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Selection of construction enterprises management strategy based on the SWOT and multi-criteria analysis

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The paper proposes a methodology for determining management strategies in construction enterprises. For this purpose, the SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis as an instrument for formulating management strategies is recommended. The best practices for this reason are also analysed. The algorithm helps to select the most preferable strategies based on the AHP, expert judgment and permutation method of feasible alternatives. A perspective of construction enterprises management regarding the SWOT is carried out on a basis of selected description of the current state and the feasible future alternatives. Finally, the selected alternatives are ranked according to the permutation method of feasible alternatives. The case study shows the applicability of the proposed model to the real management problems solution.

Keywords: *management, strategy, enterprise, SWOT, AHP, expert judgment, permutation method, MCDM*

1. Introduction

Strategic management has the crucial importance of providing a company's long-term success. The task of strategic management can be broken down into strategic planning, implementation of strategies, and strategic control. Strategic planning is a systematic process which defines the way to guarantee the permanent accomplishment of the company's overriding goals and objectives. Strategies are long-term managerial guidelines guaranteeing the permanent accomplishment of the company's overriding goals and objectives. The strategies of a company define its future way of doing business [21].

Development of successful strategies is an essential and a complex task. Evaluation of strategies focuses mainly on existing success potentials or those to be built up within the planning period. The first approach to assessing strategic options deals with financial evaluation: calculating the net present value resulting from the investments complementing discounted cash-flow analysis.

However it fails in many cases due to the impossibility of making realistic forecasts of the long-term financial outcomes of specific strategic options. The prediction of the effects of investments to protect existing success potentials is often fraught with considerable uncertainty.

Evaluation of success potentials is possible with the help of substitute assessment criteria. These must fulfil the following two requirements [21]:

– On the one hand, it must be possible to obtain the data required for the assessment of success potentials using the substitute criteria.

– On the other hand, there should be a high probability that assessment of the success potentials using substitute criteria will in practice select the strategic option whose positive effect on long-term success is greatest. So there needs to be a well founded link between substitute criteria and company success.

A systemic approach to strategic planning is seen by many company leaders and management researchers as an essential requirement for long-term corporate success. Many companies today view strategic planning as a task of top management. Unfortunately, despite the best efforts of those responsible the results are often unsatisfactory.

It is the principal objective of this research to present an integrated system of analysis and assessment tools. One of the most important factors leading to the success of a construction is its strategy development scenario and successful application.

Many researchers investigated the problem of success and the importance of rational decision-making in constantly changing and risky environment [3, 8, 45, 58, 67, 71]. Gudonavicius et al. [23] state that enterprise strategy formulation can be improved significantly by applying strategy planning tools, by widening dimensions that describe the types of entrepreneur, and by integrating them into a particular system. A company's success depends on the successful selecting of a governance strategy. The SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis as an instrument for forming management strategies is recommended. However, these instruments indicate the direction but their support is difficult to reach a final decision. There are a number of strategies (alternatives or actions) which can be ranked according to a number of criteria (criteria, aspects, or dimensions). Criteria can be cardinal or ordinal. It can be stated that the performance evaluation and optimal selection of strategy has multilevel and multi-criteria features, so it can be regarded as Multi-Criteria Decision Analysis. Multi-criteria decision analysis (MCDA), sometimes called multi-criteria decision making (MCDM), is a discipline of operations research aimed at supporting decision makers 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. Optimization models all so must be analyzed in the future [29, 51, 54, 64–65].

2. SWOT development and solving problem in construction

In many cases SWOT analysis is a strategic planning method and can be used in conjunction with other tools for audit and analysis of an involved venture [25]. It's originated from is "SOFT" (Satisfactory, Opportunity, Fault and Threat) and came from the research conducted during 1960–1970. The SOFT analysis was presented in a seminar at Zurich in 1964, Urick and Orr changed the F to a W and called it the

SWOT. Weihrich [75–76] modified SWOT (or TOWS) into the format of a matrix, matching the internal factors (i.e. the strengths and weaknesses) of an organisation with its external factors (i.e. the opportunities and threats) to systematically generate responses that ought to be undertaken by the organisation. Since this period SWOT has been applied in many fields and has undergone numerous researches, is given in review articles [12, 14, 32].

In the considered stage the data mined by SWOT analysis are applied as criteria values for MCDM. Shinno et al. [52] applied SWOT analysis aggregated with an Analytic Hierarchy Process (AHP). Problem solution on the basis of SWOT and uncertainty was developed. Kheirkhah et al. [31] proposed fuzzy SWOT analysis. Lee and Lin [34] analysed a fuzzy quantified SWOT procedure for environmental evaluation and etc.

