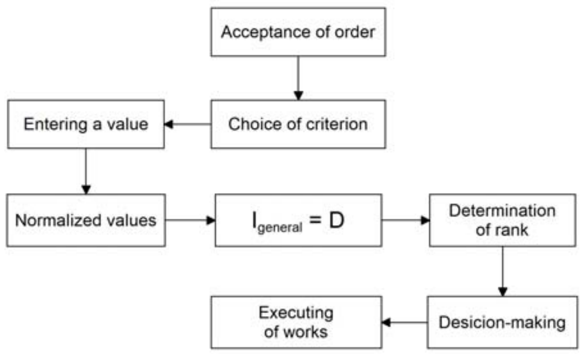

Figure 1 – Order prioritization scheme

The existing database of orders for the delivery of tiles, bulk materials and the performance of related work form a sample.

In the course of it, records are divided into groups, converted into a numerical format, and, having established significance indices, they are included in the calculation of D (3).

The obtained values of D form a series of data, which are normalized according to the ranges (ranks) of Table 2, as well as the correlation ratios in [25].

Table 2 – The rank of factor significance

№	Criterion (I_{general})	Rank
1	Dominant	$0.75 \leq I_{\text{general}} < 1$
2	Important	$0.5 \leq I_{\text{general}} < 0.75$
3	Having a value	$0.2 \leq I_{\text{general}} < 0.5$
4	Less significant	$0 < I_{\text{general}} < 0.2$

The quantitative determination of indices (3) can be done in two ways:

1. Analytically, according to the formula:

$$\mathrm{I}_{\text{general}} = \frac{\sum_{j=0}^{k} I_j f}{k} . \qquad (4)$$

2. Expertly [10].

With this approach, a questionnaire is developed and a survey of experts is conducted. Customers who have previously been provided with tile delivery services use them. Of course, this is done on condition of anonymity and the formation of presentable samples. These data serve as the basis for setting up and conducting a passive experiment.

Now let us look at its practical implementation.

4 EXPERIMENTS

For the approbation of complex accounting, 54 records of the last period were selected from the received applications and a data table was formed in Table 3.

The original sample data were scaled down to numbers using a substitution scale in Table 4.

Table 3 – Initial data on the execution of orders

Order cost	Days from order	Km to the place	Delivery or installation	Order weight (kg)	Receipt day of the order	Product availability
29317	14	17	Del. + laying	13026.2	21.11.21	1 week
95000	52	14	Del. + laying	45163.5	19.11.21	9 days
22078	15	11	Delivery	11401	13.11.21	3 days
7560	4	19.2	Delivery	2775	10.11.21	4 days
33900	2	73.5	Delivery	14520	28.10.21	In stock
5120	1	13.7	Delivery	2563	27.10.21	In stock
11384	5	27.3	Delivery	4644	25.10.21	3 days
320	0	–	Self-delivery	200	22.10.21	In stock
2158	1	19.2	Delivery	716	21.10.21	In stock
1684	5	4.5	Delivery	468	16.10.21	In stock
23875	0	18.3	Delivery	11830	14.10.21	In stock
16082	7	21.5	Delivery	7726.5	11.10.21	In stock
5910	1	46	Delivery	1120	08.10.21	In stock
38418.5	7	–	Self-delivery	21325	08.10.21	1 week
18600	1	107	Delivery	8600	07.10.21	In stock
17271	8	84.3	Delivery	7288	02.10.21	1 week
1501.5	0	84.3	Self-delivery	803	06.10.21	In stock
19851	2	107	Del. + laying	9517	30.09.21	In stock
2014.9	2	10.6	Self-delivery	854.5	30.09.21	In stock
7019.4	0	11.2	Delivery	2446	29.09.21	In stock
1905	5	–	Self-delivery	975	29.09.21	3 days
5558	0	9.2	Delivery	2903.5	28.09.21	In stock
22331	13	16.2	Del. + laying	12088	21.09.21	8 days
23705	5	14.1	Del. + laying	17209	20.09.21	In stock

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Table 4 – Scale substitutions of natural values

Price	Type of work	Weight	Receiv-ing an order	Backlog
1=<10000	0-Self-Delivery	1= <4500	Day of week	10-stock
2=<10000 <20000	1-Delivery	2= <9000	1...7	1–9 days
	2-Del.+laying	...		
9=<80000. AND. <90000		10< 10000		
10= <100000				

After substitution of values in the fields of records, the data table acquired the following form in Table 5.

