JUSTIFICATION OF THE CRITERIA FOR OPTIMIZATION OF THE COMPANY IMAGE

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Abstract. *Rationing of the customer value functions and risks for multi-criteria maximization and justification of scalar criterion for its solution to optimize the company image.Author states in the paper that multidimensional image impact on the behavior of many participants in the decision-making gives grounds for a detailed study of the factors that make the image of the company and their significance for the final result - the formation of an attractive image of a company in the market. Author proposes to use multi-criteria tasks of linear programming to make the choice of one alternative among a certain set of alternatives based on many criteria. The paper suggests using scalar convolution of criteria to reduce the problem of multi-criteria optimization to one-criterion optimization task with scalar objective function, which greatly simplifies the task of selection.*

Key words: *multi-criteria, customer value functions, risks, maximization, selection, impact.*

1. Introduction

Classically the efficiency of any company in the long run is determined by the sustainable profitability through selling to consumers of produced goods, provided services, fulfilled works, and lies the ability to ensure that customers gave preference to its products (works, services). The positive image of the company contributes significantly to this.

Having largely informed society when the worldview is formed through mass media, a company's reputation and image acquires the status of a specific type of resource that forms the economic prospects of the legal entity. The unique image as a specific enterprise resource is manifested in the fact that it exists independently of management efforts of the enterprise: it exists, even if not specifically researched and developed, the only question — what image? Therefore there is a need for its ongoing assessment and correction to determine the effect of an image on positioning the enterprise in the market and its perception by customers in the attractive light. This positive image does not only attract new customers but also facilitates access to limited and specific resources (information, technology, intellectual, etc.).

2. Materials and methods

Specific features of formation of the corporate image of the company as one of the factors increasing its competitiveness have been the subject of research of many foreign scientists. Most of them, analyzing management practices of corporate image of the organization, were linking them with marketing communications. This is seen, for example, in the works of such famous scholars as John. C. Burnett and C.Moriarty, D. Dowling, John F. Joan, P. Doyle and others. However, optimization of the image to determine its impact on consumer behavior is not indicated as the subject of a special study by the mentioned authors.

Nevertheless, it is important to see possibilities of improvement of the formation of a positive image of the company not only through marketing communications. After all, the image of the company is the result of many aspects of business, including market partners and competitors. At the same time one should take into account the risk of losing market segments (the existing customers) through a negative image of the company. This multidimensional image impact on the behavior of many participants in the decision-making gives grounds for a detailed study of the factors that make the image of the company and their significance for the final result - the formation of an attractive image of a company in the market.

The purpose of the paper is the mathematical study of image optimization criteria to assess its impact on the performance of the entity.

3. Results

Consumer value, and therefore the consumer decision in buying a particular product is influenced by several factors: both on the basis of real needs of consumers and influenced by perceptions and opinions of the surrounding environment. Under such conditions the significant role is played by the image (reputation) of the enterprise, which is a certain image that is consciously formed to consider the perceptions about the given enterprise.

Taking into account the concept of value-based management, we proposed to allocate two important components in creation of customer value in industrial goods, that significantly differ in nature: technological and cognitive. The technological part describes the company's ability to create products to provide consumers with important functional characteristics. The second component of customer value, cognitive, is largely shaped by the image of the enterprise, allowing to ensure stable supply and product promoti on in the market, and consequently leads to higher profits of the company.

We propose using multi-criteria tasks of linear programming to make the choice of one alternative among a certain set of alternatives based on many criteria. When solving such problems, a convolution of criteria builds up - criteria (scalar or vector), which establish a joint order on a single set of alternatives and allows choice. So the task of managing the image component in consumer values is revealed through the effectiveness of planning and implementation of enterprise's profitable interaction with all interested market participants based on growth rates of indirect influence on consumer behavior (market counterparties is the first criterion for our task). This cognitive component directly depends on a positive image of an industrial enterprise, since the choice falls on consumering of the product that brings maximum benefits and is most valuable to an individual from all known alternative substitutes. However, the impact of the image on the formation of customer value may be negative. And the risk of losing a certain segment of the market is another criterion for solving tasks on company image optimization.

Optimization of the company image is to select a certain set of infrastructure and socio-economic elements of the enterprise, as well as forms of combination. This choice can not be arbitrary. It is required that the selection of an image was rational (rationality and approaches to its implementation in this context will be discussed later). In other words, the image of the company must meet certain criteria for a choice [1]. Let's consider the setting of a criterion in more detail.

The most obvious criterion is profit. Profits of an enterprise depend on its image. And yet we will not specify the nature of this dependence as this question would require an individual approach to each company, not to mention the economic sector.

