The Competitive Edge of a Manufacturing Enterprise: Multicriteria Evaluating

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Abstract – The paper deals with the multicriteria evaluation of competitive edge of an enterprise on the basis of primary criteria complex. We investigated the possibilities to apply the *MCDM* methods, such as *SAW, COPRAS,* and, as a result, the comprehensive set of primary evaluation criteria having different impact significance was created. The general index of relative competitive edge of an enterprise based on presented evaluation models (adequate to applied *SAW* method) has been determined. The suggested technique was applied to the case evaluation of some Lithuanian windows manufacturing enterprises.

Keywords **- Competitive Edge, Multicriteria Evaluation, Manufacturing Enterprise, *SAW* Method.**

1. Introduction

The development (transformation) of entrepreneurship, its competitiveness in general, is an important priority for rising the state economic competitiveness and sustainable macroeconomic growth [1], especially in the newly European Union countries. The small business has been also considered as a major transferring channel for production (services) and important for solving of many social and environmental problems. At the same time, the strategic business decisions must take into account the expected new competitive advantage-oriented changes based on the complex evaluation results, by applying the effective mathematical control methods.

The separate enterprise (first of all, manufacturing) competitiveness determinants (including international ones also foremost marketing management strategy, innovations, goods or services competitiveness, diversification, production and export of high-tech goods, etc.) mostly influencing the performance effectiveness are analyzed in scientific publications [2], [3], [4], [5]. The researchers contribute to strategic innovation and knowledge-based competitive strategy by developing, refining and validating the measures of entrepreneurship capabilities, as well as account their positive effect in terms of sales, profit, and market share [6], [7], [8]. The significant relationships with new product success (focus less on the provision of customer value), organizational innovation and sustainable competitive advantage (SCA) constructs, also priorities of the establishment and accumulation of dominant advantages are also studied in the publications [8], [9]. The papers indicate the organizational knowledge and market dynamism affecting the likely value of dynamic enterprise capabilities [10].

Research works noticed how the knowledge management principles are influencing the country entrepreneurship competitive advantage, examined idiosyncratic SMEs competitiveness determinants. For contemporary SME's, the expenditures on innovations and R&D become especially important factors; effective management solutions have to be taken also into account [11]. For example, authors find that SMEs with innovative activity and the results showing their innovative actions are in Lithuania at about medium level between the EU countries [11]; but SMEs are less innovative than big enterprises, and the general level of innovations is not high enough. The globalization of the markets, as concluded the authors, requires to develop the management systems quickly reacting to the changing situation.

Some papers presented the concept of a coherent and integrated knowledge strategy of an enterprise which leads to growth of the potential to produce the optimal results of technological innovation and business performance [12]. Four types of knowledge strategy there are described, i.e. proactive, moderate, passive and inconsistent; each of them having different effects on business performance and innovation. To examine the effect of promising strategy application based on a cross-sectional sample of Spanish firms, there is used a cluster analysis. The expanded and integrative set of critical success factors (CSFs) for implementing the knowledge management in SMEs has been indicated [13]. Studies also were focused on identifying the SMEs entrepreneurial orientation and suggest a variation in product innovativeness dimensions of different performance potential [14].

In recent years, the considerable discussion on the role of corporate social responsibility (CSR) in enterprise competitive strategy, especially in small open-economy countries, investigating the influence of entrepreneurial and managerial behavior on the relationship between human capital and social capital, were intensified. When examine the intellectual capital affecting the company performance, the value added intellectual coefficient (VAIC) and its component (human, structural, and capital employed) efficiency has been measured. The relationship between these components and some indices of enterprise performance effectiveness was also found.

In the study [15] authors summarize the concepts of CSR and green management to develop an integral approach to enhance the green intellectual capital. This study utilizes small enterprise to explore the influences of CSR and environmental consciousness on three types of green intellectual capital – green human capital, green structural capital, and green relationship capital. The results demonstrate that CSR and environmental consciousness have positive effects on all three types of green intellectual capital. Besides, this study verifies that environmental consciousness is a partial mediator between CSR and three types of green intellectual capital.

