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Research paper

Selecting the market for an international construction enterprise

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Abstract: The selection of the target market (i.e., country) is a key decision that affects the contractor's development prospects and determines success or failure in the competitive international construction environment. Despite its importance, the problem of market selection has been the subject of limited research and few tools have been proposed to help reduce the risk of making the wrong choice. Availability of several compromising/conflicting criteria, the difficulty in articulating and capturing them, and the ambiguities that may arise in their interpretation make the market selection for a construction enterprise a complicated task. This paper addresses this research gap and presents a tool based on a modified Fuzzy Group Analytic Hierarchy Process, which employs a type-2 fuzzy envelope of extended hesitant linguistic term set (EHFLTS) to aggregate the decision-maker's judgments. Using extended hesitant linguistic terms, the comparative linguistic expressions (CLEs) generated using context-free grammar (CFG) enable the decision-maker(s) to express their preferences in a way that resembles a natural language. They also help to capture the hesitation in prioritizing the available options. The process of computing with word (CWW) with CLEs is implemented through EHFLTS envelopes. To illustrate the method's principles of operation, a hypothetical case of selecting the best market for the construction enterprise is introduced.

Keywords: type-2 fuzzy envelope, extended hesitant linguistic term set, fuzzy analytic hierarchy process, market selection, construction industry

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1. Introduction

In every industry, including construction, the global economy has a major impact on corporate policy and strategic choices. Globalization offers new options for companies to develop and grow. A company can expand its operations to a foreign market that seems attractive instead of striving to raise the share in the domestic market, often at the expense of accepting riskier and less profitable projects. Apart from the anticipated immediate benefits of finding a niche market abroad, the company can expect advantages from increased resistance to local legislative or economic fluctuations, gaining new experience, and increasing its prestige.

The challenges of expanding a construction business abroad may result from, among others, varying construction "habits" that are historically determined by the availability of resources, natural conditions like the climate, and culture-specific development of the social and legal systems [1–4]. These affect the supply chains available in the host country, the preferred construction methods, procurement strategies and methods of financing construction projects, and many other aspects of economic activity in construction. Therefore, international expansion means facing internal (firm-spcific) and external (host country-specific) barriers [5–7].

However, the economic globalization is motivated by the scale of economic growth potential. Opportunities to those who decide to take the risk of doing business abroad are supported by the political commitment of countries to open their domestic markets. The initiatives of the World Trade Organization (WTO), the expansion and strengthening of voluntary unions of countries such as the European Union, the North American Free Trade Agreement (NAFTA), or the Association of Southeast Asian Nations (ASEAN) effectively unify the markets. This would not be possible without worldwide acceptance of international standards (e.g., International Standards Organization, Eurocodes, etc.), and significant technological advances in global communications and logistics [8]. The balance of threats and opportunities of doing construction business internationally is positive: in 2022, the total revenue of 250 greatest contractors was \$428.5 billion and it increased by 7.7% in relation to 2021 [9].

Interestingly, though the International Market Selection (IMS) problem is an object of numerous studies, the focus on construction contracting is very limited. Chen et al. [8] claim that this may be due to the construction contracting being a project-based industry, thus a more natural direction of research was project selection and not a broader problem of IMS. The works devoted specifically to construction IMS focused mainly on defining the criteria for foreign market selection [5, 6, 10], the search for the most beneficial entry mode from the perspective of a particular construction company [7], or were devoted to analyzing a particular target market [8, 11, 12]. Some of the aforementioned works were case studies, and they employed project-specific data and concentrated more on the project rather than market selection [13, 14].

Although the contributions of the former researches analyzing the construction IMS to the existing body of knowledge is considerable, there is still a need for a simple and user-friendly tool to support the IMS decision-making process specific to construction. This paper aims to fill this knowledge gap by presenting a multiple criteria analysis method tailored to the construction IMS problem. The proposed tool is designed to meet the needs of the decision-makers trying to conclude from generalized and uncertain information on such as the conditions of foreign markets projected into the future. Using the hesitant fuzzy sets, the authors strive to capture expert judgements expressed by linguistic terms. The comparative linguistic expressions (CLEs) based on a context-free grammar (CFG) are intended to help the experts communicate their opinions in a way close to the natural language with minimal loss of information. The tool presented in this paper is based on the well-established Analytic Hierarchy Process (AHP) and intended to support drawing from the expertise of multiple decision-makers without forcing them to rich consensus on particular aspects affecting the final decision.