If there are K options of the company image, with $K = 1, 2, 3, \ldots$, so the considerations of their analysis are as follows. Option with $K = 1$ is trivial — here, with the only option of the company image (its implementation in practice, rather than purely theoretical existence), no choice is required. With $K \geq 2$ the task of choice will always be present. If EI_k is k option of the enterprise image (EI — Enterprise Image). Accordingly, the choice we make on the set (list) of all options $EI_k \,{}_{k=1}^{K}$.

If we consider a unified income, there is a matter of interaction with the external competitive environment. This interaction is generated as a reaction of the competitive environment to a certain kind of image of the company. Thus if $p_j \; EI_k$ is a company income which is realized through k option of its image on the condition of interaction (reaction) with j factors of competition. To put it simply, j — is the number of competitors, though in general, we will discuss the factors of competitive interaction. It could be for one competitor undertaking, but this competitor may have different leverages over the outcome of competition (e.g. dumping, additional services, flexible payment system, the ability to purchase goods and services via the Internet). Then there is the task

$$EI^* \in \arg\max_{\{EI_k\}_{k=1}^{K}} p_j(EI_k), \qquad (1)$$

in which $j = \overline{0, M}$ with the maximum number of factors of competitive interaction M. This number also depends on certain conditions, where $M = 0, 1, 2, \ldots$, though $M = 0$ is unlikely.

Based on the conditions of the optimization task (1), we get a number of problems - each for a corresponding number of factors of competitive interaction, the appearance of which is impossible to predict.

However, apart from the criterion of profit maximization, which is almost directly dependent on the company image, we keep in mind the economic risks which are more indirectly determined by the image [2]. Therefore, on one hand, we need to maximize profits, but on the other hand - to minimize risks.

So we get a multi -criteria optimization task:

$$EI^* \in \arg\max_{\{EI_k\}_{k=1}^{K}} p_j(EI_k) \quad \text{with} \quad j = \overline{0, M} \qquad (2)$$

and

$$EI^* \in \arg\min_{\{EI_k\}_{k=1}^{K}} r_j(EI_k) \quad \text{with} \quad j = \overline{0, M}, \qquad (3)$$

where $r_j(EI_k)$ is the company's risks, which practically implements k option of its image in the interaction (reaction) with j competition factors. In order to solve this problem it is necessary to evaluate $M+1$ function $\{p_j(EI_k)\}_{j=0}^{M}$ and $M+1$ function $\{r_j(EI_k)\}_{j=0}^{M}$ on the determined set of options of the company image $\{EI_k\}_{k=1}^{K}$. This is done using expert assessments and applying the analytic hierarchy process [1; 3; 4].

Let's assume that functions $\{p_j(EI_k)\}_{j=0}^{M}$ and $\{r_j(EI_k)\}_{j=0}^{M}$ are already evaluated. In advance we will notice that after using the analytic hierarchy process (in this case it is only one), the functions $\{p_j(EI_k)\}_{j=0}^{M}$ and $\{r_j(EI_k)\}_{j=0}^{M}$ have not been normalized. Actually

$$0 < \min_{k=\overline{1, K}} p_j(EI_k) \le \max_{k=\overline{1, K}} p_j(EI_k) < 1$$

and

$$0 < \min_{k=\overline{1, K}} r_j(EI_k) \le \max_{k=\overline{1, K}} r_j(EI_k) < 1$$

for all $j = \overline{0, M}$, in other words these functions are dimensionless. However, the maximum values $\max_{k=\overline{1, K}} p_j(EI_k)$ and $\max_{k=\overline{1, K}} r_j(EI_k)$ will be different which is incorrect in the present regulation. A valuation is fundamentally necessary to solve $2M+2$ -a criterion optimization task (2) and (3) practically by any method.

Then instead of functions $\{p_j(EI_k)\}_{j=0}^{M}$ and $\{r_j(EI_k)\}_{j=0}^{M}$ we will consider normalized functions

$$\tilde{p}_j\left(EI_k\right)_{j=0}^{M} \text{ and } \tilde{r}_j\left(EI_k\right)_{j=0}^{M} \tag{4}$$

defined on the same set. Obviously, at first glance, it would be normalization of this type:

$$\tilde{p}_j\left(EI_k\right) = \frac{p_j\left(EI_k\right)}{\max\limits_{q=\overline{1,K}} p_j\left(EI_q\right)} \tag{5}$$

and

$$\tilde{r}_j\left(EI_k\right) = \frac{r_j\left(EI_k\right)}{\max\limits_{q=\overline{1,K}} r_j\left(EI_q\right)}. \tag{6}$$

