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Modelling of Competitive Space of A Product in Order to Improve Cost Management Efficiency

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***Abstract* — In this article, the authors substantiate the prerequisites for increasing of the interest of the industrial companies' management in improving the cost management system in the context of digitalization. The key aspect in the development of theoretical and methodological principles of cost management is the construction of an effective information subsystem that enables a company to successfully compete in the market and form its own competitive product space. On the basis of a combination of the hierarchy method and the «product demand space» method, key indicators of increasing cost management efficiency are identified as follows: costs of the new technologies; product quality; innovation (novelty of the product). It is concluded that the formation of a competitive space and the success of products on the market is determined by a combination of three parameters which are costs, quality, and uniqueness. It is necessary to achieve the optimal combination of these parameters for a promising way of managing production costs. A matrix of comparisons of indicators of the product demands spaces and a model of the demand space have been developed. The procedure for the implementation of the developed procedure at an industrial company introducing digitalization of control is described, and the algorithm for positioning the analysis object relative to the demand space is proposed. The options for increasing the competitiveness of products through the management of company costs were tested, and the assumption was made that in order to ensure a constant increase in efficiency, it is necessary to increase the quality and innovativeness of the product while reducing costs. The developed model is universal and recommended by the authors for use for companies in various fields of activity.**

Keywords* — *cost management, company's competitiveness, digitalization of the management system, product competitive space, modeling the improvement of the cost management efficiency.

I. INTRODUCTION

In the context of the transition of companies to digitalization, cost management is considered as a means of obtaining high economic result of the company's operation, since in general terms it is determined as the difference in the income received from the sale of products and the costs of their production and marketing.

Typically, the problems of cost management affect the solutions in planning, accounting, analysis, cost control, and production cost reduction. At the same time, the formation of market relations requires a change in the views on cost management, taking into account the features of the transition period to the market economy, significant innovations occurring in the processing, storage, and transmission of data, in consumer preferences, in the competitive environment [6, 5].

In this regard, it is important to determine the basic principles that companies should be guided by when choosing the best option for a cost management system, to identify the purpose and roles of this system in the overall company management system, and to correlate these roles with the current and future tasks of the company, as well as its specifics. Besides, it is important to create a competitive product space in order to increase cost-effectiveness.

Even in the context of digitalization, cost management processes in companies often do not have the necessary level of systematicity, flexibility, and dynamism. Against the background of significant interest in the implementation of cost management methods in the context of new information technologies, there are a number of problems of a theoretical, methodological, and procedural nature. Their presence is largely due to the following circumstances: the lack of proper attention to the analysis of the external business environment when structuring cost management processes; difficulties in choosing of cost management methods and putting these methods into practice; insufficient development of criteria for evaluating the cost management efficiency under the implementation of digitalization. All this defines promising

directions for the development of the theory and practice of cost management in the company and necessitates the development of an integrated approach to improving the cost management [1, 7].

At the same time, the main emphasis in cost management improving should be placed not only on the creation of a cost management system, but also on the introduction of an effective information subsystem that enables the company to successfully compete in the market, and, accordingly, giving it the properties and qualities necessary to implement this task, with the aim of building a competitive product space for solvent consumers [2, 6].

II. METHODOLOGY AND ANALYSIS

For the goal of creating a competitive product space and building a demand area for new products in cost management, the authors use a combination of the hierarchy method and the "product demand space" method [1, 11] (table 1).

TABLE I. THE COMPARISON MATRIX FOR THE INDICATORS OF THE PRODUCT DEMAND SPACE [6, 8]

Comparison parameters	Maximum cost level (Cmax), RUR	Maximum quality level (Qmax)	Maximum innovation level (Imax)
Minimum cost level (C_{min})	x		
Minimum quality level (Q_{min})		x	
Minimum innovation level (I_{min})			x

The use of this combination is due to the relative simplicity of its practical implementation, as well as the sufficiency of a small number of indicators for making forecasts.

The authors selected the following key indicators for this method:

- costs of the new technologies;
- product quality;
- innovativeness (product novelty).