The remainder of the paper is organized as follows: Section 2 is the literature review on the construction IMS. Section 3 presents the proposed method of multicriteria analysis. Section 4 illustrates application of the method to a notional case of selecting a foreign market by an originally Poland-based contractor. Section 5 contains conclusions and defines directions for future research.

2. Literature review

One of the most important aspects of business internationalization is the choice of a foreign area or country as a target market [15]. In the light of the extensive literature review [5, 8, 16], it can be concluded that the international market selection (IMS) process comprises three steps:

- screening – deciding on the set of options worth considering, so markets that, for various reasons (size, rate of growth, geographic or cultural proximity, etc.), may be attractive to a particular company,
- identification – collecting detailed information on the preselected markets that is deemed important from the point of the decision-making process, such as economic indicators, competitive analysis and barrier analysis,
- selecting – making decision to enter a particular market using information gathered in Step 2.

Very little of the literature on IMS deals with screening and identification – in fact, all the methodological tools presented in the literature deal with the third step of IMS, i.e. selection. Most items of the literature on IMS have not considered any sector/branch-specific requirements [17–20], other focused on particular, but non-construction businesses as health insurance services [21], fibreboard production [22], restaurants [23], textile sector [24], metalware production [25], hotels [26], or software industry [27]. Construction contracting has its unique features [5, 28–32] such as:

- unique design affecting the selection of materials and methods,
- unique site-related conditions (plot size, ground conditions, existing infrastructure, etc.),
- the fact that the contractor needs to manage limited resources to serve a number of projects in many locations at the same time,
- the need to coordinate operations with other contractors, subcontractors and suppliers serving the same project,
- frequently, the contractor's little influence on the product specification: the design, the selection of materials and methods,

- frequently, the contractor's little influence on the client's choice of other members of the project team,
- the need to use local suppliers instead of "trusted" ones; this is due to the perishable character of the key materials like concrete mixes, the scale of logistic costs, or the client requirements.

Due to the aforementioned features, many general IMS methods proposed for other businesses naturally aim to build relatively stable supply chains, which are inadequate for construction [5]. The literature provides few analyses of construction-specific IMS problems. One of them is the paper by Ozorhon et al. [14], putting forward a case-based reasoning model with the knowledge base fed with competitors' experience. The authors claim that the model provides grounds for reliable prediction of the user's potential competitive position in the new market. Still, the authors adopt a project-based perspective rather than focus on all anticipated operations in the new market. Similar approach was adopted by Dikmen and Birgonul [13] with their neural network model intended to prompt what data is worth gathering during international expansion and how to improve the enterprise's strategic planning process.

Chen et al. [8] conducted a regression analysis of IMS choices of 37 big Chinese construction companies in 87 countries and concluded that the choice was mainly on countries with large market potential, small cultural distance, high country risk and intensive competition. However, this method cannot be translated to the small and medium contractors, and the set of selection criteria is likely to differ from country to country.

Maqsoom [12] conducted a questionnaire survey to investigate on the Pakistani contractors' foreign market entry considerations to conclude that the size of the new market and its potential of growth are the most important criteria. A similar method of input collection was applied by Isa et al. [6] who, having surveyed Malaysian construction companies and having applied statistical regression analysis, deduced that project-specific factors have the greatest influence on the decision to explore a particular market.

Viswanathan et al. [5] identified the most important factors influencing the IMS of Indian construction companies. They drew from input obtained from 29 companies operating in 108 countries. High market potential and a low-risk rating were found to be the most important factors. The authors also deduced that the relevance of factors affecting entering a new market in developing countries differed significantly from country to country. The authors continued their investigations [7] to construct their Entry Mode Sequencing Model based on interpretative structural modeling method. However, the model presented is not intended for very experienced companies, as some of the entry modes are unsuitable for them.

Li et al. [10], considering foreign market choices of Chinese contractors, also started with the identification of criteria affecting IMS. They found that cultural differences and entry barriers do not discourage the contractors from new markets. The most important factor was institutional distance (lower formal institutional quality attracts Chinese contractors despite higher risk). In their further work, Li et al. [33] combined the IMS and entry mode selection models proving that this offers synergetic effect due to sharing information.