SWOT was applied in many fields and has undergone numerous researches [12, 14, 32]. It has been widely used in all areas of business management and strategic management aspects. SWOT analysis has been successfully used for problem solving in construction areas: Lee et al. [35] analysed strategies choices for developing countries; Xu et al. [78] applied forms of collaboration and project delivery in Chinese construction markets; Maydl et al. [41] analysed applying of steel for building constructions.

Today's research focuses on multi-stage analysis including three elements: SWOT, MCDM, and fuzzy sets theory. Celik et al. [6] used the elements in the following way: he applied axiomatic design and TOPSIS methodologies under fuzzy environment for proposing competitive strategies; Zaerpour et al. [63] suggested an innovative hybrid methodology consisting of SWOT analysis and Fuzzy Analytic Hierarchy Process (FAHP).

3. Model of enterprise management based on the SWOT analysis

The strengths and weaknesses may either be identified be in the functional enterprises fields, or may be a consequence of abnormal interaction between different fields. Furthermore, the strengths and weaknesses of an aspect must be measured at different levels of the organization: at group level, individual enterprise level or product level. 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 internal strengths and weaknesses, as well as the external opportunities and threats, is based on of a SWOT analysis. To operate successfully the construction enterprise must concentrate its future objectives on its strengths, while averting tendencies related to its weaknesses. It is one of the methods finding wide application in economic activities, involving specifying the objective of the enterprise venture or project and identifying the internal and external factors that are favourable and unfavourable to achieve that objective. Responding to internal strengths and weaknesses is therefore an essential component of the strategic management process.

The management processes of the construction enterprises are complicated and resource consuming [18]. Wrong decision making is directly concerned (outcome) with heavy expenses. For this reason, the risk in construction is very high [67]. The enterprises success evaluation attributes are selected taking into consideration the interests and goals of the stakeholders as well as the factors that have influence on the construction process efficiency. Therefore, the SWOT analysis can be used for choosing the management strategy of enterprise.

The SWOT analysis was employed to develop a new model for management effectiveness in construction enterprises. It is presented in Figure 1.

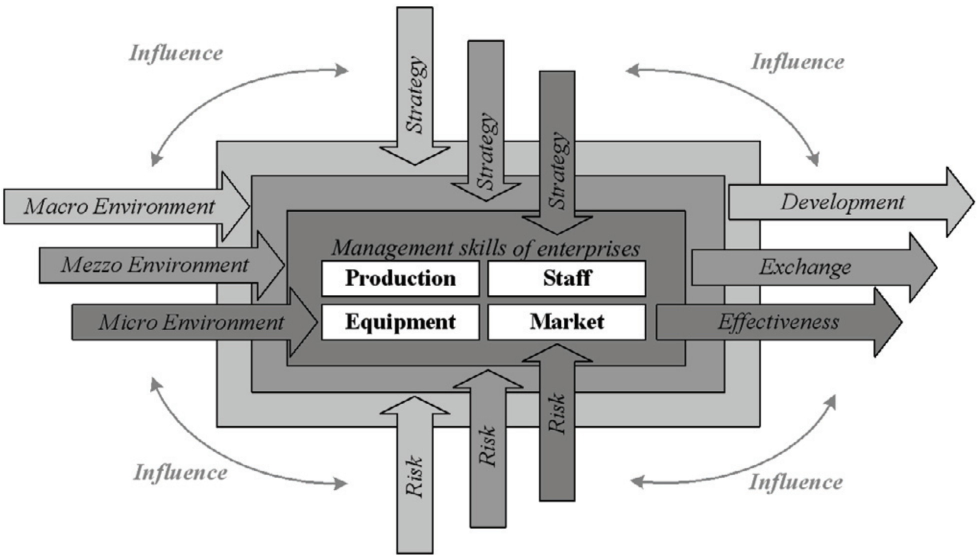

Fig. 1. The model of SWOT analysis for construction enterprise management

There are 4 general aspects of the developed model of SWOT analysis for effectiveness of management in construction enterprises:

1. Macro-, mezzo-, micro-environment analysis;
2. Determination strategy for the construction enterprise management;
3. Risk assessment;
4. Influence on the overall effectiveness, exchange and development.

Depending on the level strategy can be classified as: macro, mezzo and micro. Every enterprise is confronted with different internal and external environment which may compromise potential stimulants, or, on the other hand, can compromise potential limitations regarding the performances of the enterprises or the objectives the construction enterprises wish to achieve [16].

There are lot of SWOT analysis investigations which are applied in construction economics and management.

