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IT2 Hybrid Decision-Making Approach to Performance Measurement of Internationalized Firms in the Baltic States

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Abstract: International activities of firms contribute to environmental socio-economic development and have a positive influence on prosperity of countries. The novelty of this study is to extend prevailing theory on the performance measurement of internationalized firms by suggesting a hybrid decision-making model based on interval type 2 fuzzy sets for the Baltic states. The integrated method is defined as the interval type-2 (IT2) decision making trial and evaluation laboratory qualitative flexible multiple criteria method (DEMATEL-QUALIFLEX). IT2 DEMATEL is used for weighting each criterion of internationalized firms and IT2 QUALIFLEX is applied for ranking the Baltic states, respectively. Within this context, six different criteria are defined for ranking the internationalized firms of the Baltic states. The ranking of all three countries enable us to conclude that Estonia demonstrates the best results of internationalized firms. Meanwhile, Latvia has the worst performance of internationalized firms. The findings are useful for decision makers responsible for supportive policies focused on the research and development (R&D) and internationalization of firms. The implications for managers lie in the awareness of necessary conditions for successful internationalization. The study extends prevailing knowledge on the performance measurement of internationalized firms and provides findings on multinational companies (MNCs) in the Baltic states' context.

Keywords: internationalized firms; performance measurement; interval type-2 fuzzy DEMATEL; interval type-2 fuzzy QUALIFLEX; Baltic states

1. Introduction

In the last few decades fundamental changes were impacted by the economic restructuring and market liberalization of Eastern European, Asian and other countries [1,2]. These changes, along with technological advances and the development of transportation, increased the numbers of internationally active firms. The international activities of the firms became an interest of public policy makers due to their contribution to employment, improvement of productivity, accumulation of foreign exchange reserves, and the prosperity of countries. From the managerial perspective, the interest in international activities lies in the long-term survival and growth of the firms. On the other hand, growing sustainable development concerns in emerging economies are forcing the firms to assume the argument that environmental integrity, social equity and economic prosperity principles are consistent with internal policies and practices [3]. Apparently, international experience of the firms contributes to the knowledge acquisition that is unavailable to the firms operating in domestic markets. For instance, multinational companies (MNCs) acquire market knowledge and technological knowledge which are significant for developing advanced environmental initiatives [4]. The collective learning of MNCs leads to new sets of sustainable development practices embracing different preferences of international communities, technologies and regulations. The recent studies confirm that internationalization of the firms is positively related to the firms' corporate responsibility across 44 countries [5]. Furthermore, international activities lead to new organizational capabilities, contributing to the integration of sustainable development practices in the firms [3]. Finally, sustainable development practices adopted by MNCs influence the environmental socio-economic development of their home countries.

Although a number of studies investigated international firms from advanced economies, recent studies have begun considering the internationalization of emerging economy firms. Emerging market multinationals (EM-MNCs) have gained a significant role both locally and internationally since 2004. Firstly, emerging markets comprise 39% of the global foreign direct investment (FDI) outflow. Secondly, in 2015 about 30% of the Fortune Global 500 were the firms of top 20 emerging economies and a total of 36 countries had the firms in this ranking [6]. The scientific discussions on EM-MNCs surround Latin American, Asian, and Middle Eastern companies [7]. Meanwhile, the investigations from the Baltic states' perspective are scant.

The Baltic states are perceived to be small and open economies. Considering size, geographical location and socio-economic development of the countries, it is common to observe the three Baltic states as one region. The collapse of the Soviet Union in the early 1990s triggered the processes of transition from a planned to a market economy. Later on, the accession of the Baltic states to the European Union impacted the internationalization level and subsequently, the growth of economies. Although changes of institutional environment were impacted by the mass privatization in the Baltic states, the observations suggest that these countries lack solid institutional foundations [8,9]. While the Global Competitiveness Report (2017) disclosed that the competitiveness ranking of Latvia (ranked 42nd) and Lithuania (ranked 40th) have improved recently, the competitiveness ranking of Estonia remained stable (ranked 32nd) [10]. In addition, the Global Competitiveness Report (2017) revealed that inefficient government bureaucracy, tax rates, tax regulations, corruption and inadequately educated workforce were the main obstacles in Latvia to doing business. Meanwhile, tax rates, inadequately educated workforce, government instability, inefficient government bureaucracy and insufficient capacity to innovate were the main challenges for business in Estonia. Finally, tax rates, inefficient government bureaucracy, restrictive labor regulations tax regulations and an inadequately educated workforce were the main issues in Lithuania [10].