Table 5 – Fragment of the initial normalized data

Count	Delay (days)	Distance (km)	Works	Weight	Date	Epsent
3	14	17	2	3	7	10
10	52	14	2	10	5	9
3	15	11	1	3	6	3
1	4	19	1	1	3	4
4	2	74	1	4	4	10
6	1	14	1	1	3	10
2	5	27	1	2	1	3
1	0	0	0	1	5	10
1	1	19	1	1	4	10
1	5	5	1	1	6	10
3	0	18	1	3	4	10
2	7	22	1	2	1	10
1	1	46	1	1	5	10
4	7	0	0	5	5	7
2	1	107	1	2	4	10
2	8	84	1	2	6	7
1	0	84	0	1	3	10
2	2	107	2	3	4	10
1	2	11	0	1	4	10
1	0	11	1	1	3	10
1	5	0	0	1	3	3
1	0	9	1	1	2	10
3	13	16	2	3	2	8
3	5	14	2	4	1	10

The number of individual fields is characterized by a large difference in values. Therefore, this sample was checked for normal distribution.

Of the available arrays, the Gaussian distribution was noted only for 6 factors (day of the week), which is reflected in Figure 2.

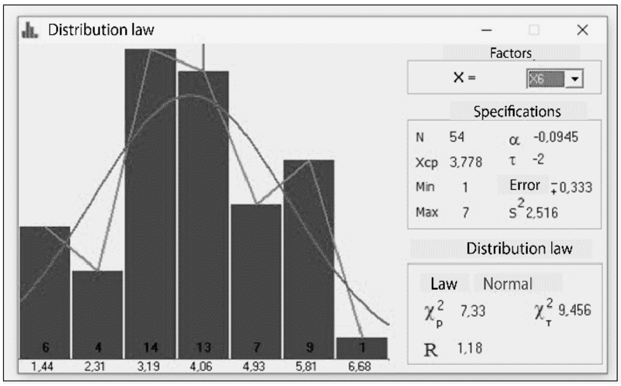

Figure 2 – Graph and parameters of the distribution of the factor "day of the week of receipt of the order"

For the assessment, the software system of statistical modeling MathModel [24] was used, which is used in a number of mathematical studies.

A comprehensive assessment involves knowing the rank of the factor being investigated. In this case, the target function is the delay in order execution, and the rest will be used as influencing factors. Their list is given in Table 3.

The investigated factors were tested for the presence of a pair wise correlation of the available data. The result of checking in MathModel is shown in Figures 3–8.

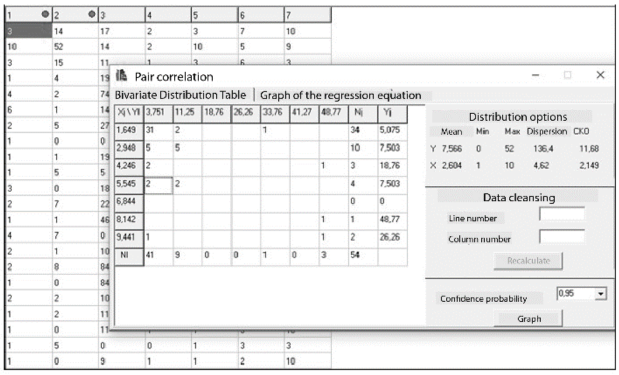

Figure 3 – Cost-time distribution table

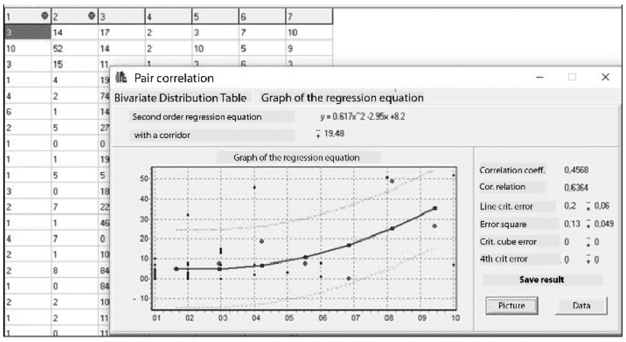

Figure 4 – Graph of the regression equation "cost-time"