The proposed method of product demand space is considered as a modification of the hierarchy method, but the main difference is that if the hierarchy method considers comparisons of mainly 2 factors affecting the goal, i.e. in the form of a linear (two-dimensional) dependence, the product demand space takes into account n-possible parameters (in this case, 3).

Traditionally, the value of the product competitiveness indicator depends on two parameters – the price of the product (and, naturally, its costs) and its quality. In order to effectively manage the costs, it is proposed to take into account one more parameter of the product – its uniqueness (innovativeness), characterizing the degree of the product's novelty and thus distinguishing it from other products of this series and making it more attractive in the eyes of the consumer.

In the proposed author's model, a new concept is introduced – «demand space», characterized by indicators of costs, quality, uniqueness of goods (industrial products). Once in this space, the product will be sold in the market for the benefit of the company and with appropriate customer satisfaction [15].

The success of a product in the market is thus determined by a combination of three parameters – costs, quality, and uniqueness. The search for the optimal combination of these parameters is a promising way to manage production costs.

In practice, the shape and position of this enclosed space will be determined by the following factors: first of all, the nature of competition in the market where the company operates, as well as the nature of consumer preferences. This space defines the potential area of change in the parameters of a particular product or group of goods, carried out as part of a production cost management strategy developed by each company [5, 14].

The characteristics of the parameters forming the product competitive space are presented as follows (table 1):

- minimum cost level (C_{min});
- maximum cost level (C_{max});
- maximum quality level (Q_{max});
- minimum quality level (Q_{min});
- maximum innovation level (I_{max});
- minimum innovation level (I_{min});

The authors have developed the model of the demand space (figure 1).

TABLE II. DESCRIPTION OF THE INDICATORS FORMING THE PRODUCT COMPETITIVE SPACE

Indicators	Description
Minimum cost level (C_{min})	the minimum acceptable value of costs below which the manufacturing of this product is impossible at the present stage of technical and technological development
Maximum cost level (C_{max})	describes the maximum cost value above which the production is not economically beneficial for the manufacturer or can not satisfy the buyers if the desirable profitability level is preserved
Maximum quality level (Q_{max})	the topmost quality level which can not be exceeded at the present stage of technical and technological development
Minimum quality level (Q_{min})	the lowest quality limit below which the product can not be used as intended
Maximum innovation level (I_{max})	the topmost innovativeness level above which the product would not meet the presently existing needs of the consumers and the present level of technical and technological development
Minimum innovation level (I_{min})	the lowest value of innovativeness beyond which the products fails to be attractive for the consumers