The indicated factors having importance on overall competitive edge level of an enterprise must be taking into account when compiling a set of criteria for constructing the complex evaluation system.

Effective financial management is very important for the companies competitiveness, especially manufacturing companies, so the researchers pay attention to composition of the financial performance indicators system, as well as to developing methods of their measurement. Actually, a comprehensive set of financial indices was discussed also in scientific literature [16], [17]. However, we do not have the acceptable technique for integrated evaluation of a whole of financial indices (ratios) of the investigated enterprise; thus the comparing and ranking of competitors according to the financial performance effectiveness stay as problematic one up to date.

Nevertheless, only few researches are dedicated to describing the complex of small business competitive edge, especially in the newly European Union countries, as well as to integrated evaluation of such phenomenon as business competitiveness in the open economy.

In the paper, we propose to perform the examination and complex evaluation of competitive edge of a manufacturing enterprise on basis of a quantitative evaluation methodology. The analytical *research findings* consist in the constructing of complex evaluation technique of an enterprise's competitive edge using multiple criteria evaluation *SAW* method based on suggested adequate models.

2. Main Attitudes of Multicriteria Evaluation Technique

Foremost, the principal attitude consists in the measurement of overall competitive edge phenomenon that has been performed on basis of its key determinant evaluations (if every key determinant is subject to essential primary factors). Here the deterministic approach to the measurement of relative competitive edge of an enterprise is also discussed, and quantitative evaluation technique (compatible with expert investigation, SWOT analysis, also with scenario method based on the determined hierarchical set of evaluation criteria is provided.

Primarily we emphasize that conceptual approach lies in the formalization of an integrated criteria system describing the evaluated phenomenon and having various directions of influence. Therefore, an all-round (general matrix) expression of the overall competitive edge vector $\{CE^{(M)}\}$ can look like as follows:

$$\{CE^{(M)}\} = [A][\{R\},\{L\},...,\{T\}], \quad (1)$$

there $\{R\}$, $\{L\}$, ..., $\{T\}$ are integrated criteria (in sub-vector expression); $[A]$ is a matrix of the parameters of direct and indirect influence of integrated criteria (as well as generated synergetic effect) on the general competitive edge vector $\{CE^{(M)}\}$.

According to the utilitarian view, this model must be adopted in principle adequately to the reasoned evaluation methods. These preconditions undoubtedly determine the required evaluation methods. Because of the promising complex evaluation technique oriented on the quantitative assessment, foremost a purposeful analysis of the applicable multicriteria methods must be performed. The basic set of essential evaluation criteria must be compiled, and the adequate evaluation models must be developed.

The multicriteria evaluation methods have been recently used under consideration of multitude quantitative and qualitative criteria, having multidimensional character, different directions of their influence (maximizing or minimizing) and various impact significances [18], [19], [20]. When analyzing the applicability of the multicriteria methods, specific for measurement of analogous processes, foremost the exclusive approach must be

focused to the MCDM system, also the *SAW* and the *COPRAS* methods [21].

For the evaluation of such social processes, the *SAW* method is often used. This method allows to combine different types of primary criteria (factors) including the qualitative, according to their importance, but all criteria must be maximized; so it is important to format an adequate system of the primary evaluation criteria when applying this method [22]. The relative criteria having various dimensions must be normalized prior to their application. Besides, with the purpose to include minimizing criteria, they may be easily converted into the maximizing ones by the well-known formulas [23]. The sum of influence parameter significances of primary criteria to generalized dimension have amounted to 1, i. e. 100%. By applying this method, the significances of the criteria may be determined by calculations on the basis of objective information (using the *AHP* method) or by expert way; only the most significant criteria can be revealed [22].