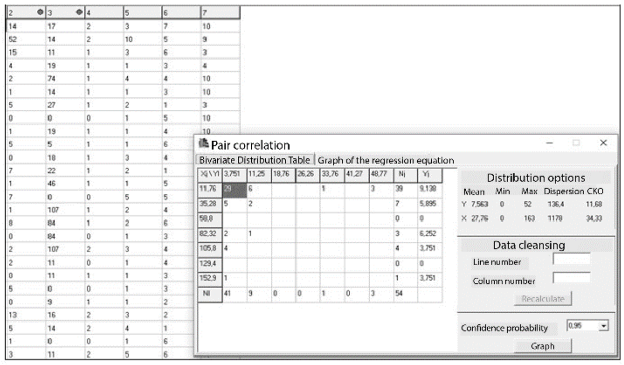

Figure 5 – Table of distribution "distance-timing"

For pairs of other factors ("Terms-type of work", "Terms-date of order fulfillment" and "Terms-availability of backlog in stock"), it was not possible to find a stable relationship, which led to the need to use other methods of analysis.

One of them, which has shown its effectiveness in practice, was the method of calculating the contingency coefficient with the construction of pleiades and nuclei. Its detailed description is given in [23].

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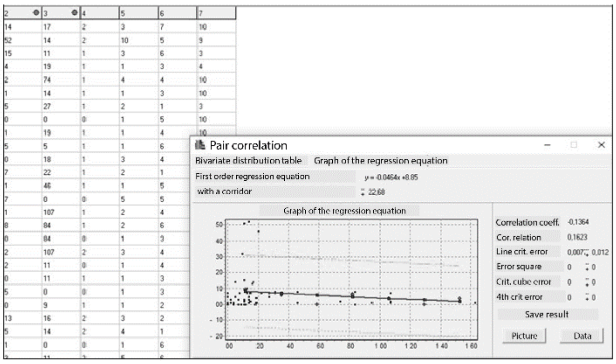

Figure 6 – Graph of the regression equation “distance-timing”

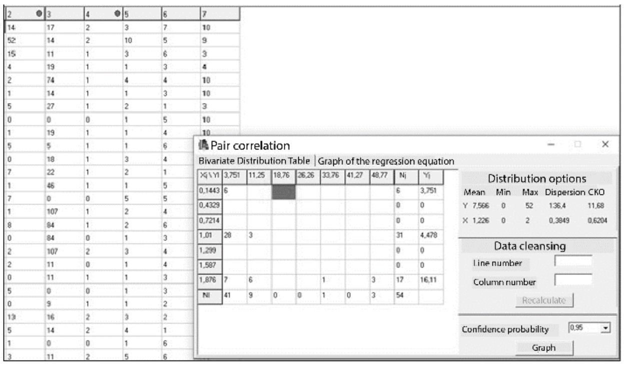

Figure 7 – Table of distribution “cargo weight-terms”

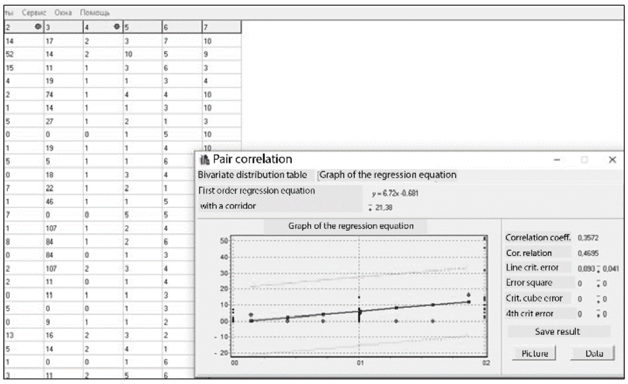

Figure 8 – Graph of the regression equation “cargo weight-terms”

Let us dwell on the key points of its application in the framework of solving the problem.