Previous works have mostly focused on defining the most relevant factors affecting IMS, but they seem to neglect the problem of how to translate the assessment of such factors into a decision. Thus, there are no proposals for a decision support tool dedicated to IMS for construction enterprises. This paper tries to fill this gap and presents a method of group decision support for foreign market selection of construction companies based on the fuzzy AHP method using a type-2 fuzzy envelope of Extended Hesitant Fuzzy Linguistic Term Set (EHFLTS) to aggregate the preferences of multiple decision makers.

3. The proposed IMS approach

In the proposed approach, expert linguistic expressions are aggregated using the type-2 envelope of EHFLTS sets proposed by Liu et al. [34] and using the typical FAHP introduced by Buckley [35] developed by Kahraman et al. [36].

As a first step, experts are to define two sets. One is to serve as a standardized dictionary for expressing assessments; it is a set of linguistic terms $S = \{s_0 s_g$ with a triangular membership function $T(a_L^{\alpha_i}, a_M^{\alpha_i}, a_R^{\alpha_i})$. The other is a set of the objects of comparison; here, they are the criteria $C = \{c_1, c_2, \ldots, c_r\}$ $(r \geq 2)$ important in the decision-making process. Next, each expert $d \in D$ is to provide assessments, denoted by p_{ij}^d, expressing the level of personal preferences in pairwise comparisons of the criteria importance. The assessments are to be made using the available linguistic terms and the context-free grammar as in [37]:

$V_N = \{(\textit{primary term}), (\textit{composite term}), (\textit{unary relation}),$
$(\textit{binary relation}), (\textit{conjunction})\},$
$V_T = \{\textit{lower than}, \textit{greater than}, \textit{between}, \textit{and}, s_0, s_1, \ldots, s_g\},$
$I \in V_N,$
$P = \{I ::= (\textit{primary term})|(\textit{composite term}),$
$(\textit{composite term}) ::= (\textit{unary relation})(\textit{primary term})|$
$(\textit{binary relation})(\textit{primary term})(\textit{conjunction})(\textit{primary term}),$
$(\textit{primary term}) ::= s_0|s_1|\ldots|s_g,$
$(\textit{unary relation}) ::= \textit{lower than}|\textit{greater than},$
$(\textit{binary relation}) ::= \textit{between},$
$(\textit{conjunction}) ::= \textit{and}\}.$

Then the experts' opinions need to be aggregated using the following formula:

$$p_{ij} = \bigcup_{d \in D} p_{ij}^d, \tag{3.1}$$

where p_{ij}^d – assessments expressing the level of personal preferences in pairwise comparisons of the criteria importance given by each expert $d \in D$. The aggregated opinions on the criteria importance are arrayed in matrix **C** whose elements are the EHFLTS.

Next, trapezoidal type-1 envelopes $E_{EH_S} = T(a, b, c, d)$ are created for each element of the matrix **C**. The characteristic points of the membership functions are calculated as follows [34]:

$$a = \min\{a_L^{\alpha_1}, a_M^{\alpha_1}, a_M^{\alpha_2}, \ldots, a_M^{\alpha_l}, a_R^{\alpha_l}\} = a_L^{\alpha_1}, \tag{3.2}$$

$$b = OWA_{W^2}\{a_M^{\alpha_1}, a_M^{\alpha_2}, \ldots, a_M^{\alpha_l}\}, \tag{3.3}$$

$$c = OWA_{W^1}\{a_M^{\alpha_1}, a_M^{\alpha_2}, \ldots, a_M^{\alpha_l}\}, \tag{3.4}$$

$$d = \max\{a_L^{\alpha_1}, a_M^{\alpha_1}, a_M^{\alpha_2}, \ldots, a_M^{\alpha_l}, a_R^{\alpha_l}\} = a_R^{\alpha_l} \tag{3.5}$$

where $a_L^{\alpha_1}, a_M^{\alpha_1}, a_M^{\alpha_2}, \ldots, a_M^{\alpha_l}, a_R^{\alpha_l}$ are the linguistic terms of a set of T, and OWA operators are as proposed by Filev and Yager [38].

The next step is calculating the total entropy of each EHFLTS (i.e. for each element of the matrix **C**) ; to this end, we apply the method presented by Wei et al. [39]. This is to calculate the parameter h of a trapezoidal type-2 fuzzy set $(a; b; c; d; a'; b'; c'; d'; h)$ of each EHFLTS. Once h is defined, the remaining parameters a', b', c', d' can be calculated from simple geometric relationships. Thus, each EHFLTS can be expressed as a nine-interval trapezoidal type-2 fuzzy set.