The essence underlying the method *COPRAS* is as follows: the estimate of the *j*-th alternative K_j is directly proportional to the effect produced by whole of maximizing criteria *S+j* and inversely proportional to the sum of the weighted normalized values of minimizing criteria – the component *S-j*. A main expression of model would be as follows:

$$K_j = S_{+j} + \frac{S_{-\min} \sum_{j=1}^{n} S_{-j}}{S_{-j} \sum_{j=1}^{n} \frac{S_{-\min}}{S_{-j}}}; \qquad (2)$$

where K_j – integrated value (score) of j – th alternative; S_{+j} – resumptive value of normalized values of maximizing evaluation criteria; S_{-j} – resumptive value of normalized values of minimizing evaluation criteria.

Initial investigation reveals that the priority is given to applying of the *SAW* method in the case evaluation of system efficiency while using this method; it make one‘s possible to determine the overall competitive edge of a particular enterprise. Naturally, a particular estimate value shows the relative competitive edge at the time of evaluation. This is main advantage of the method compared to classical application circumstances of other multicriteria evaluation methods, when several alternatives are compared and evaluated by rank ordering of alternatives (*COPRAS* method). The normalization of the primary criteria values must be performed.

We propose a complex evaluation methodology using the *SAW* method when encompassing both quantitative and qualitative (mostly composite) essential criteria at the first hierarchical level; the last one mentioned in the case could be assessed quantifiable by expert way.

When investigating (by means of the *SAW* method) a multitude (so-called matrix) of primary evaluation criteria, it is expedient to compile their idiosyncratic groups (as partially integrated criteria in complex evaluation system). The typical criteria groups (configured in the case by taking into account the scientific publication findings, also accomplished initial investigation and SWOT analysis) are presented in Table 1.

1. *Group (P) of primary quantitative financial indicators:*
1.1. Profitability
1.2. Return on assets (ROA)
1.3 Return on investment
1.4. Cash flows equilibrium
1.5. Stock turnover
1.6. Dividend yield
1.7. Liquidity
2. *Group (Q) of composite non-financial indicators*:
2.1. Adaptation to influence of macro factors
2.2. Organizational and technological innovations
2.3. Marketing sophistication
2.4. Competitiveness of production
2.5. Market share growth
2.6. R&D expenditure
2.7. Production diversification

Table 1. The basic set of the primary financial and composite non-financial indicators

Actually, these basic groups need an adaptation within case evaluation conditions. So, the group *(P)* of primary quantitative financial indicators foremost includes the traditional profitability, ROA, liquidity ratios, but also cash flows equilibrium, stock turnover. The group *(Q)* is focusing on the composite non-financial indicators essentially influencing the competitive edge, but don’t having the quantitative expression. Some of them (market share growth) may be measured quantifiable on basis of derivative parameters, however their integrated measurement is preferred within unified dimensionless or point system.

3. Background Evaluation Models

Based on previous approaches, the following background model may be employed, with the *SAW* method has been applied, in order to estimate the group index *P(I)* (as first partially integrated criterion in the complex evaluation process):

$$P(I) = \sum_{i=1}^{i=r} a_i P_i; \sum_{i=1}^{i=r} a_i = 1; \quad (3)$$

where P_i is the normalized (dimensionless) value of primary financial criterion (such as profitability, ROA, liquidity, etc.); a_i is the weight coefficient of a direct impact of primary criterion P_i on the group index *P(I); r* is the number of primary criteria determining the group index *P(I)*.

The normalized values of various financial indices may be also simply established in the case as $P_i = p_i / p_i\ max$ (p_i – value of appropriate financial index for the investigated enterprise; $p_i\ max$ – maximal (highest) value of this index corresponding to comparable enterprises (for example, benchmark value for the particular sector). If the investigated enterprise has maximal value of appropriate index, the normalized value of this index is equal to unity.