The calculation of the contingency coefficient is based on establishing the presence of an associative relationship between features.

Directly to calculate the Pearson contingency coefficient [23.25], an expression of the form:

$$C_{conting} = \sqrt{\frac{\chi^2}{\chi^2 + N}} . \tag{5}$$

In this case, the parameter f is the Fechner index and determines the presence of gross blunders. Index f is determined by the formula:

$$f = \frac{v - w}{v + w} = (v-1)(w+1) . \tag{6}$$

Let us see how this technology is implemented using the MathModel program.

In the menu of the Correlation Pleiades and Nuclei Method group, activate the Contingency coefficient method. This will open a table window with data in Figure 9.

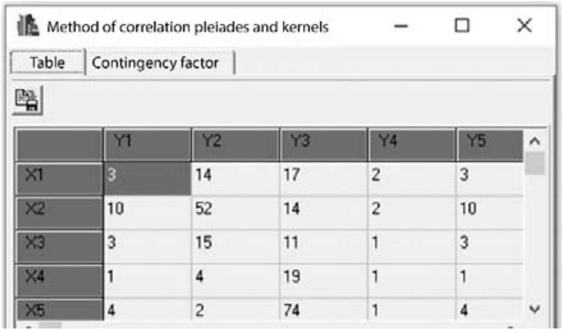

Figure 9 – Table data for calculation contingency coefficient

Opening the contingency coefficient will display the formula with the calculation of the quintile of the χ2 distribution and the obtained value of the coefficient on Figure 10.

The bottom line shows the magnitude of the error that determines the significance of the correlation coefficient.

So, if it is significant, then according to [9], the relation.

$$r \ge 3\sigma_r ,$$
$$\sigma_r = \frac{1 - r^2}{\sqrt{N}} . \tag{7}$$

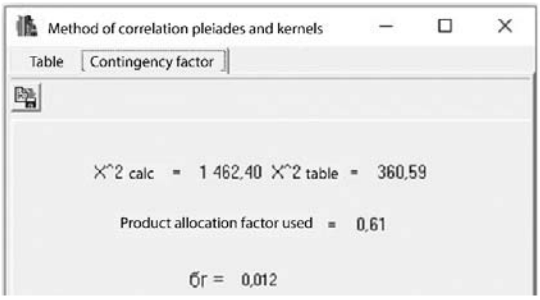

Figure 10 – Calculation of the contingency coefficient

Next, we start the process of calculating the correlation pleiades and nuclei [26] by selecting the appropriate menu line. A tabular data window will open on Figure 11.

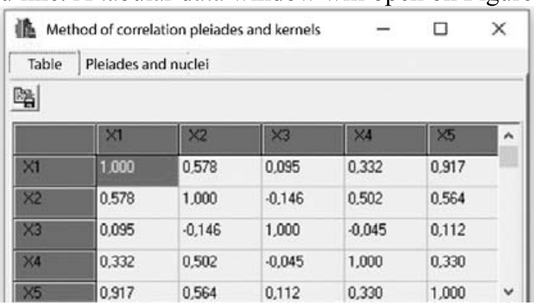

Figure 11 – Window with data for calculating correlation pleiades and nuclei

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In the tab Pleiades and kernels, set the threshold value for the calculation for the separation of the pleiades 0.5 on Figure 12.