Scientific studies suggest that the firms from the periphery of global factor system experience limitations of institutional environment [11]. Apparently, the location and institutional environment of the Baltic states cause the challenges for the domestic firms effectively replicate know-how developed in advanced countries. Therefore, the production of low-tech goods is the main specialization of all three countries [12]. Taking into consideration the implications of MNCs on the countries' development, the performance of internationalized firms appears to be important topic to investigate from the support and policy making perspectives. Although the investigations on international firms have considered firm-level performance as a multi-faceted phenomenon [13], scholars revealed the shortcomings of the performance measurement approaches [14]. Furthermore, scientists urge a need to move towards new frameworks that explain international performance of the firms [15]. Therefore, new approaches towards performance measurement of internationalized firms are promising.

The research provides a novel approach to the theory on the performance measurement and EM-MNCs in the following ways. Firstly, a set of criteria for measuring performance of the internationalized firms is defined by using an expert evaluation approach. Secondly, a hybrid decision-making model based on interval type 2 fuzzy sets is developed. Thirdly, the integrated method, defined as the IT2 decision making trial and evaluation laboratory qualitative flexible multiple criteria method (DEMATEL-QUALIFLEX), is used for weighting each criterion of the internationalized firms and ranking the Baltic states respectively.

The paper is structured as follows. First, the discussion on the approaches to internationalized firms and performance measurement is provided. Next section defines methodology of the research. The set of criteria, interval type-2 fuzzy sets, type-2 fuzzy DEMATEL and type-2 fuzzy QUALIFLEX approaches are presented. In addition, IT2 Fuzzy VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR) and IT2 Fuzzy technique for order preference by similarity to ideal solution (TOPSIS) are presented for the comparison. The next section presents the application of the hybrid decision model. Finally, discussion of the results and conclusions is provided.

2. Theoretical Background

2.1. Approaches to Internationalized Firms

Traditionally, international activities of firms are believed to have been interrelated with a number of benefits and thus, lead to the higher profitability. While internationalization of the firms was linked to market seeking, resource seeking and efficiency seeking motives, environmental changes in the last few decades led to the extended discussion on the other motives of the firms [16]. Off course, doing business abroad is costly as compared to the home country. Thus, some tenets how the firms should expand internationally have emerged in the scientific literature.

Scholars suggested particular sets of the firm's advantages, impacting international production [17]. The firm has to gain competitive advantage in the home market which helps to compensate the costs occurring due to operations abroad. Hence, the ownership advantage or competitive advantage stems from the firm's ability to exploit particular assets (e.g., intangible assets, technologies and etc.). A second set of advantages stems from the firm's ability to internalize the markets by integrating different stages of value-added value chain. Finally, locational advantages are shaped by institutional and production factors [17].

The proponents of the product life cycle model refers to the innovations, developed in advanced countries and later on exported in other countries [9]. The product life cycle approach implies that the innovation is produced and sold in developing countries. Later on, the production of innovations stops in advanced countries and products are produced and exported from developing countries. The growth of MNCs was interrelated to the structural shift towards technology-based goods and subsequently, increased investments into research and development (R&D). Technology transfer was initiated from the headquarters to the subsidiaries abroad [18], aiming to extend prevailing and accumulate new technological resources [19].

Considering internationalization as the incremental process of decisions, the proponents of the Uppsala model suggested sequential steps as to how the firm can be involved in international markets [20]. It appears that an individual firm gradually acquires, integrates and uses knowledge about foreign markets and thus, a lack of such knowledge can be a significant obstacle in international activities. Therefore, resource commitment to the foreign markets, market commitment, decisions to commit resources and the performance of current business activities contribute to internationalization of the firm [20]. The change aspects affect the firm and consequently, increases the market knowledge about and further commitment of the firm to the international markets. The model emphasized the relevance of psychic distance and slow internationalization process. The firms start international expansion with a less risky entry mode and expand their activities into the countries that are closer in terms of psychic distance.

Currently the theory suggests that traditional patterns of internationalization are not appropriate to emerging market (EM) multinationals [1]. Contrary to their counterparts from Western Europe and North America, these firms did not delay and were persuaded to undertake fast internationalization aiming to grow larger. It appears that these firms invest in other countries and not necessarily in the countries with similar or lower development level [7]. Furthermore, these firms expand without strong products and develop required capabilities abroad rather than in the home market. Interest in the success of EM-MNCs triggered a number of investigations [7]. Notably, two major contradicting streams have emerged in the literature. While one stream of studies argues that EM-MNCs lack knowledge-based advantage and thus, rely on locational advantages such as cheap labor and natural resources [21], another stream [22] suggests that EM-MNCs possess knowledge-based advantage developed through operations in specific and tough home markets. The latter stream is grounded on unique internal capabilities developed by the firms [1,10]. It appears that MNCs develop and exploit unique resources and capabilities which influence the internationalization and performance level of the firms. Thus, the growth of the firms is driven by their ability to create and replicate new knowledge while expanding the market. The scholars point out that EM-MNCs divert R&D investment to entrepreneurial and innovative activities which contribute to monopoly-based financial gains from internationalization [11].