Ling et al. [38] presented a study where the SWOT of architectural, engineering and construction firms was investigated. The following researchers presented the SWOT analysis for the strategy in macro-level research: Chintoanu et al. [9] presented national strategy for production; Celik et al. [6] analysed competitive strategies; Ghazinoory and Kheirkhah [13] analysed strategic approach for decreasing accidents.

Lot of researches on SWOT analysis at micro- environment level is presented at last three years: Arslan and Er [2] presented successful bridge team organisation and safer operations; Ling and Gui [37], Ling et al. [38] applied SWOT for a consulting company; Celik and Peker [7] made benefit/cost analysis of production for diversification of income; Zhao et al. [74] assessed the performance and strategy of contractors in the international market; Lee [33] selected technology for changing markets; Ginevicius [19] analysed effectiveness of cooperation among industrial enterprises; Pleban-kiewicz [46] investigated prequalification of a construction contractor from Polish clients' perspective; Gudas [22] analysed management success. It is very important to assess all levels risk of environment. The SWOT analysis applying risk was presented by the following researchers: Andreica et al. [1] analysed the risk in project from managerial perspective, Bartel-Kratochvil et al. [4] analysed the success in local supply chains for products, etc.

The resolved problem influenced the effectiveness, exchange and development. Markovska et al. [39] used the SWOT analysis to investigate the sustainable development in energy sector. The results show that most identified factors determining innovation success in the market are attributed to the process of innovation creation and the knowledge-based framework. The SWOT analysis applying the above mentioned research aspects were presented by the following scientists: Diskiene et al. [10] presented a strategic management model for economic development; Dwivedi and Alavalapati [11] analysed stakeholders' perceptions in bioenergy development; Ghazinoory et al. [15] described the development of the national technology strategy; Markovska et al. [39] analysed the national energy sector for sustainable energy development; Pankratova et al. [43] proposed definition of indicators of sustainable development in the context of regional priorities. The selection of multiple criteria decision making model solve the problem under investigation is based on above presented overview. Plebankiewicz [46] investigated prequalification of a construction contractor from Polish clients' perspective; Gudas [22] analysed management success. It is very important to assess all levels risk of environment. The SWOT analysis applying risk was presented by the following researchers: Andreica et al. [1] analysed the risk in project from managerial perspective, Bartel-Kratochvil et al. [4] analysed the success in local supply chains for products, etc.

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4. Developing the model based on SWOT analysis and MCDM methods

Multiple criteria decision aid provides several powerful solution tools for confronting sorting problems [68]. For the solution of the problem considered in this paper three-stage different technique were to be developed and are presented below in Figure 2 [66]:

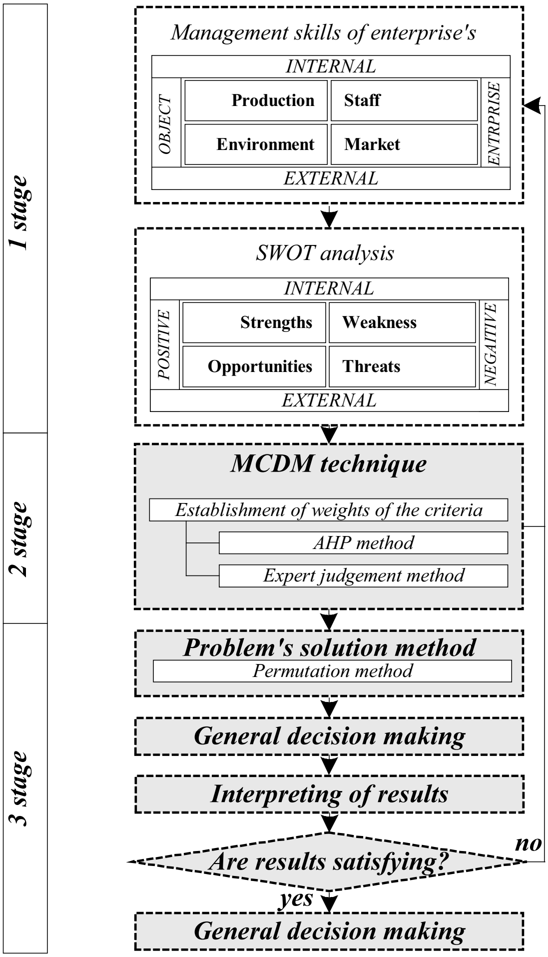

Fig. 2. The algorithm of SWOT analysis and MCDM for management effectiveness

Stage 1: Some of the key areas to consider when identifying and evaluating strengths, weaknesses, opportunities and threats are listed in the SWOT analysis;

Stage 2: Weight establishing methods, in the paper used as AHP, expert judgment techniques;

Stage 3: Problem solution method: in the paper used as permutation method.