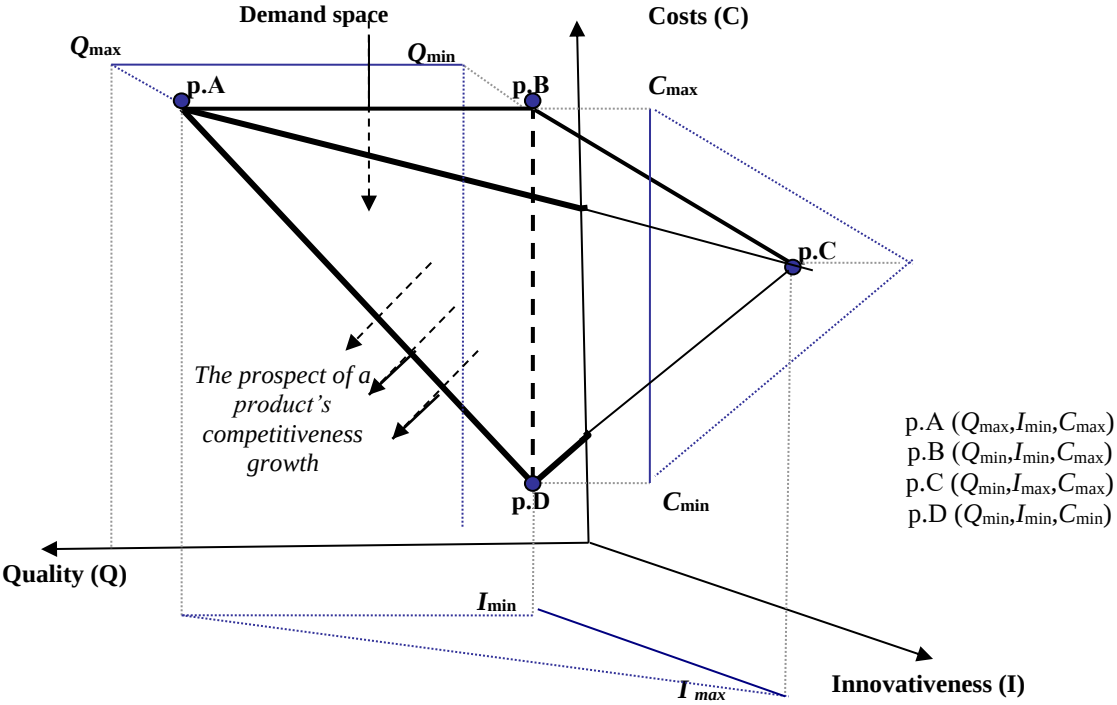

Fig. 1. Product demand space

III. Discussion and Results

The proposed method of creating a product demand space (a competitive space of a company) is an effective method for use in an industrial enterprise introducing digitalization of management. It can be implemented based on the following procedure [3]:

1) definition of the analyzed object's parameters;

2) definition of the parameters of the product demand space;

3) description of the product demand space;

4) definition of the position of the analyzed object within the product demand space;

5) alteration of the analyzed object's parameters.

These stages are implemented as follows:

Stage 1. The information department provides data on costs for the product(s) of interest. Evaluation of the quality and uniqueness of the goods can be carried out according to the determinant indicators characterizing the quality and the innovativeness, based on the expert assessment method, with the participation of various company units. The production unit with certain prime cost is taken as a calculation object, and the innovation level and the quality level are taken in the form of expert survey data. Thus, we get some point with coordinates (Q, I, C).

Stage 2. Using engineering calculations and on the basis of marketing research, the values of C_{max}, C_{min}, Q_{max}, Q_{min}, I_{max}, I_{min} are determined expertly. Thus, we obtain the coordinates of the extreme points of the competitiveness space – p. A (Q_{min},I_{min},C_{max}), p. B (Q_{min},I_{min},C_{max}), p. C (Q_{min},I_{max},C_{max}), p. D (Q_{min}, I_{min}, C_{min}).

Stage 3. Description of the product demand space (product competitiveness). A special case is considered when four planes make up the demand space, as shown in Figure 2: one of these planes is parallel to the QC plane (ABD plane), the second is parallel to the IC plane (BCD plane), the third plane is parallel to the QI plane (ABC plane), the fourth the plane is at an angle (ACD plane).

Let us set the equations for each of the four planes using the well-known equation of a plane passing through three points [4, 16]:

- plane ABC is defined by the equation:

$$\det\begin{bmatrix} Q-Q_{max} & I-I_{min} & C-C_{max} \\ Q_{min}-Q_{max} & I_{min}-I_{min} & C_{max}-C_{max} \\ Q_{min}-Q_{max} & I_{max}-I_{min} & C_{max}-C_{max} \end{bmatrix}=0 \quad (1)$$

After solving this equation, we get the following equation: $C=C_{max}$

- plane ABD is defined by the equation:

$$\det\begin{bmatrix} Q-Q_{max} & I-I_{min} & C-C_{max} \\ Q_{min}-Q_{max} & I_{min}-I_{min} & C_{max}-C_{max} \\ Q_{min}-Q_{max} & I_{min}-I_{min} & C_{min}-C_{max} \end{bmatrix}=0 \quad (2)$$

After solving this equation, we get the following equation: $U=U_{min}$

- plane BCD is defined by the equation [10]:

$$\det\begin{bmatrix} Q-Q_{\max} & I-I_{\min} & C-C_{\max} \\ Q_{\min}-Q_{\min} & I_{\max}-I_{\min} & C_{\max}-C_{\max} \\ Q_{\min}-Q_{\min} & I_{\min}-I_{\min} & C_{\min}-C_{\max} \end{bmatrix}=0 \quad (3)$$

