MULTI-CRITERIA DECISION MAKING OF MANAGEMENT EFFECTIVENESS OF CONSTRUCTION ENTERPRISES BASED ON THE SWOT AND MCDM

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Abstract. The article offers a methodology for formulating management strategies in construction enterprises. For this purpose, the SWOT (strength, weakness, opportunities and threats) analysis as an instrument for forming management strategies is recommended. As well as the best practices for formulating strategies are analysed in the article. Presented algorithm selects the most significant strategies based on the permutation method of feasible alternatives. A perspective of construction enterprises management regarding the SWOT is carried out as a basis of selecting describing the current state and the feasible future alternatives. Finally, the selected alternatives are ranked according to the permutation method of feasible alternatives.

Keywords: management, enterprises, construction, MCDM, SWOT, Operation Research.

1. Introduction

Each human’s feasible economic activities are based on generating alternatives and accessing them. Operations research encompasses a wide range of problem-solving techniques and methods applied in the pursuit of improved decision-making. There are lots of techniques that assist decision-makers to select the best alternative from the set of feasible alternatives. Work in operations research and management science may be characterized as one of three categories:

– Application of Probability, Optimization, and Dynamical systems theory;
– Modeling work that is concerned with the construction of models and solving them;
– Using models to make a practical impact no the real-world problems.

Many researchers analysed the problem of success and the importance of rational decision-making in constantly changing and risky environment (Auruskeviene et al. 2008; Zavadskas et al. 2008, Zavadskas et al. 2010). Multi-criteria decision analysis (MCDA), sometimes called multi-criteria decision making (MCDM), is a discipline of operations research aimed at supporting decision makers who are faced with making numerous and conflicting evaluations. MCDA aims at highlighting these conflicts and deriving a way to come to a compromise in a transparent process. There a number of strategies (alternatives or actions) can be ranked according a number of criteria (criteria, aspects, or dimensions). Criteria can be cardinal or ordinal.

Management is one of the most important position in economic activities. Assessment of possible management alternatives is very complicated. Banyte and Salickaite (2008) analyzed, identified and substantiate theoretically the factors that determine successful diffusion and adoption of innovation, revealing their importance for increasing competitiveness of enterprises, and stated that it is important for enterprises to seek exclusiveness by innovation to find ways that would allow increasing the probability of successful diffusion and adoption of innovation.

Ginevicius (2009), on the basis of wide investigations, declared that diversification of activities is one of the main strategies of an enterprise. Business globalization trends raise the new priorities for management theory and practice. This situation increases the need of expatriates doing international assignments and working in foreign cultural settings (Gundey 2008). Gudonavicius et al. (2009) stated that enterprise strategy formatting significantly can be improved by applying strategy planning tools, by widening dimensions that describe the types of entrepreneur, and by integrating them into a particular system.

2. SWOT for management effectiveness of construction enterprises

To operate successfully the construction enterprise must concentrate its future objectives on its strengths, while averting tendencies related to the enterprise weaknesses. Responding to internal strengths and weaknesses is therefore an essential component of the strategic management process. But success can only be achieved in this respect to the extent that one is familiar with the opportunities and threats resulting from the
external environment. The recognition of the internal strengths and weaknesses, as well as external opportunities and threats, takes place on the basis of a SWOT. SWOT is a strategic planning method used to evaluate the strengths, weaknesses, opportunities, and threats involved in a project or in a construction enterprises venture. SWOT analysis can be used in conjunction with other tools for audit and analysis (Houben et al. 1999). It is one of the widely using methods in economic activities, and involves specifying the objective of the enterprises venture or project and identifying the internal and external factors that are favourable and unfavourable to achieving that objective. Ghazinoory and Ghazinoori (2006) purposed the method for formulating government strategies for improving and strengthening national innovation systems in particular for the developing countries. There are series of scientific researches that investigates SWOT. Kaplinski (2008) identified three groups of planning techniques, and identified foundations for decision-making techniques.

Chung et al. (2009) investigated the process of developing an enterprise resource planning systems success model to guide a successful ERP implementation project and to identify success factors for ERP systems implementation and identified factors associated with the success and failure, developed success model to analyze between key factors and the success of such systems.

Ling et al. (2009) presented the study where SWOT of Vietnamese architectural, engineering and construction firms was investigated. The SWOT analysis presented in the research reveals that construction enterprises are logging behind firms from developed countries in financial capacity, experience in complex projects, and knowledge in advanced design and construction technology and management ability. To improve the competitive advantage of foreign organizations it is recommended to offer superior products and services and familiarise themselves with local culture and regulations.