Meanwhile, some scholars suggested that EM-MNCs gain knowledge-based advantage by tapping into the networks of global players, resource leverage and constant learning [1,23]. The explanation resides in the network approach to internationalization which assumes the relationships as the key assets, shaping the strategy of the firm [24]. The gradual accumulation of knowledge is gained through the relationships initially established in domestic markets and later on expanded in international markets. The network approach implies that international success of the firm depends on the position in the established network. EM-MNCs adopt the strategies and catch-up with major market leaders through leveraging of their latecomers' advantages and established partnerships with major players [25].

While scientific discussions on the phenomenon of EM-MNCs expand, two issues have been emerging. Firstly, these firms are constrained by the periphery of the global factor system [11] and thus, the location of these firms appears to be a significant disadvantage. The assumption is grounded on the idea that the location restricts the effective replication of know-how developed in advanced markets and engage in innovations. Secondly, the institutional environment of these firms is different in comparison to the developed countries and may form the constraints for international activities. This suggestion implies that some countries lack enabling institutions encouraging entrepreneurship and risk taking. However, there is a need to investigate the performance of EM-MNCs. Thus, the next sections will focus on the performance measurement of internationalized firms.

2.2. Performance Measurement of Internationalized Firms

Research in strategic management and international business considers performance as a multi-faceted phenomenon [13]. Moreover, organizational performance was investigated from different viewpoints, time periods and criteria.

The investigations carried out by Venkatraman and Ramanujam [26] have led to the performance measurement framework which included financial performance indicators (e.g., sales level, profitability and etc.) and operational performance indicators (operating efficiency, product quality and etc.). It appears that financial performance indicators demonstrate the achievement of a firm's financial objectives [13]. Meanwhile, operational performance indicators contribute to financial indicators. In addition, the framework distinguished sources of data, i.e., primary (e.g., data collected from organizations) and secondary data (e.g., data collected from public sources). These elements let scholars to suggest classification scheme which juxtapose different measurement approaches. The framework disclosed a need to conceptualize organizational performance in terms broader than financial performance [27] and include non-financial indicators. Moreover, attention was drawn to conflicting perspectives of performance dimensions, impacting either long-term growth or short-term profitability.

Although organizational performance, as the major interest, attracted a number of scholars, studies did not reach conclusive results. While some findings demonstrated positive relationships between multinationality of business and performance, other studies revealed negative relationships or no impact [28]. However, the studies acknowledged diverse and complex operationalization of performance construct. Grounded on the ideas of Venkatraman and Ramanujam [26], other studies included a level of analysis [14]. The research of Hult et al. [14] considered 96 articles, focused on performance as a dependent variable in the international context. The analysis of types of performance measure applied in the studies (i.e., financial, overall effectiveness and operational) revealed that two types were common, but comprised only 32.3%. Thus, the studies did not follow the suggestions of Venkatraman and Ramanujam [26] to consider more than one type of performance measurement. Moreover, financial and operational performance measures predominated in the studies. With respect to specific measure, 52% of studies considered sales-based measures as financial performance, 44% considered market share as operational performance and 47% considered perceived overall performance as overall effectiveness performance [14]. The majority of studies in international business rely on primary measures and the firm as a primary level of analysis. These tendencies disclosed some shortcomings of the extant researches. Firstly, the reliance on a single performance measurement lead to a narrow perspective and do not allow researchers to fully capture all performance dimensions. Secondly, in some cases management is not tended to disclose primary data and thus, the issue of the bias of subjectivity might appear.

The above insights allow us to suggest that the performance measurement requires consideration of criteria that capture various activities of internationalized firms. In addition, new approaches to the measurement are needed. Grounded on the theory of EM-MNCs, we argue that the firms from the periphery of the global factor system appear to be an interesting object for investigation. In spite of prevailing constraints, some firms from the periphery demonstrate successful international expansion. While different criteria of performance measurement are considered, multiple criteria decision-aid methods could be applied [29]. Therefore, our study extends prevailing knowledge on the performance measurement of internationalized firms and EM-MNC phenomenon. In the next sections, a hybrid decision-making model based on interval type 2 fuzzy sets, applied for the performance measurement, will be presented.