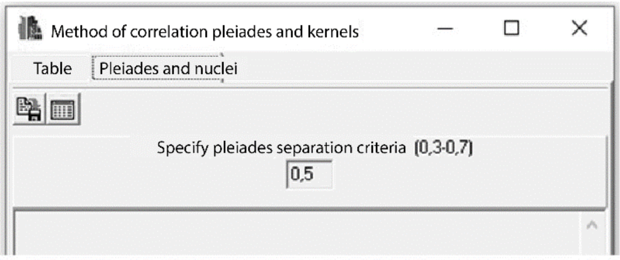

Figure 12 – Setting the threshold for constructing the pleiades

After clicking on the icon and moving along the vertical scroll bar, the window will display a table on Figure 13 with the calculated pleiades, kernels according to the correlation ratios of the factors under study and pairs with maximum connections.

The graphical interpretation of the magnitude of the connection between individual factors is the length of the edges of the pleiades graph.

The factor numbers are shown in circles. Correlation coefficient values are indicated above the edges connecting the circles. The shorter the lines, the stronger the connection. The formed constellations are highlighted with frames.

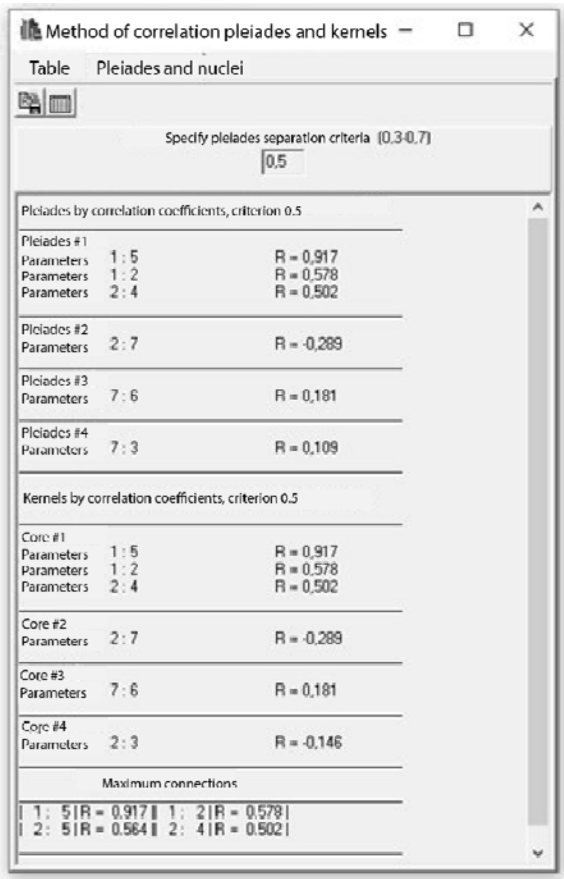

Figure 13 – The window with the results of calculation by the method of correlation and pleiades nuclei

The graph constructed according to the recommendations of [24] can be represented in the following form on Figure 14.

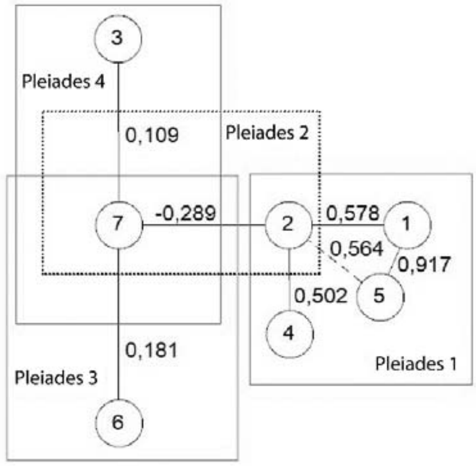

Figure 14 – Graph of pleiades and kernels of correlation of factors

5 RESULTS

Because of the study of the sample, the normal nature of the data distribution was revealed only for the days of the week on which the order was received.

To assess the degree of connection with other signs of performance, check for the presence of pair correlation according to the “factor-cause-factor-effect” scheme. The target function, according to the task, is set – the terms of the order. Of the six factors for which the analysis was carried out, a correlation was established with 3: costs, distance to the customer and the weight of the supplied products.