Markovska et al. (2009) used SWOT analysis to investigate the sustainable development in energy sector. Its results show that most identified factors that determine innovation success in the market are attributed to the process of innovation creation and the knowledge-based framework. Krylovas and Kosareva (2008) analyzed mathematical modeling of forecasting the results of knowledge testing. Gudas (2009) presented analysis where one of the main aspects was management success. Kheirkhah et al. (2009) proposed fuzzy SWOT analysis. Lee and Lin (2008) analyzed a fuzzy quantified SWOT procedure for environmental evaluation.

The strengths and weaknesses can be found in the functional enterprises fields, or they may be a consequence of abnormal interaction between different fields. Furthermore, the strengths and the weaknesses of an aspect must be measured at different levels of the organisation at group level, at individual enterprises level or at product level.

3. The model based on the SWOT and MCDM

Every enterprise is confronted with a variety of internal and external environment which, on the one hand, can comprise potential stimulants, or, on the other hand, can compromise potential limitations as regards the performances of the enterprises or the objectives the construction enterprises wish to achieve (Ghazinoory et al. 2007). Auruskeviciene et al. (2008) identified key factors determining the development of competitive advantages within subsidiaries of international enterprises and empirically examines these factors exhibited in a sample of Lithuanian subsidiaries of international enterprises in business-to-business sector. But success can only be achieved in this respect to the extent that one is familiar with the opportunities and threats resulting from the external groups criteria.


For the development of the SWOT, the background information and the static knowledge was mostly obtained by study of the literature.

The key groups – internal and external issues: strengths and weaknesses are internal factors. Opportunities and threats are external factors. Some of the key areas to consider when identifying and evaluating strengths, weaknesses, opportunities and threats are listed in the algorithm of SWOT and MCDM for management effectiveness and are presented in the Figure 1.

The model of SWOT defines five general skills:

- Clients;
- Brands;
- Technological;
- Management;
- Production.

After SWOT of the construction enterprises then the following evaluation criterion is given to
this permutation. The best concordant ordering is having the largest value of evaluation criterion. The best alternative has to be chosen applying calculation results.

Fig. 1. The algorithm of SWOT and MCDM for management effectiveness

4. Methodology

For the solution of the problem permutation method was selected. The method was developed by Paelnick (1976). The permutation method uses Jaquet-Lagreze’s successive permutations of all possible rankings and alternatives (Hwang and Yoon 1981). When applying this MCDM method, all permutations of alternatives according to their preferability are checked and compared among themselves (Turskis 2008). With \( m \) alternatives, \( m! \) permutations are available. The algorithm of this method is given in Figure 2 (Zavadskas 1991).

Suppose a number of alternatives \( a_i \), \( i = 1, 2, \ldots, m \) have to be evaluated according to criterion \( (x_j), \ j = 1, 2, \ldots, n \).

From these \( m \) alternatives we must assign the ranks of alternatives and choose the best alternative. If we have \( m = 3 \) alternatives, then there exist \( m! = 3 \cdot 2 \cdot 1 = 6 \) permutations:

- \( \pi_{01} = a_1 \succ a_2 \succ a_3 \);
- \( \pi_{02} = a_1 \succ a_3 \succ a_2 \);
- \( \pi_{03} = a_2 \succ a_1 \succ a_3 \);
- \( \pi_{04} = a_2 \succ a_3 \succ a_1 \);
- \( \pi_{05} = a_3 \succ a_2 \succ a_1 \);
- \( \pi_{06} = a_3 \succ a_1 \succ a_2 \).

Fig. 2. Model of ordering feasible alternative solutions according to their preferability

5. Practical example for assessment of management effectiveness of construction enterprises

The management tree different enterprises were investigated. The optimal and the most pessimistic values of criteria were determined. For this reason was used SWOT analysis. Rating of feasible alternatives is performed according to following criteria, which determine strengths and opportunities. The initial decision-making matrix has been formed according to these criteria values and is presented in the Table 1. The weights \( w_j \) of criteria, presented in Table 1, were determined by application of the expert judgment method proposed by Kendall (Kendall, 1970; Turskis et al. 2006). The majority of respondents (72 %) have university education, and 28 % of respondents have college education. Next, the Kendall coefficient of concordance was calculated to test the reliability of the responses, and significance testing was based on the Chi–square distribution at the 1 % significance level.

Alternatives are rated by applying permutation method (Zavadskas 1991). Permutations and calculations of evaluation criterion are presented in the Table 2.