The consistency of the evaluation matrix needs to be checked. As the matrix is fuzzy, the DTraT approach described by Kahraman et al. [36] can be used:

$$DTraT = \frac{\dfrac{a+b+c+d}{4} + \dfrac{d' + h \cdot (c' + b') + a'}{4}}{2} \tag{3.6}$$

where a; b; c; d; a'; b'; c'; d'; h are the characteristic points of the nine-point type-2 fuzzy set.

From this point, the proposed method follows the steps of the classic FAHP by Buckley [35], i.e. calculating the fuzzy geometric mean and defining the fuzzy eigenvector $\tilde{\tilde{w}}_i$. The final crisp ranking w_i is obtained after the defuzzification of $\tilde{\tilde{w}}_i$ using Formula (3.6).

The procedure outlined above is to be repeated for pairwise comparisons of options (markets under consideration) against the predefined criteria, one criterion at a time.

To obtain the final vector reflecting the ranking of options in the form of type-2 interval fuzzy sets, the following formula is used:

$$\tilde{\tilde{U}}_j = \sum_{i=1}^{r} \tilde{\tilde{w}}_i \tilde{\tilde{v}}_{ij}, \quad j \in X \tag{3.7}$$

where $\tilde{\tilde{w}}_i$ and $\tilde{\tilde{v}}_i$ are the priority vectors for assessment criteria and alternatives, respectively.

The fuzzy vector $\tilde{\tilde{U}}_j$ is to be defuzzified using Formula (3.6). The result is the final ranking of alternatives against given evaluation criteria obtained in a group decision-making process using a type-2 fuzzy envelope of extended hesitant linguistic term set (EHFLTS) to aggregate the decision makers' judgments.

4. Notional example

To illustrate the application of the method presented, let us consider the following notional example. A construction company based in Poland is planning international expansion. Therefore, the company's board of directors (so the group of experts) evaluate the potential foreign markets. To this end, the board members brainstormed on the criteria of market selection and the set of countries worth considering.

In this case, five factors for evaluating the attractiveness of a given market were identified: the scale market barriers (C1), the country risk (C2), the intensity of competition (C3), the scale of cultural differences (C4), and market size (C5). The expert decided to analyze five potential new markets: Hungary (A1), Lithuania (A2), Slovakia (A3), United Kingdom (A4) and Germany (A5).

The next step was the assessment of the relative importance of the market selection criteria. The experts agreed on using a particular linguistic scale presented in Table 1 and the context-free grammar presented in Section 3.

Table 1. Linguistic scale based on HFLTSs for AHP [40]

Linguistic term	**Triangular fuzzy number**	**Symbol**
Absolutely better/greater	$(7, 9, 9)$	s_{10}
Very significantly better/greater	$(5, 7, 9)$	s_9
Significantly better/greater	$(3, 5, 7)$	s_8
Better/greater	$(1, 3, 5)$	s_7
Weakly better/greater	$(1, 1, 3)$	s_6
Equal	$(1, 1, 1)$	s_5
Weakly worse/lower	$(1/3, 1, 1)$	s_4
Worse/lower	$(1/5, 1/3, 1)$	s_3
Significantly worse/lower	$(1/7, 1/5, 1/3)$	s_2
Very significantly worse/lower	$(1/9, 1/7, 1/5)$	s_1
Absolutely worse/lower	$(1/9, 1/9, 1/7)$	s_0

Table 2. Preferences of experts regarding assessment criteria [B. (*) a. (**) means Between (*) and (**)]