After solving this equation, we get the following equation: $Q=Q_{\min}$

- plane ACD is defined by the equation:

$$\det\begin{bmatrix} Q-Q_{\max} & I-I_{\min} & C-C_{\max} \\ Q_{\min}-Q_{\max} & I_{\max}-I_{\min} & C_{\max}-C_{\max} \\ Q_{\max}-Q_{\min} & I_{\min}-I_{\min} & C_{\min}-C_{\max} \end{bmatrix}=0 \quad (4)$$

Then this equation is thus altered:

$$\begin{gathered}(Q-Q_{\max})(I_{\max}-I_{\min})(C_{\min}-C_{\max})- \\ -(C-C_{\max})(I_{\max}-I_{\min})(Q_{\max}-Q_{\min})- \\ -(I-I_{\min})(Q_{\max}-Q_{\min})(C_{\min}-C_{\max})=0\end{gathered} \quad (5)$$

In accordance with that equation we introduce the following function:

$$\begin{gathered}f(Q,U,C)=(Q-Q_{\max})(I_{\max}-I_{\min})(C_{\min}-C_{\max})- \\ -(C-C_{\max})(I_{\max}-I_{\min})(Q_{\max}-Q_{\min})- \\ -(I-I_{\min})(Q_{\max}-Q_{\min})(C_{\min}-C_{\max})\end{gathered} \quad (6)$$

Stage 4. The determination of the position of the object of analysis in relation to the product demand space. The authors propose an algorithm for positioning the analysis object in relation to the demand space (figure 02).

The analysis object was a certain product with the parameters *Q, I, C*.

Stage 5. Implementation of the changes in the parameters of the analysis object depending on the results obtained in stage 4, as well as the goals and the current situation in the market [9].

Parameters *Q, I, C* may change in three directions: grow (↑), decrease (↓), remain the same (const). In accordance with the rule of combinatorics multiplication, the number of possible options for changing the studied parameters is 27. It is advisable to consider 19 options out of the 27 possible options that ensure that manufactured goods fall into the demand space, as well as control the production costs of goods inside the demand space. These are the options which are not considered:

1) $C\uparrow, Q\downarrow, I\downarrow$;
2) $C\uparrow, Q\downarrow, I$ = const;
3) $C\uparrow, Q$ = const, I = const;
4) $C\uparrow, Q$ = const, $U\downarrow$;
5) C = const, $Q\downarrow, I\downarrow$;
6) C = const, $Q\downarrow, I$ = const;
7) C = const, Q = const, $I\downarrow$;
8) C = const, Q = const, U = const.

It is not advisable to consider these options, since they do not satisfy the goal in terms of the fact that either the experts do not satisfy the high costs, or the quality of the goods decreases [13].

All of these options for improving the competitiveness of the goods with a combination of different cost management methods should be thoroughly analyzed so that the company's management can make an informed choice and create a product's competition space [12].