According to the results of Table 3, we can find that the priority of considered alternatives is \( a_1 \succ a_2 \succ a_3 \) (permutation \( \pi_i \)). The best alternative is the first alternative and the worst alternative is the third one.
Table 1. Initial decision making matrix

<table>
<thead>
<tr>
<th>Positive</th>
<th>Strengths (points)</th>
<th>Optimum</th>
<th>Weight</th>
<th>Strategy</th>
<th>Company</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria</td>
<td></td>
<td>w_j</td>
<td>Optimistic a</td>
<td>a_2</td>
<td>a_3</td>
<td></td>
</tr>
<tr>
<td>x_1: Technological skills</td>
<td>max</td>
<td>0.14</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>x_2: Leading brands</td>
<td>max</td>
<td>0.10</td>
<td>8</td>
<td>5</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>x_3: Clients relationship</td>
<td>max</td>
<td>0.06</td>
<td>7</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>x_4: Management skills</td>
<td>max</td>
<td>0.11</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>x_5: Products quality</td>
<td>max</td>
<td>0.19</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Table 2. Permutations and calculations of evaluation criterion

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Optimum</th>
<th>Weight</th>
<th>Strategy</th>
<th>Company</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>w_j</td>
<td>Optimistic a</td>
<td>a_2</td>
<td>a_3</td>
<td></td>
</tr>
<tr>
<td>x_6: Changing clients tastes</td>
<td>max</td>
<td>0.14</td>
<td>10</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>x_7: Liberalization of markets</td>
<td>max</td>
<td>0.19</td>
<td>10</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>x_8: Technological advances</td>
<td>max</td>
<td>0.04</td>
<td>10</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>x_9: Changes in government policies</td>
<td>max</td>
<td>0.03</td>
<td>6</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

\[ \pi_1 = a_1 \succ a_2 \succ a_3 \]

\[ \pi_2 = a_1 \succ a_2 \succ a_3 \]

\[ \pi_3 = a_2 \succ a_1 \succ a_3 \]

\[ \pi_4 = a_2 \succ a_1 \succ a_3 \]
MULTI-CRITERIA DECISION MAKING BASED ON THE SWOT ANALYSIS OF MANAGEMENT EFFECTIVENESS...

6. Conclusions

The algorithm of construction enterprises management effectiveness has been developed applying SWOT and MCDM methods.

The algorithm describes a long-term goal which forms a solid framework for strategic planning of construction enterprises. Following the suggested algorithm, the evaluation criteria are selected by taking into consideration the objectives and interests of the stakeholders.

The algorithm presented in this research is a feasible tool to aid in decision making for alternatives ranking, when alternatives are described by cardinal, and ordinal criteria.

The calculation results showed that the first enterprise is the best.

Table 3. Summary of calculation results

<table>
<thead>
<tr>
<th>Permutation</th>
<th>Concordance</th>
<th>Non-concordance</th>
<th>$\beta_i$ (g = 1,2,…,m!)</th>
<th>$\beta_i$,rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$\pi_1 = a_3 \succ a_1 \succ a_2$</td>
<td>0.67+0.65+0.71</td>
<td>0.44+0.48+0.58</td>
<td>2.03–1.50=0.53</td>
</tr>
<tr>
<td>2</td>
<td>$\pi_2 = a_4 \succ a_3 \succ a_2$</td>
<td>0.65+0.67+0.58</td>
<td>0.48+0.44+0.71</td>
<td>1.90–0.61=0.39</td>
</tr>
<tr>
<td>3</td>
<td>$\pi_3 = a_2 \succ a_3 \succ a_4$</td>
<td>0.44+0.71+0.65</td>
<td>0.67+0.58+0.48</td>
<td>1.80–1.73=0.07</td>
</tr>
<tr>
<td>4</td>
<td>$\pi_4 = a_3 \succ a_2 \succ a_1$</td>
<td>0.71+0.44+0.48</td>
<td>0.58+0.67+0.65</td>
<td>1.63–1.90=0.27</td>
</tr>
<tr>
<td>5</td>
<td>$\pi_5 = a_1 \succ a_3 \succ a_2$</td>
<td>0.48+0.58+0.67</td>
<td>0.65+0.71+0.44</td>
<td>1.73–1.80=0.07</td>
</tr>
<tr>
<td>6</td>
<td>$\pi_6 = a_3 \succ a_2 \succ a_1$</td>
<td>0.58+0.48+0.44</td>
<td>0.71+0.65+0.67</td>
<td>1.50–2.03=0.53</td>
</tr>
</tbody>
</table>

References


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1132