This is reflected in the graphs (Fig. 4, 6 and 8) and regression equations reflecting:

– cost-time relationship

$$y = 0.617x_{costs}^2 - 2.95x + 8.2 \tag{8}$$

with a range of ± 19.48;

– the relationship “distance-timing”

$$y = -0.0464x_{dist} + 8.85 \tag{9}$$

with a range of ± 22.68;

– dependence “weight of cargo-terms”

$$y = 6.72x_{weight} - 0.681 \tag{10}$$

with a range of ± 21.38.

It was found that the correlation is weak [25], at which the coefficient $r \in [0.136 \ldots 0.456]$.

In addition, if for indicators of cost and weight, the trend curve shows a growth, and then an increase in the distance of delivery of goods reflects a decrease in terms [22].

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The study of pair wise correlation for other factors did not reveal the presence of a connection and made it possible to programmatically build models.

Therefore, to study the overall relationship between factors, the contingency coefficient was calculated and a graph of the pleiades and correlation kernels was formed. Because of the construction, as the size of the bonds decreases, 4 pleiades are formed. The greatest relationship is determined between 1, 2 and 5 factors (cost, lead time and cargo weight, respectively).

6 DISCUSSION

The use of statistical analysis of data reflecting the fulfillment of orders for the delivery of paving slabs made it possible to study the factors based on a passive experiment.

According to experts, mistakes made when planning transportation schemes can lead to significant costs (up to 50% of those declared in advance).

The difference between this approach and the solutions proposed by other authors is that the key calculation parameters are formed based on empirical data, i.e., according to the results of natural observations.

What does not cancel the existing planned activities (based on logistics [3], normative indicators), but only increases their accuracy, in accordance with the actual traffic conditions along the routes during the delivery of building materials.

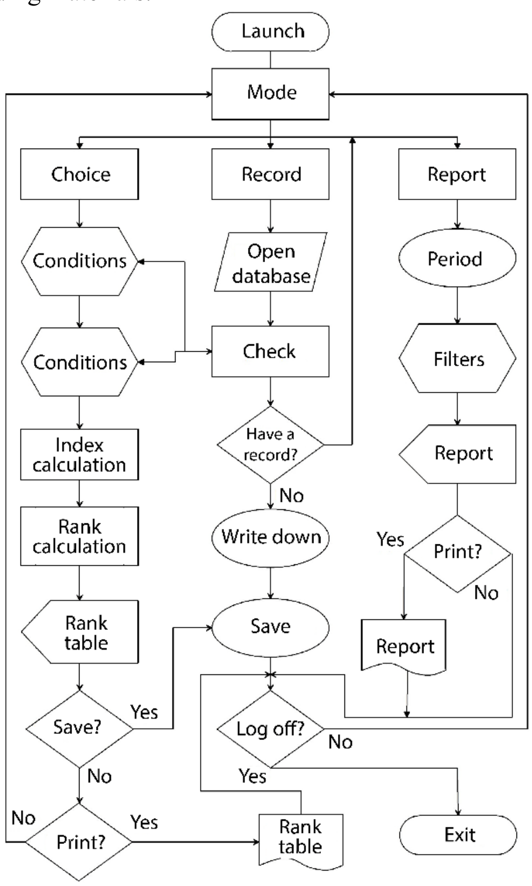

Figure 15 – Block diagram of the decision-making program

Of course, the methods of expert analysis, which provide for a questionnaire and data processing, are left outside the scope of the study.

This circumstance is caused by objective reasons for the change in the staffing and reorganization measures in the work of the construction company.

Therefore, such an assessment under current conditions cannot be recognized as possible, and the results cannot be final.

Nevertheless, the main goal of such a study is to obtain grounds for assigning the weights of the significance indices, the calculation of which is carried out according to the scheme on Figure 1 and formulas (1–4).

To automate the execution of such procedures, a program can be used, the algorithm of which is given below on Figure 15.

CONCLUSIONS

The urgent problem of developing mathematical models using small samples to make adequate management decisions on the delivery of building materials to the customer is being solved.