Expert 1					
	C1	**C2**	**C3**	**C4**	**C5**
C1	Is s_5	B. s_5 a. s_7	Is s_5	B. s_2 a. s_5	Lower than s_3
C2	B. s_3 a. s_5	Is s_5	B. s_5 a. s_6	Is s_3	At most s_1
C3	Is s_5	B. s_4 a. s_5	Is s_5	B. s_1 a. s_4	Is s_0
C4	B. s_5 a. s_8	Is s_7	B. s_6 a. s_9	Is s_5	B. s_7 a. s_6
C5	Greater than s_7	At least s_9	Is s_{10}	B. s_4 a. s_3	Is s_5
Expert 2					
C1	Is s_5	B. s_4 a. s_6	B. s_4 a. s_6	B. s_3 a. s_5	Is s_0
C2	B. s_4 a. s_6	Is s_5	B. s_5 a. s_7	Is s_3	At most s_1
C3	B. s_4 a. s_6	B. s_3 a. s_5	Is s_5	Is s_3	Lower than s_2
C4	B. s_5 a. s_7	Is s_7	Is s_7	Is s_5	Is s_7
C5	Is s_{10}	At least s_9	Greater than s_8	Is s_3	Is s_5
Expert 3					
C1	Is s_5	Is s_5	Is s_5	Is s_2	Is s_0
C2	Is s_5	Is s_5	Is s_6	Is s_3	Is s_1
C3	Is s_5	Is s_4	Is s_5	Is s_2	Is s_1
C4	Is s_8	Is s_7	Is s_8	Is s_5	Is s_6
C5	Is s_{10}	Is s_9	Is s_9	Is s_4	Is s_5

Next, each member of the board conducted a pairwise comparison of the impact of the criteria on the attractiveness of a new market – the results of the experts' assessments are collected in Table 2.

The expert's judgements were then aggregated: Table 3 lists EHFLTS of the matrix **C** using the symbols, whereas Table 4 presents their 2-type envelopes. The outcome of this step of analysis, so the fuzzy weights expressed as the nine-point IT2FS and their final defuzzified values, are shown in Table 5.

Table 3. Matrix **C** containing HFLTSs

	C1	**C2**	**C3**	**C4**	**C5**
C1	$\{s_5\}$	$\{s_4, s_5, s_6, s_7\}$	$\{s_4, s_5, s_6\}$	$\{s_2, s_3, s_4, s_5\}$	$\{s_0, s_1, s_2\}$
C2	$\{s_3, s_4, s_5, s_6\}$	$\{s_5\}$	$\{s_5, s_6, s_7\}$	$\{s_3\}$	$\{s_0, s_1\}$
C3	$\{s_4, s_5, s_6\}$	$\{s_3, s_4, s_5\}$	$\{s_5\}$	$\{s_1, s_2, s_3, s_4\}$	$\{s_0, s_1\}$
C4	$\{s_5, s_6, s_7, s_8\}$	$\{s_7\}$	$\{s_6, s_7, s_8, s_9\}$	$\{s_5\}$	$\{s_6, s_7\}$
C5	$\{s_8, s_9, s_{10}\}$	$\{s_9, s_{10}\}$	$\{s_9, s_{10}\}$	$\{s_3, s_4\}$	$\{s_5\}$

Table 4. 2-type envelopes corresponding to the EHFLTSs of **C** matrix

	C1	**C2**	**C3**	**C4**	**C5**
C1	(1, 1, 1, 1, 1, 1, 1, 1; 1)	(0.333, 1, 1.444, 5, 0.965, 1, 1.444, 1.633; 0.053)	(0.143, 0.822, 1, 3, 0.757, 0.822, 1, 1.191; 0.095)	(0.143, 0.304, 1, 1, 0.283, 0.304, 1, 1; 0.127)	(0.111, 0.111, 0.134, 0.333, 0.111, 0.111, 0.134, 0.266; 0.662)
C2	(0.2, 0.852, 1, 3, 0.817, 0.852, 1, 1.106; 0.053)	(1, 1, 1, 1, 1, 1, 1, 1; 1)	(1, 1, 1.222, 5, 1, 1, 1.222, 1.456; 0.062)	(0.2, 0.333, 0.333, 1, 0.312, 0.333, 0.333, 0.440; 0.160)	(0.111, 0.111, 0.114, 0.2, 0.111, 0.111, 0.114, 0.184; 0.819)
C3	(0.333, 1, 1, 3, 0.984, 1, 1, 1.049; 0.025)	(0.2, 0.852, 1, 3, 0.817, 0.852, 1, 1.106; 0.053)	(1, 1, 1, 1, 1, 1, 1, 1; 1)	(0.111, 0.187, 0.481, 1, 0.166, 0.187, 0.481, 0.628; 0.282)	(0.111, 0.111, 0.114, 0.2, 0.111, 0.111, 0.114, 0.184; 0.819)
C4	(1, 1, 3.444, 7, 1, 1, 3.444, 3.896; 0.127)	(1, 3,3, 5, 2.680, 3, 3, 3.320; 0.160)	(1, 2.556, 5.444, 9, 2.116, 2.556, 5.444, 6.449; 0.282)	(1, 1, 1, 1, 1, 1, 1, 1; 1)	(1, 1, 3, 5, 1, 1, 3, 3.194; 0.097)
C5	(3, 7.880, 9, 9, 4.651, 7.880, 9, 9; 0.662)	(5, 8.800, 9, 9, 5.688, 8.800, 9, 9; 0,819)	(5, 8.800, 9, 9, 5.688, 8.800, 9, 9; 0.819)	(0.2, 0.333, 1, 1, 0.320, 0.333, 1, 1; 0.097)	(1, 1, 1, 1, 1, 1, 1, 1; 1)