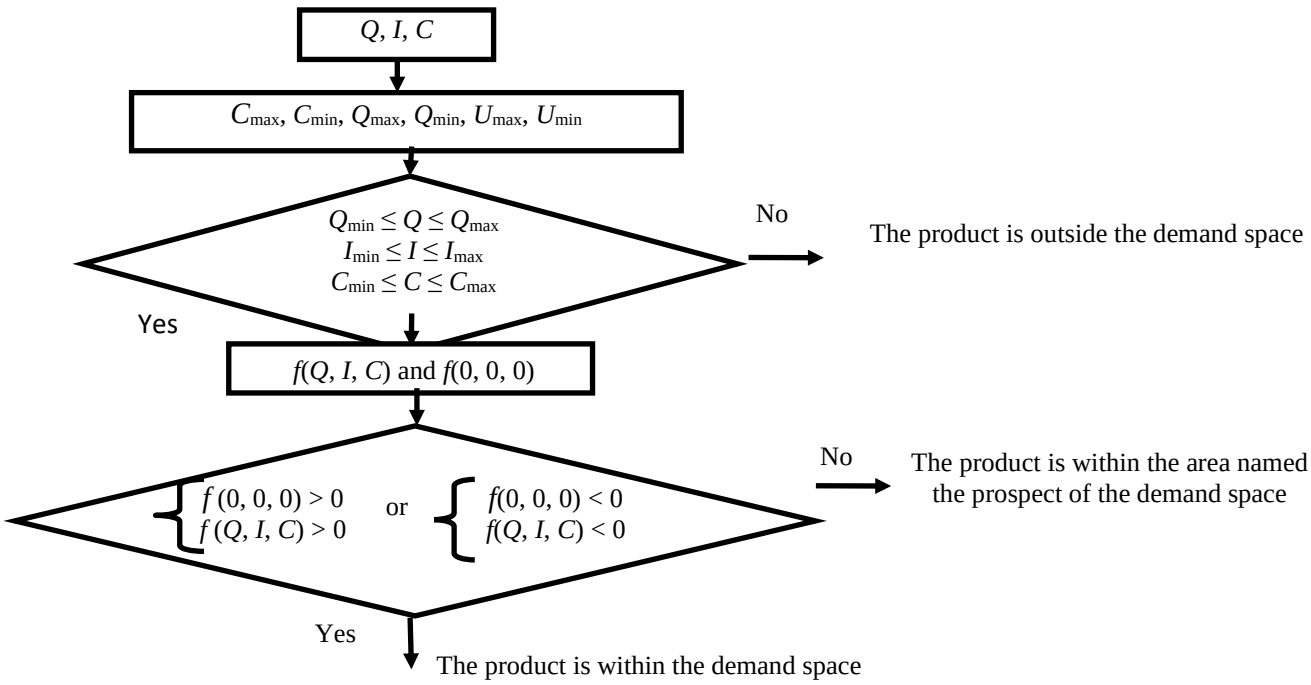

Fig. 2. The algorithm for the positioning of the analysis object in relation to the demand space

IV. Conclusion

Thus, the possible options of the product competitiveness improvement (company's cost management) are presented as follows:

1) $C\downarrow$, Q = const, I = const;
2) $C\downarrow$, $Q\downarrow$, I = const;
3) $C\downarrow$, $I\downarrow$, Q = const;
4) $C\downarrow$, $I\downarrow$, $Q\downarrow$;
5) $Q\uparrow$, $C\uparrow$, I = const;
6) $I\uparrow$, $C\uparrow$, Q = const;
7) $Q\uparrow$, $I\uparrow$, $C\uparrow$;
8) $Q\uparrow$, $I\uparrow$, C = const;
9) $Q\uparrow$, I = const, C = const;
10) $I\uparrow$, Q = const, C = const;
11) $I\uparrow$, $C\uparrow$, $Q\downarrow$;
12) $Q\uparrow$, $C\uparrow$, $I\downarrow$;
13) $Q\uparrow$, $C\downarrow$, $I\downarrow$;
14) $I\uparrow$, $C\downarrow$, $Q\downarrow$;
15) $Q\uparrow$, $C\downarrow$, I = const;
16) $Q\uparrow$, $I\uparrow$, $C\downarrow$;
17) $I\uparrow$, $C\downarrow$, Q = const;
18) $Q\uparrow$, $I\downarrow$, C = const;
19) $I\uparrow$, $Q\downarrow$, C = const.

If the company manages to ensure that its products move to the area designated as «the prospect of the product demand» (product competitiveness space), this means that the parameters of the existing space are shifted in the direction of providing higher quality or increasing innovation at lower costs. Then it is possible that a number of products of the competing companies will turn out to be outside the demand space, which provides certain competitive advantages for the company under study, which has formed a new demand space for its products.

In this case, the demand vector can be set as follows:

$$\bar{a} = (Q,I,C), \text{ where } Q_{\min}<Q<\infty,\ I_{\min}<I<\infty,\ 0<C<C_{\max} \quad (7)$$

Finally:

$$Q\rightarrow \infty,\ I \rightarrow \infty,\ C \rightarrow 0$$

for the case where the quality and innovativeness of a product growth with simultaneous cost reduction.

It should be emphasized that an important advantage of the developed model is its universalism: the possibility of its application for companies in various fields of activity.

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