But normalization (3.20) and (3.21) occurs only within profits or risks. It is not quite appropriate. If, say,

$$\max_{k=\overline{1,K}} r_j\left(EI_k\right) < \max_{k=\overline{1,K}} p_j\left(EI_k\right),$$

it means that with j factors of competitive interaction the influence of the image type on income is more significant than the impact of the image on risk. But after normalization (5) and (6) this fact will be lost, as will be

$$\max_{k=\overline{1,K}} \tilde{r}_j\left(EI_k\right) = \max_{k=\overline{1,K}} \tilde{p}_j\left(EI_k\right) = 1.$$

So, instead of normalization (5) and (6) we must perform normalization of the following type:

$$\tilde{p}_j\left(EI_k\right) = \frac{p_j\left(EI_k\right)}{\max\left\{\max\limits_{q=\overline{1,K}} p_j\left(EI_q\right), \max\limits_{q=\overline{1,K}} r_j\left(EI_q\right)\right\}}, \tag{7}$$

$$\tilde{r}_j\left(EI_k\right) = \frac{r_j\left(EI_k\right)}{\max\left\{\max\limits_{q=\overline{1,K}} p_j\left(EI_q\right), \max\limits_{q=\overline{1,K}} r_j\left(EI_q\right)\right\}}. \tag{8}$$

Normalization types (7) and (8) we will use further.

We know that, generally speaking, even a two-criteria optimization problem has no exact solution [1]. We have much more complicated case. So step by step we find the closest (to the best) solution for the following reasons.

Any multi -criteria task should only be reduced to minimization or maximization. Therefore, we note that to replace the minimum to maximum instead of the normalized risk function $\tilde{r}_j\left(EI_k\right)$ we should consider an inverse function $1-\tilde{r}_j\left(EI_k\right)$. So, in general, $2M+2$ - criteria optimization task (3.13) and (3.14) let's present in the form of sections subsets of options for company image $\left\{EI_k\right\}_{k=1}^{K}$:

$$EI^* \in \left\{\bigcap_{j=0}^{M} \arg\max_{\left\{EI_k\right\}_{k=1}^{K}} \tilde{p}_j\left(EI_k\right)\right\} \cap \left\{\bigcap_{j=0}^{M} \arg\max_{\left\{EI_k\right\}_{k=1}^{K}} \left[1-\tilde{r}_j\left(EI_k\right)\right]\right\}. \tag{9}$$

In order to solve a $2M+2$ -criteria task (9) you can build a so-called convolution of criteria (perform scalarization). A criterion refers to each individual function in (9). Convolution or scalarization is performed with some (usually normalized) factors (coefficients of relative importance or significance). Each factor is multiplied by its function. All functions are added and we receive a unified function of quality that you can minimize or maximize. However, this procedure requires involvement of relevant experts for evaluation of factors. So before you go directly to scalarization, let's consider a possibility of solution a $2M+2$ -criteria problem (9).

With the maximin approach [1; 5; 6], solving of this problem has to be the following:

$$EI^{*} \in \arg\left\{ \max_{\{EI_k\}_{k=1}^{K}} \min\left(\min_{j=0,\,M} \tilde{p}_j\left(\{EI_k\}\right),\ \min_{j=0,\,M}\left[1-\tilde{r}_j\left(\{EI_k\}\right)\right] \right) \right\}.$$

Problem (10) is potentially feasible, but its feasibility comes only having little time for expert procedures or lack of experts to assess the importance (factors) of each of the functions (7).

But here you can use the method of successive concessions. To apply the method of successive concessions, a person who makes the decision shall determine the order of importance of the functions (7). Actually, functions (7) are numbered in descending order of importance. Let's have them recorded in descending order of importance.

Let's present these functions as $\{h_i(x)\}_{i=1}^{N}$. Then performing the minimization task N functions $\{h_i(x)\}_{i=1}^{N}$ with $x \in \{EI_k\}_{k=1}^{K}$ the following procedures should be taken.