In the cases when both maximizing and minimizing criteria (debt ratios, etc.) have been embraced and when comparable alternative variants according to trend scenarios evaluated on the base of whole financial performance indices, actually, the *COPRAS* method has a merit for determining the integrated criterion. Transformation of the minimizing primary criteria values into maximizing as well as classical normalization procedure for all primary criteria values must be performed (respective formulas used have been analytically developed and employed). The respective evaluation models may be adopted on basis of background expressions (see, for example, [23]). It may be noted that the evaluation results obtained by the *COPRAS* method match the data yielded by the *SAW* method if only maximizing criteria and classical normalization of primary criteria values are used.

The group index *Q(I)* (as second partially integrated criterion in the complex evaluation process) may be defined on basis of a model:

$$Q(I) = \sum_{i=1}^{i=n} b_i Q_i; \sum_{i=1}^{i=n} b_i = 1 (100\ \%); \quad (4)$$

where b_i is the weight of a direct impact of composite indicator Q_i (adaptation to influence of macro factors, organizational and technological innovations, marketing sophistication, competitiveness of production, etc.) on the index *Q(I); n* is the number of composite indicators, determining the index *Q(I)*.

The primary indicators Q_i may be measured (by expertise) non-dimensional (when highest score is equal to 1); the defined group index *Q(I)* should be also dimensionless. The score of index *Q(I)* is determined in points when primary indicators Q_i have been measured in points (in 10 or 100 point system). The weights of composite indicators have been determined by expert ranking.

The value of the competitive edge index *CE(I)* (overall score**)** may be established on the basis of the previously determined indices *P(I)* and *Q(I)* allowing to the significance parameters of the partially integrated criteria when applying following additive assessment model:

$$CE(I) = k_p P(I) + k_k\ Q(I); \quad (5)$$

where k_p and k_k are significance parameters of the partially integrated criteria *P(I)* and *Q(I)* respectively describing the degree of their impact on the overall index *CE(I)*, for example, in percent. When the score of the previously determined index *Q(I)* has been in points, it must be transformed into dimensionless measure (the maximum score within 10 or 100 points is corresponding to 1).

So the developed assessment technique was backed-up on the consecutive procedures:

- Examination of the primary evaluation criteria (the composite indicators of the group *Q* have been assessed quantifiably by expert method);
- Establishment of the group indexes (as partially integrated criteria) taking into account a relative significance of each primary criterion;
- Determination of the general relative measure – overall index - taking into account the different significance of each partially integrated criteria.

When performing the simplified procedure by establishing the weights of primary criteria as well as significance parameters of partially integrated criteria, the reliability of expert examination data was achieved by applying the justified methods, as summing-up numbers (ratings) in a row, calculations of concordance coefficient *W* as well as the concordance coefficient significance parameter χ^2 (Pearson's Chi- Square Test), etc. [24].

As can be seen, the oneness of the proposed evaluation technique is in the applying of different weights of primary financial indices and composite indicators as well as adequate differentiation significances of partially integrated criteria, i.e. groups of criteria.

5. Case evaluation results for Lithuanian manufacturing enterprises

Practical application of the prepared technique has been verified by assessing the relative competitive edge for window manufacturing enterprises functioning in Lithuania. To estimate the overall index of enterprise's competitive edge in the case evaluation (for enterprise LTE1 and LTE2 in 2011 and 2012), the adequate set of primary criteria was compiled. The essential criteria (according the weights of criteria described in Table1 and determined by expert ranking method) 1.1, 1.2, 1.3, 1.4 and 1.7 in the group *P* and composite criteria 2.1, 2.2, 2.3, 2.5 in the group *Q* (Table 1) were identified.

The expert examination procedures were performed by team of 7 experts (including authors). The consensus (and the necessary reliability) was also achieved whereas the values of coefficient *W* were amounted to 0.7-0.8. The calculation of parameter χ^2 in the case (number of determinative primary criteria in the group as well as in second group, $n \leq 7$) is also excess procedure [24].