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

The key groups are the internal and external issues: strengths and weaknesses (internal factors), and opportunities and threats (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.

4.1. Methodology for the weight establishment

The Analytic Hierarchy Process is a well-known method that is only able to rank different alternatives according to their AHP weights, accept/reject alternatives based on AHP weights. In that method, pairwise comparisons are performed by the Decision-Maker (DM) and then the pairwise comparison matrix and the eigenvector are derived to specify the weights of each parameter in the problem. The weights guide the DM in choosing the superior alternative.

The AHP was introduced by Saaty [49], but also utilized AHP in planning and anticipating for the first time [50]. He employed forward and backward process to determine logical future and then find promising control policies to attain the desired future. Application of AHP in mathematical optimization and operational research is widely practised and the weights gained by the AHP method are frequently employed as the coefficient of the objective function in linear and integer programming. The weights have also been applied for ranking multiple objectives in goal programming. The integrated AHP-ELECTRE method presented Kaya and Kahraman [28].

A number of studies have been carried out regarding AHP and its applications: Sinuany-Stern et al. [53] utilise AHP along with DEA (Date Envelopment Analysis) for ranking decision-making units. But it does eliminate the weaknesses of the above mentioned methods. In this article, AHP weights were employed as coefficients of the objective function and they were not used as the coefficients of the decision variables in constraints (technological coefficients). The literature review concerned with AHP and its applications was presented by Ho [24]. Raharjo et al. [48] presented modelling dynamic priorities in AHP using compositional data analysis. Ghazinoory et al. [17], Tiryaki and Ahlatcioglu [59] were concerned with the fuzzy AHP; Wu et al. [77] presented AHP-grey target theory systematic model. Skibniewski and Chao [56] were the first to apply the AHP method for construction problems. The AHP method is used for solving different problems e.g. Stein and Ahmad [57] constructed a measure of the magnitude of consequences component of moral intensity; Ginevicius and Podvezko

[20] evaluated the changes in economic and social development; Zavadskas et al. [70] evaluated the organisation of manufacturing and technological processes; Li and Li [36] gave the assessment of strategy under uncertainty; Vainiunas et al. [62] presented the evaluation managers for construction design projects; Tserng et al. [60] analysed risk management framework of construction projects through project life cycle; Bayraktar and Hastak [5] selected the optimal contracting strategy; Maskeliunaite et al. [40] analysed the quality of passenger railway transportation; Jaskowski et al. [27] assessed contractor selection criteria weights; Podvezko et al. [47] presented complex evaluation of contracts for construction; Sivilevicius [54] presented the interaction of transport system elements.

The expert judgment method proposed by Kendall [30] was used for determining criteria weights in the following research papers: Peldschus et al. [44] for construction site assessment, Sivilevicius [55] for determine the importance of operating asphalt mixing plant quality, Zavadskas et al. [67–69] for contractor selection.

4.2. Permutation method

The permutation method was developed by Paelnick [42]. The permutation method uses Jaquet-Lagreze‘s successive permutations of all possible rankings and alternatives [26]. When applying this MCDM method, all permutations of alternatives according to their preference ability are checked and compared among one another [61]. If there are *m* alternatives, then *m*! permutations are available. The algorithm of this method is given in Figure 3 [72–73].

Suppose a number of alternatives a_i, $i = \overline{1,m}$ to be evaluated according to criterion x_j, when $j = \overline{1,n}$. The decision making matrix is set up according to the earlier adopted forms given in Equation (1):

$$P = \begin{array}{c} \\ a_1 \\ a_2 \\ \vdots \\ a_m \end{array} \begin{array}{c} \begin{array}{cccc} x_1 & x_2 & \cdots & x_n \end{array} \\ \left| \begin{array}{cccc} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{array} \right| \end{array}; \tag{1}$$