Table 5. The fuzzy weights in nine-point IT2FS and defuzzified forms of the assessment criteria

	C1	C2	C3	C4	C5
$\tilde{\tilde{w}}_i$	(0.020, 0.058, 0.123, 0.390, 0.052, 0.058, 0.123, 0.176; 0.053)	(0.029, 0.060, 0.093, 0.352, 0.054, 0.060, 0.093, 0.134; 0.053)	(0.020, 0.053, 0.096, 0.318, 0.048, 0.053, 0.096, 0.135; 0.025)	(0.084, 0.180, 0.478, 1.233, 0.157, 0.180, 0.478, 0.614; 0,097)	(0.145, 0.347, 0.641, 1.057, 0.241, 0.347, 0.641, 0.751; 0.097)
w_i	9.98%	8.77%	8.10%	33.77%	39.38%

Once the criteria weights have been determined, the experts proceed to pairwise comparisons of the markets by one criterion at a time. This is done in the same manner as in the case of comparing the criteria, with the same set of linguistic terms and the same context-free grammar.

The outcome of the analysis, so the vector representing the aggregated attractiveness of each market measured according to all criteria and considering the criteria weights, is shown in Table 6. It is presented in the form of the type-2 interval fuzzy set and in a defuzzified form; the latter form is translated into a radar chart (Figure 1) for easy comparison.

Table 6. The final ranking of the alternatives in nine-point IT2FS and defuzzified forms

	A1	A2	A3	A4	A5
$\tilde{\tilde{U}}_j$	(0.012, 0.114, 0.267, 2.288, 0.074, 0.114, 0.267, 0.420; 0.062)	(0.013, 0.138, 0.343, 2.725, 0.090, 0.138, 0.343, 0.491; 0.053)	(0.014, 0.127, 0.301, 2.782, 0.085, 0.127, 0.301, 0.447; 0.025)	(0.011, 0.078, 0.238, 1.967, 0.056, 0.078, 0.238, 0.408; 0.097)	(0.024, 0.173, 0.446, 3.539, 0.111, 0.173, 0.446, 0.683; 0.053)
U_j	17.20%	20.59%	20.26%	15.00%	26.95%

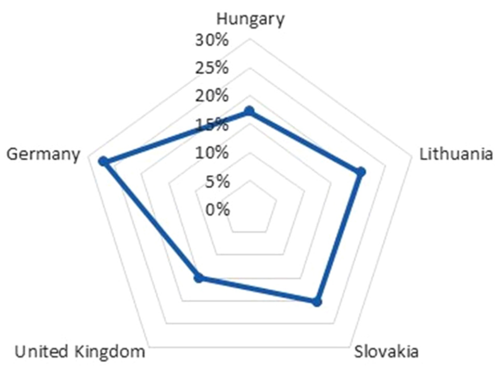

Fig. 1. The final ranking of the alternatives in the graphical form

According to the experts, the German market (A5) was the most attractive for the construction company to expand its business. The British market (A4), on the other hand, was considered to be the least attractive. In this particular case the differences in the ratings of the analyzed markets seem not big: the range does not exceed 12 percentage points.

5. Conclusions

Foreign market selection is a key decision in developing an inherently risky construction business abroad. This problem is of multicriterial nature, but the criteria cannot be brought down to a reasonable number of precisely measurable indicators. Rather than that, they are broad categories. The volatile nature of economy, politics, natural environment and other factors affecting this project-based business add to the problem's complexity: these broad categories can be assessed only qualitatively and with a large margin for uncertainties. Nevertheless, the strategic decision on taking the effort to start in a foreign market calls for an objective and structured approach and should leave traces why and how it has been made.