The scientific novelty of the results obtained lies in the fact that mathematical models have been developed to assess the complex action of various factors influencing the achievement of the target function – the delivery of building materials. At the same time, the samples were systematized and analyzed for normality of distribution, weights were determined, and a graph of correlation galaxies and kernels was formed to assess the relationship between factors. The calculation of the contingent coefficient determines the degree of such a connection and allows us to establish stochastic patterns in the form of mathematical models. The use of programs allows you to automate the analysis of samples and speed up the construction of such models, which makes the data processing process unified, excluding criteria that are not critical for achieving the target function.

The practical significance of the results obtained lies in the fact that the developed technology makes it possible to use various software that allows processing statistical data. The field of experiment can be expanded, which will increase the quality of the resulting models and the ability to use other factors that are not included in the list of those studied, but can be considered additionally. The results of the conducted research make it possible to narrow the list of factors, eliminating unimportant parameters and increase the efficiency of management actions taken to solve related problems (planning raw materials reserves, delivery dates and schedules, etc.).

Prospects for further research are in study the capabilities of the proposed set of parameters for assessing other economic indicators that affect the operation of an enterprise (financial, material, energy, labor).

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МОДЕЛІ ПРИЙНЯТТЯ РІШЕНЬ ТА ЇХ ЗАСТОСУВАННЯ В ЗАДАЧАХ ТРАНСПОРТНОЇ ДОСТАВКИ БУДМАТЕРІАЛІВ

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АНОТАЦІЯ

Актуальність. У статті зображено, що визначення критеріїв, що впливають на черговість виконання замовлень по доставці продукції замовнику є головною задачею. Мета такої роботи міститься у розробці алгоритму щодо вибору пріоритетів при вирішенні завдання транспортного обслуговування в умовах невизначеності.

Мета роботи – розробка алгоритму розрахунку пріоритетів при вирішенні задачі транспортного обслуговування в умовах невизначеності вибору.

Метод. В контексті проблеми оперативності виконання замовлень наведені причини, що впливають на логістику розв'язуваної задачі – поставки будівельної продукції за місцем вимоги. З метою вибору схеми, що відбиває основні етапи прийняття рішень по доставці тротуарної плитки замовнику, виконано обґрунтування і проведено порівняльний аналіз існуючих моделей. Визначено критерії, що пред'являються вимоги для опису таких моделей. Зазначено, що цільова функція залежить від різних причин, тобто є комплексним показником. Стохастичний характер таких факторів зумовив використання для їх оцінки методів статистичного аналізу. Встановлено межі зміни використовуваних в розрахунках параметрів. Рішення багатокритеріальної задачі укладено в зведенні діючих факторів до безумовним показниками, їх угруповання і подальшому ранжируванні. Ухвалення рішення та вибір показника буде залежати від встановленого порога і рівня пріоритету фактору. Індекси, що формують пріоритет фактору, визначаються аналітично або експертним шляхом. Черговість виконуваних дій представлена у вигляді алгоритму, що дозволяє автоматизувати вибір моделі і визначення пріоритетів. Для оцінки адекватності пропонованих рішень наведені таблиці порівняльних результатів за вибором пріоритетності виконуваних замовлень.

Результати. Метод дозволяє комплексно підійти до врахування різнорідних чинників, що впливають на пріоритети вибору при прийнятті управлінських рішень, забезпечивши досягнення корисного ефекту (упорядкування графіка виконання робіт з доставки тротуарної плитки замовнику).

Висновки. Пропонована схема по переходу до комплексного безумовному показником (індексом пріоритету) дозволяє кількісно обґрунтувати прийняття управлінських рішень. Особливістю є те, що список діючих факторів може бути змінений або доповнений новими параметрами. Значення цих параметрів можуть уточнювати і мати більш високу вірогідність з розширенням плану пасивного експерименту, оскільки залежать від ретроспективи отримання, а також точності наявних даних. Як перспектив, при визначенні пріоритетів, можлива оптимізація вибору заявок із застосуванням методів масового обслуговування (для типу відповідного потоку – однорідного, без наслідків, стаціонарного, гамма-потоку та ін.).

КЛЮЧОВІ СЛОВА: модель прийняття рішень, фактор, пріоритет, ранжування, черговість замовлення, алгоритм.

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