For a solution of problems there exists an obligatory set of criteria weight coefficients q_j;

$$\sum_{j=1}^{n} q_j = 1 .$$

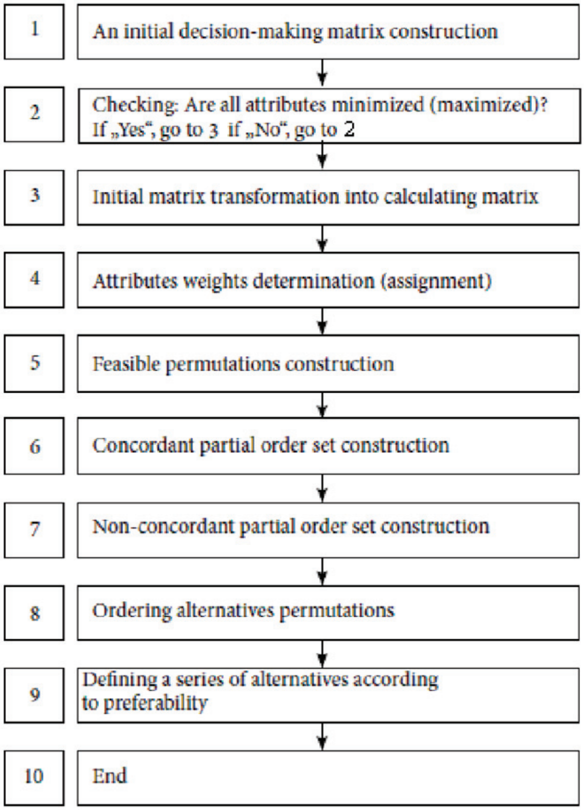

Fig. 3. Model of ordering feasible alternative solutions according to their preferability

From the given *m* alternatives the most appropriate need to be chosen, i.e., the preferability relationship must be assigned the set of alternatives which to best fit the system of values. Assume there are three total alternatives: a_1, a_2, a_3. Then, there exist six permutations in total (3! = 6):

$\pi_1 = \{a_1, a_2, a_3\}$, $\pi_2 = \{a_1, a_2, a_3\}$, $\pi_3 = \{a_1, a_2, a_3\}$,
$\pi_4 = \{a_1, a_2, a_3\}$, $\pi_5 = \{a_1, a_2, a_3\}$, $\pi_6 = \{a_1, a_2, a_3\}$.

Assume the checked order of alternatives is as follows: $\pi_5 = \{a_1, a_2, a_3\}$, then the set of the concordant partial order is $\{a_3 > a_1, a_3 > a_2, a_1 > a_2\}$ and the set of no concordant partial order is $\{a_3 < a_1, a_3 < a_2, a_1 < a_2\}$.

If in ranking (permutation) of the alternatives a partial order of $a_k > a_e$ it is evident that $x_{kj} \geq x_{ej}$ is evaluated by virtue of q_j, it is evident that $x_{ej} < x_{en}$ shows that it is evaluated by virtue of q_n.

The evaluation of ordering of the alternatives $\beta_g (g = \overline{1, m!})$, is carried out in the following way: suppose there is the *g*-th permutation $\pi_g = \{..., a_k, ..., a_e\} \forall g, g = \overline{1, m!}$, where a_k is preferable to a_e. Then, to this permutation the following estimate β_g is assigned is given as Equation (2):

$$\beta_g = \sum_{k,e=1}^{m} \sum_{j \in C_{ke}} q_j - \sum_{\substack{k,e=1 \\ k \neq e}}^{m} \sum_{j \in H_{ke}} q_j, \forall g; q = \overline{1,m!}\,, \tag{2}$$

where $C_{ke} = \{j / x_{kj} \geq x_{ej}\}, k, e = \overline{1,m}; k \neq e;$ $H_{k,e} = \{j / x_{kj} < x_{ej}\}, k, e = \overline{1,m}; k \neq e.$

Then the following evaluation criterion is given to the permutation. The best concordant ordering is the one, for which the value of the evaluation criterion is the largest [61]. The best concordant ordering is the one for which value β_g is the largest. The considered method had has been tested quite a number of times in solving practical MCDM problems.

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

Feasible alternatives' rating is performed according to the criteria which determine strengths, weaknesses, opportunities and threats. The initial decision-making matrix has been formed according to the criteria values presented in Table 1. The weights w_j of criteria, presented in Table 2–8, were determined by applying the expert judgment method [30] and AHP [49].

Table 1. Criteria set for the assessment of management effectiveness in construction enterprises

Criteria group	Criteria		Optimum
C_1 – strengths	x_1	Technology skills	max
	x_2	Leading brands	max
	x_3	Customer relationship	max
	x_4	Management skills	max
	x_5	Products quality	max
C_2 – opportunities	x_6	Changing customer tastes	max
	x_7	Liberalization of geographic markets	max
	x_8	Technological advances	max
	x_9	Changes in government policies	max
C_3 – weaknesses	x_{10}	Absence of important skills	min
	x_{11}	Weak brands	min
	x_{12}	Low customer retention	min
	x_{13}	Management	min
	x_{14}	Unviable product	min
C_4 – threats	x_{15}	Changing customer tastes	min
	x_{16}	Closing of geographic markets	min
	x_{17}	Technological advances	min
	x_{18}	Changes of government policies	min