In the first step a one-criterion task must solve the problem — firstly we maximize [G_1]:

$$c_1^{*} = \max_{x \in \{EI_k\}_{k=1}^{K}} h_1(x).$$

In the second step, for practical reasons and accepted accuracy we define assignment $\Delta c_1 > 0$. This is the amount by which the reduced value is reached c_1^{*} of the most important function, by concessions to try as far as possible, to increase the value of the next most important function c_2^{*}. So, the problem is solved as to the other function:

$$c_2^{*} = \max_{\substack{x \in \{EI_k\}_{k=1}^{K} \\ h_1(x) \ge c_1^{*} - \Delta c_1}} h_2(x).$$

The third step is assigned to the second assignment function Δc_2. So, the problem is solved as to the third function:

$$c_3^{*} = \max_{\substack{x \in \{EI_k\}_{k=1}^{K} \\ h_1(x) \ge c_1^{*} - \Delta c_1 \\ h_2(x) \ge c_2^{*} - \Delta c_2}} h_3(x).$$

The appointment of concessions for each function and solving one-criterion problems continues until we reach the last step. At the N step we make an assignment for the ($N-1$)-function Δc_{N-1} and the last optimization problem is solved:

$$c_N^* = \max_{\substack{x \in \{EI_k\}_{k=1}^K \\ h_1(x) \geq c_1^* - \Delta c_1 \\ h_2(x) \geq c_2^* - \Delta c_2 \\ \dots \\ h_{N-1}(x) \geq c_{N-1}^* - \Delta c_{N-1}}} h_N(x). \quad (14)$$

In case the company image is optimized through the method of successive concessions, apart from simplicity, that solution resulted from this approach of the problem (19) is quite effective. However, the application of the scheme is based on additional assumptions on the study of which a separate expert group should be involved.

So let's go back to the scalarization possibility of the $(2M+2)$-criteria problem (19). In general form, the normalized scalar criterion, which takes into account the importance of the individual components, is as follows:

$$H(x) = \sum_{i=1}^{2M+2} \lambda_i h_i(x), \quad (15)$$

where $\{\lambda_i\}_{i=1}^{2M+2}$ — are the coefficients with the condition

$$\sum_{i=1}^{2M+2} \lambda_i = 1 \text{ with } 0 < \lambda_i < 1 \quad \forall i = \overline{1, 2M+2}, \quad (16)$$

and λ_1 — is the coefficient for the functions $h_1(x)$, λ_2 — is the coefficient for the functions $h_2(x)$, …, and generally speaking, λ_i — is the coefficient for the functions $h_i(x)$ [1; 7; 8].

Let's note that from a mathematical point of view, the sum (15) with partial criteria of coefficients importance $\{\lambda_i\}_{i=1}^{2M+2}$ is an additive function of value. To design such a logic system to correctly reproduce preferences of the person taking the decision, it requires that the used criteria had the property of independence on mutual benefits. Such assessment is more effectivein a method of normalized scalar criterion [1; 7].

In our case, the normalized scalar criterion would be as follows:

$$H(EI_k) = \sum_{j=0}^{M} \left\{ \lambda_j \tilde{p}_j(EI_k) + \lambda_{M+1+j} \cdot \left[1 - \tilde{r}_j(EI_k)\right] \right\}, \quad (17)$$

where λ_i — is the coefficient for the functions $\tilde{p}_j(EI_k)$ and λ_{M+1+j} — is the coefficient for the functions $1-\tilde{r}_j(EI_k)$ with $j = \overline{0, M}$.

The coefficients can be defined in different ways, but any approach is identical to the use of expert opinion. Therefore, there can also be used the method of analysis of approach hierarchies. However, the pairwise matrix will have format $(2M+2) \times (2M+2)$.

In the case of image optimization solution is based on a $(2M+2)$-criteria problem (9) we consider the experts, whose profession is connected with the processes of formation of risks and profits with the external (including competition) influence.

Now, with all the necessary evaluation, the function (17) is explicitly known in a (tabular) form. We can solve the one-criterion problem

$$EI^{**} \in \arg\max_{\{EI_k\}_{k=1}^K} H(EI_k) \quad (18)$$

and move on to the practical implementation of optimal company image EI^{**}.

4. Conclusions

Highlighting image components in the structure of creating customer value of the product enables the enterprise management to better define the areas of influence on consumers, who stay outside the production process. Taking into account the significant impact of the image on consumer perception of the goods value, as well as a significant number of factors that shape the image of the company, it is important to determine among them those criteria, whose influence is most productive. In practice, this complicates the task of selection because with the growing number of criteria increases the amount of computation in the appropriate algorithms of its solution. In this regard, the actual problem is the construction of multi-objective optimization problems to problems with fewer criteria. The article suggests using scalar convolution of criteria to reduce the problem of multi-criteria optimization to one-criterion optimization task with scalar objective function, which greatly simplifies the task of selection. If the optimal alternative of a multi-criteria task can be obtained as the optimal solution of the corresponding optimization problem with objective function, which is a linear convolution of criteria, such alternative is achievable by the total sum of equally important criteria.

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