The proposed method of multicriteria analysis was intended to address these requirements. It assumes, first, the inclusion of a group of experts to decide what and how strongly affects the international market selection decision, and then to give judgements on the possible markets against these criteria with no need for consensus: the fact that the divergence in the opinions also carries important information. The group decision-making process aims to reach synergy of knowledge and experience of multiple experts and thus reduce the risk of making a wrong decision.

Second, the imprecise nature of the criteria and hesitance of judgements is captured by integrating the traditional FAHP method with a type-2 fuzzy envelope of EHFLTS. The proposed method rests upon concluding from pairwise comparisons (more practical than providing ready rankings of more than two objects) and the natural way of expressing the relationships between the compared imprecisely defined objects using an almost natural language: whole expressions and context-free grammar instead of individual words.

Moreover, the decision-makers do not need to be familiar with the issues involved in building the EHFLTS envelope, thereby the mathematics behind the final result. The calculations can be easily conducted by a simple computer program or even a spreadsheet.

The tools currently presented for international market selection for construction companies could be significantly affected by the development of these methods. Moreover, these methods are developing very quickly. The further development of multi-criteria decision support tools, especially those based on linguistic terms and using Context-Free Grammar and Comparative Linguistic Expressions, seems inevitable.

Although the proposed method of multicriteria analysis has its merits in analyzing the IMS problem, it is not complete as a decision-making tool. Further research should involve finding support for the first phase of IMS, i.e. the screening. The method does not prompt how to determine a reasonable number of the most promising foreign markets in a large number of possibilities on the basis of a small amount of readily available data.

The proposed method assumes that it does not matter how many times a given linguistic term has been used by decision-makers in assessing a particular pair of criteria or options. This does not seem appropriate. Therefore, a natural direction of further development of this method is enabling it to capture effect of the frequency of using a particular linguistic term on the shape of the EHFLTS.

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Wybór rynku międzynarodowego przez międzynarodowe przedsiębiorstwo budowlane

Słowa kluczowe: rozmyta obwiednia 2 typu, przemysł budowlany, rozszerzony wahający się zbiór terminów lingwistycznych, rozmyta metoda AHP, wybór rynku

Streszczenie:

Wybór rynku (kraju) jest kluczową decyzją w rozwoju przedsiębiorstwa i może zadecydować o sukcesie bądź porażce na bardzo konkurencyjnym rynku budowlanym. Pomimo swojej istotności problem wyboru rynku na który ma wejść przedsiębiorstwo był rozpatrywany w niewielkiej liczbie prac i nie ma zbyt wielu narzędzi pozwalających na dokonanie efektywnego, i zminimalizowaniu nieodpowiedniego, wyboru. Mnogość czynników, trudności w ich wyartykułowaniu i ujęciu, ich bardzo niejednoznaczna interpretacja sprawiają, że problem wyboru rynku dla przedsiębiorstwa jest zadaniem trudnym. W niniejszej pracy autorzy próbują wypełnić istniejącą w literaturze lukę i przedstawiają narzędzie do wyboru rynku dla przedsiębiorstwa budowlanego oparte na zmodyfikowanej metodzie grupowej rozmytej AHP wykorzystującej do agregacji ocen decydentów rozmytą obwiednię typu 2 rozszerzonego wahającego się rozmytego zbioru terminów lingwistycznych (ang. *Type-2 Fuzzy Envelope of Extended Hesitant Fuzzy Linguistic Term Set*). Dzięki zastosowaniu rozszerzonych wahających terminów lingwistycznych (ang. *Extended Hesitant Fuzzy Linguistic Term Set*), porównawczych wyrażeń lingwistycznych (ang. *Comparative Linguistic Expressions*) wykorzystujących gramatykę bezkontekstową (ang. *Context-free Grammar*) decydenci mają możliwość wyrażać swoje preferencje w sposób bardziej zbliżony to naturalnego języka i uwzględnić wahanie pomiędzy poszczególnymi wariantami. Proces obliczeń z użyciem słów (ang. *Computing With Words*) z wykorzystaniem porównawczych wyrażeń lingwistycznych jest realizowany dzięki rozmytej obwiedni typu 2 rozszerzonego wahającego się rozmytego zbioru terminów lingwistycznych. W celu zwizualizowania sposobu działania przedstawianej metody rozwiązano ilustrujący przykład wyboru rynku przez przedsiębiorstwo budowalne.

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