Table 2. Establishment weights *C* for criteria groups

		Criteria group				
		C_1	C_2	C_3	C_4	
Criteria	C_1		2	3	4	
	C_2			2	3	
	C_3				2	
	C_4					$\sum$
		0.46	0.28	0.16	0.10	1
CR = 0.011						

Table 3. Establishment of criteria weights *s* in the C_1 criteria group (by applying Expert Judgment method)

Criteria				
s_1	s_2	s_3	s_4	s_5
0.23	0.17	0.10	0.18	0.32

Table 4. Establishment of criteria weights *s* in the C_2 criteria group (by applying Expert Judgment method)

Criteria			
s_6	s_7	s_8	s_9
0.35	0.47	0.10	0.08

Table 5. Establishment of criteria weights *s* in the C_3 criteria group (by applying AHP method)

		Criteria				
		s_{10}	s_{11}	s_{12}	s_{13}	s_{14}
Criteria	s_{10}		2	0.5	2	0.5
	s_{11}			0.5	1	0.5
	s_{12}				2	0.5
	s_{13}					1
	s_{14}					
$\sum = 1$		0.19	0.12	0.25	0.15	0.29
CR = 0.062						

Table 6. Establishment of criteria weights *s* in the C_4 criteria group (by applying AHP method)

		Criteria				
		s_{15}	s_{16}	s_{17}	s_{18}	
Criteria	s_{15}		1	2	3	
	s_{16}			1	2	
	s_{17}				1	
	s_{18}					$\sum$
		0.37	0.28	0.20	0.15	1
CR = 0.03						

The majority of the respondents (72%) have university education, and 28% of respondents have college education. Next, the Kendall coefficient of concordance *W* was calculated to test the reliability of the responses, and significance testing was based on the Chi–square distribution at the level of 1% significance. The alternatives are rated by applying permutation method. The process of calculations is presented in Table 9.

Table 7. Final establishment of criteria weights *w*

Criteria group									
C_1					C_2				
0.46					0.28				
Criteria									
	s_1	s_2	s_3	s_4	s_5	s_6	s_7	s_8	s_9
	0.23	0.17	0.10	0.18	0.32	0.35	0.47	0.10	0.08
w_j	0.1	0.08	0.05	0.08	0.15	0.10	0.13	0.03	0.02
Criteria group									
C_3					C_4				
0.16					0.10				
Criteria									
	s_{10}	s_{11}	s_{12}	s_{13}	s_{15}	s_{16}	s_{17}	s_{18}	
	0.19	0.12	0.25	0.15	0.37	0.28	0.20	0.15	
w_j	0.03	0.02	0.04	0.02	0.04	0.03	0.02	0.02	

There $w_j = g_k \cdot s_l$; $k = 1, \ldots, 4$; $l = 1, \ldots, 18$; if $l < 6$ then k=1; if $5 < l < 10$ then $k = 2$; if $9 < l < 15$ then $k = 3$; if $14 < l$ then $k = 2$.

Table 8. Initial decision making matrix

Criteria									
	Optimum is maximum				Optimum is minimum				
w_j		A_1	A_2	A_3	w_j		A_1	A_2	A_3
w_1	0.11	7	6	8	w_{10}	0.03	2	3	4
w_2	0.08	5	6	6	w_{11}	0.02	1	1	2
w_3	0.05	4	5	4	w_{12}	0.04	3	4	5
w_4	0.08	4	4	5	w_{13}	0.02	2	3	3
w_5	0.15	7	5	5	w_{14}	0.05	2	4	3
w_6	0.10	7	8	6	w_{15}	0.04	5	3	6
w_7	0.13	9	8	7	w_{16}	0.03	6	7	6
w_8	0.03	9	7	9	w_{17}	0.02	5	4	5
w_9	0.02	4	5	4	w_{18}	0.02	7	8	7

Table 9. Permutations and calculations of evaluation criteria

	$\pi_1 = a_1 > a_2 > a_3$		
	a_1	a_2	a_3
a_1	0	**0.11 + 0.05 + 0.08 + 0.15 + 0.13 + 0.03 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.03 + 0.02 = 0.76**	**0.05 + 0.15 + 0.1 + 0.16 + 0.03 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.04 + 0.03 + 0.02 + 0.02 = 0.78**
a_2	0.08 + 0.08 + 0.1 + 0.02 + 0.02 + 0.04 + 0.02 = 0.36	0	**0.08 + 0.05 + 0.15 + 0.1 + 0.13 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.04 + 0.02 = 0.70**
a_3	0.11 + 0.08 + 0.05 + 0.08 + 0.03 + 0.02 + 0.03 + 0.02 + 0.02 = 0.44	0.11 + 0.08 + 0.08 + 0.15 + 0.03 + 0.02 + 0.05 + 0.03 + 0.02 = 0.57	0
Evaluation criterion β_1		**0.76+0.78+0.70 = 2.24**	0.36+0.44+0.57 = 1.37