The evaluation for investigated enterprises was performed applying the *SAW* method. The partially integrated criteria have been computed (applying models (3) when $r=5$ and (4) when $n=4$) on the basis of the normalized values of indicated above financial performance indices (they were calculated according to the provision that justified above) and scores (in points) of composite indicators. Finally, the overall score of the general relative competitive edge index has been determined (according to model (5)) taking into account the significances of partially integrated criteria 40% and 60% respectively (assessed by experts, $W=0.73$).

Results of computing the overall index *CE(I)* for enterprise LTE1 have shown that this index is equal to 0.68 (this score is equivalent to 6.8 point) in 2011 and equal to 0.71 (7.1 point) in 2012. It should be noted that the growth of index *CE(I)* was achieved when the marked growth of index *P(I)* is from 0.70 to 0.75. The analogous computing results (marked growth of the group index *P(I)* of financial indices in 2012) were indicated for enterprise LTE2, when the overall index *CE(I)* for 2011 was scored 0.70 (7.0 point) and in 2012 - 0.74 (7.4 point). So the ultimate growing of the levels of composite competitive edge indicators (describing index *Q(I)* as second partially integrated criterion) both for enterprise LTE1 and for enterprise LTE2 was denoted as direction for strategic management development.

When summarizing the findings, it may be denoted that the outcome of this analytical research is a technique for determining the complex competitive edge dimension (the overall index as quantitative measure of relative competitive edge of an enterprise) essentially based on multicriteria evaluation principles. The oneness of an evaluation technique suggested in the present paper is as follows: it may be used, when the particular enterprise was investigated and when different significance parameters of evaluation criteria were applied. Simulation of the different (by process stages mentioned above) conditions in specific businesses is possible by compiling the adequate system of primary evaluation criteria. An algorithm of proposed evaluation process may be integrated into perspective *MCDM* systems, i.e. into a computerized support system of strategic business decisions.

6. Conclusion

The common entrepreneurship competitiveness and separate enterprise performance effectiveness indicators have been still analyzed insufficiently in the scientific publications. Yet, it is not enough of studies dedicated to complex assessment of the level of enterprise's competitive edge. The adequate quantitative evaluation technique is still not accepted. To solve such complicated problem of quantitative evaluation of the state of socio-economic systems, the multicriteria evaluation methods have been used recently. It could take into consideration a multitude of the factors, that have different significance as well as multidimensional character.

The technique for complex evaluation of overall competitive edge of an enterprise must be constructed on basis of the investigated formalization system. We present the research findings that consist in the constructed adequate evaluation models when using multiple criteria methods. We attempted to classify a set of primary evaluation criteria, having different significance and describing the investigated phenomenon, into two groups: those of quantitative indices of finance management effectiveness as well as those of qualitative composite advantage indicators. They reflected abilities for adaptation on macro factor dynamic trends, efficiency of human and material resource components, competitiveness of production (services).

A quantitative assessment process integrated with separate expert evaluations was recommended when determining the general index as overall quantitative measure of relative competitive edge of an enterprise. It may be focused also on the oneness (and advantage) of a present evaluation technique based essentially on applying of *SAW* method; this technique may be used when competitive edge of the one particular enterprise (the data for which are available) have been evaluated.

The prepared evaluation technique was approved in the establishment process of overall index of

relative competitive edge of the manufacturing enterprises having performance in Lithuania: overall index computed for enterprise LTE1is equal to 0.68 (in 2011) and 0.71 (in 2012) and these scores are equivalent to 6.8 and 7.1 point; for enterprise LTE2 overall index was scored 0.70 and 0.74 accordingly. Because the growth of this index was achieved when the index of financial indicators group marked growing, the growing levels of composite competitive edge indicators both for enterprise LTE1 and for enterprise LTE2 could be denoted as ultimate direction for strategic management development.

When continuing the analytical research, the measuring system of the quantitative (derivative) characteristics of composite competitive edge indicators should be accepted.

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