	$\pi_2 = a_1 > a_3 > a_2$		
	a_1	a_3	a_2
a_1	0	**0.05 + 0.15 + 0.1 + 0.16 + 0.03 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.04 + 0.03 + 0.02 + 0.02 = 0.78**	**0.11 + 0.05 + 0.08 + 0.15 + 0.13 + 0.03 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.03 + 0.02 = 0.76**
a_3	0.11 + 0.08 + 0.05 + 0.08 + 0.03 + 0.02 + 0.03 + 0.02 + 0.02 = 0.44	0	**0.11 + 0.08 + 0.08 + 0.15 + 0.03 + 0.02 + 0.05 + 0.03 + 0.02 = 0.57**
a_2	0.08 + 0.08 + 0.1 + 0.02 + 0.02 + 0.04 + 0.02 = 0.36	0.08 + 0.05 + 0.15 + 0.1 + 0.13 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.04 + 0.02 = 0.70	0
Evaluation criterion β_2		**0.78 + 0.76 + 0.57 = 2.11**	0.44+0.36+0.70 = 1.50
	$\pi_3 = a_2 > a_1 > a_3$		
	a_2	a_1	a_3
a_2	0	**0.08 + 0.08 + 0.1 + 0.02 + 0.02 + 0.04 + 0.02 = 0.36**	**0.08 + 0.05 + 0.15 + 0.1 + 0.13 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.04 + 0.02 = 0.70**
a_1	0.11 + 0.05 + 0.08 0.15 + 0.13 + 0.03 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.03 + 0.02 = 0.76	0	**0.05 + 0.15 + 0.1 + 0.16 + 0.03 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.04 + 0.03 + 0.02 + 0.02 = 0.78**
a_3	0.11 + 0.08 + 0.08 + 0.15 + 0.03 + 0.02 + 0.05 + 0.03 + 0.02 = 0.57	0.11 + 0.08 + 0.05 + 0.08 + 0.03 + 0.02 + 0.03 + 0.02 + 0.02 = 0.44	0
Evaluation criterion β_3		**0.36 + 0.70 + 0.78 = 1.84**	0.76 + 0.57 + 0.44 = 1.77
	$\pi_4 = a_2 > a_3 > a_1$		
	a_2	a_3	a_1
a_2	0	**0.08 + 0.05 + 0.15 + 0.1 + 0.13 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.04 + 0.02 = 0.70**	**0.08 + 0.08 + 0.1 + 0.02 + 0.02 + 0.04 + 0.02 = 0.36**
a_3	0.11 + 0.08 + 0.08 + 0.15 + 0.03 + 0.02 + 0.05 + 0.03 + 0.02 = 0.57	0	**0.11 + 0.08 + 0.05 + 0.08 + 0.03 + 0.02 + 0.03 + 0.02 + 0.02 = 0.44**
a_1	0.11 + 0.05 + 0.08 + 0.15 + 0.13 + 0.03 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.03 + 0.02 = 0.76	0.05 + 0.15 + 0.1 + 0.16 + 0.03 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.04 + 0.03 + 0.02 + 0.02 = 0.78	0
Evaluation criterion β_4		**0.70 + 0.36 + 0.44 = 1.50**	0.57 + 0.76 + 0.78 = 2.11
	$\pi_5 = a_3 > a_1 > a_2$		
	a_3	a_1	a_2
a_3	0	**0.11 + 0.08 + 0.05 + 0.08 + 0.03 + 0.02 + 0.03 + 0.02 + 0.02 = 0.44**	**0.11 + 0.08 + 0.08 + 0.15 + 0.03 + 0.02 + 0.05 + 0.03 + 0.02 = 0.57**

a_1	0.05 + 0.15 + 0.1 + 0.16 + 0.03 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.04 + 0.03 + 0.02 + 0.02 = 0.78	0	**0.11 + 0.05 + 0.08 + 0.15 + 0.13 + 0.03 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.03 + 0.02 = 0.76**
a_2	0.08 + 0.05 + 0.15 + 0.1 + 0.13 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.04 + 0.02 = 0.70	0.08 + 0.08 + 0.1 + 0.02 + 0.02 + 0.04 + 0.02 = 0.36	0
Evaluation criterion β_5		**0.44 + 0.57 + 0.76 = 1.77**	0.78 + 0.70 + 0.36 = 1.84
	$\pi_6 = a_3 > a_2 > a_1$		
	a_3	a_2	a_1
a_3	0	**0.11 + 0.08 + 0.08 + 0.15 + 0.03 + 0.02 + 0.05 + 0.03 + 0.02 = 0.57**	**0.11 + 0.08 + 0.05 + 0.08 + 0.03 + 0.02 + 0.03 + 0.02 + 0.02 = 0.44**
a_2	0.08 + 0.05 + 0.15 + 0.1 + 0.13 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.04 + 0.02 = 0.70	0	**0.08 + 0.08 + 0.1 + 0.02 + 0.02 + 0.04 + 0.02 = 0.36**
a_1	0.05 + 0.15 + 0.1 + 0.16 + 0.03 + 0.02 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.04 + 0.03 + 0.02 + 0.02 = 0.78	0.11 + 0.05 + 0.08 + 0.15 + 0.13 + 0.03 + 0.03 + 0.02 + 0.04 + 0.02 + 0.05 + 0.03 + 0.02 = 0.76	0
Evaluation criterion β_6		**0.57 + 0.44 + 0.36 = 1.37**	0.70 + 0.78 + 0.76 = 2.24

Bold font – concordance values, Regular font - non-concordance values

Table 10. Summary of calculation results

	Permutation	**Concordance**	Non-concordance	β_g	β_g rank
1	$\pi_1 = a_1 > a_2 > a_3$	**0.36 + 0.70 + 0.78 = 1.84**	0.76 + 0.57 + 0.44 = 1.77	**1.84**–1.77 = **0.07**	2
2	$\pi_2 = a_1 > a_3 > a_2$	**0.78 + 0.76 + 0.57 = 2.11**	0.44 + 0.36 + 0.70 = 1.50	**2.11**–1.50 = **0.61**	1
3	$\pi_3 = a_2 > a_1 > a_3$	**0.36 + 0.70 + 0.78 = 1.84**	0.76 + 0.57 + 0.44 = 1.77	**1.84**–1.77 = **0.07**	3
4	$\pi_4 = a_2 > a_3 > a_1$	**0.70 + 0.36 + 0.44 = 1.50**	0.57 + 0.76 + 0.78 = 2.11	**1.50**–2.11 = –0.61	4
5	$\pi_5 = a_3 > a_1 > a_2$	**0.44 + 0.57 + 0.76 = 1.77**	0.78 + 0.70 + 0.36 = 1.84	**1.77**–1.84 = –0.07	5
6	$\pi_6 = a_3 > a_2 > a_1$	**0.57 + 0.44 + 0.36 = 1.37**	0.70 + 0.78 + 0.76 = 2.24	**1.37**–2.24 = –0.87	6

According to the results of Table 10, we can find the priority of considered alternatives is (permutation π_2). It can be concluded that the best alternative is the first alternative and the worst one is the second. The provided example suggests second one presented methods sixth are feasible to manage modern construction enterprises.

6. Conclusion

The algorithm of the effectiveness of construction enterprises management has been developed by applying SWOT and MCDM methods: AHP and permutation.

The algorithm describes a long-term goal which forms a solid framework for strategic planning in 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 the research is a feasible tool to aid in decision making for alternatives ranking, when alternatives are described by cardinal and ordinal criteria. It has been found that the second enterprise is the best.

If they are numbered make sure that they are numbered consecutively. Place the numbers in parentheses flush with the right margin and level with the last line of the equation.

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Wybór strategii zarządzania przedsiębiorstwem budowlanym na podstawie metody SWOT i analizy wielokryterialnej

W pracy zaproponowano metodologie określania strategii zarządzania dla przedsiębiorstw budowlanych. W tym celu wykorzystywana jest analiza SWOT (mocnych stron,

słabych stron, szans, zagrożeń) jako narzędzie służące do formułowania odpowiedniej strategii zarządzania. Algorytm pomaga wybrać najbardziej korzystną strategie opartą na AHP, ekspertyzie i metodzie permutacyjnej dla prawdopodobnych scenariuszy. Perspektywa zarządzania przedsiębiorstwem budowlanym w ujęciu SWOT jest przeprowadzana na podstawie wybranych opisów stanu aktualnego oraz przyszłych możliwych scenariuszy. Finalnie wybrane scenariusze są oceniane w oparciu o metodę permutacyjną. Studium przypadku pokazuje możliwości zastosowania proponowanego modelu do rozwiązywania rzeczywisty problemów zarządzania.