3. Materials and Methods

The above discussion on the approaches to internationalized firms and the shortcomings of the performance measurement have led to the selection of the research methods. Aiming to measure the performance of the internationalized firms in the Baltic states, a set of criteria was defined. The criteria were defined by using the expert evaluation approach and consulting with experts in international business field. The experts were selected taking into consideration their work experience in international business (more than 10 years) and education (at least master degree in business management). In such set terms, business strategists experienced in international insurance business (alternative sales channels, e-commerce, and business process management), global transports and logistics (air and sea business development), social media and public relations (PR) (digital marketing, digital media, conversion-rate oriented models, and international trade) were interviewed. Thus, we aimed to provide a comprehensive analysis by considering the opinions of these qualified experts.

The multicriteria decision making (MCDM) approach is suitable for the decision making due to complexity of socio-economic issues. While uncertainty is a common feature of preferences, fuzzy set theory appears to be a prominent theory to apply. The theory emphasizes that some problems require for clarification the linguistic evaluations in a fuzzy environment. Thus, the group decision-making with consensus or the averaged values of experts could bring more valuable solutions to evaluate the criteria and alternatives properly. Moreover, the extended method by using the interval type-2 fuzzy sets aims to manage the uncertainty in a more comprehensive way. Hence, a novel evaluation methodology by considering the hybrid multi-criteria decision based on interval type-2 fuzzy sets will be proposed.

These criteria are weighted with the help of interval type-2 fuzzy DEMATEL. On the other side, the interval type-2 fuzzy QUALIFLEX methodology is considered to rank the Baltic countries. For a robust analysis, IT2 Fuzzy VIKOR and IT2 Fuzzy TOPSIS are applied. Hence, in this section, firstly, interval type-2 fuzzy sets are explained. Secondly, necessary information is given regarding interval type-2 fuzzy DEMATEL and interval type-2 fuzzy QUALIFLEX approaches. Thirdly, IT2 Fuzzy VIKOR and IT2 Fuzzy TOPSIS are presented.

3.1. Interval Type-2 (IT2) Fuzzy Sets

Type 2 fuzzy sets are generalized for a set X to a type 1 fuzzy set on the interval $[0,1]$. In this process, a type-2 fuzzy set is named as $\widetilde{A}$. On the other hand, $\mu_{\widetilde{A}(x,u)}$ refers to the membership function [30,31]. They are detailed on Equation (1).

$$\widetilde{A}=\left\{\left((x,u),\mu_{\widetilde{A}(x,u)}\right)\middle|\forall_x\in X,\forall_u\in J_x\subseteq[0,1]\right\}\text{ or }\widetilde{A}=\int_{x\in X}\int_{u\in J_x}\mu_{\widetilde{A}}(x,u)/(x,u)\ J_x\subseteq[0,1]\tag{1}$$

In Equation (1), the membership function can take a value between 0 and 1. Additionally, with respect to the discrete universe, can be replaced with Σ. By considering these factors, can be explained in Equation (2).

$$\widetilde{A}=\int_{x\in X}\int_{u\in J_x}1/(x,u)\ J_x\subseteq[0,1]\tag{2}$$

In addition, the upper and lower trapezoidal membership functions are defined as $\widetilde{A}_i^U$ and $\widetilde{A}_i^L$. Equation (3) gives information about this condition.

$$\begin{aligned}\widetilde{A}_i&=\left(\widetilde{A}_i^U,\widetilde{A}_i^L\right)\\&=\left(\left(a_{i1}^U,a_{i2}^U,a_{i3}^U,a_{i4}^U;H_1\left(\widetilde{A}_i^U\right),H_2\left(\widetilde{A}_i^U\right)\right),\left(a_{i1}^L,a_{i2}^L,a_{i3}^L,a_{i4}^L;H_1\left(\widetilde{A}_i^L\right),H_2\left(\widetilde{A}_i^L\right)\right)\right)\end{aligned}\tag{3}$$

In Equation (3), the values of interval type-2 fuzzy set refer to the "$a_{i1}^U,a_{i2}^U,a_{i3}^U,a_{i4}^U$, $a_{i1}^L,a_{i2}^L,a_{i3}^L,a_{i4}^L$". Moreover, Equations (4)–(8) demonstrate the calculation of this process.

$$\begin{aligned}\widetilde{A}_1\oplus\widetilde{A}_2=\left(\widetilde{A}_1^U,\right.&\left.\widetilde{A}_1^L\right)\oplus\left(\widetilde{A}_2^U,\widetilde{A}_2^L\right)\\&=((a_{11}^U+a_{21}^U,a_{12}^U+a_{22}^U,a_{13}^U+a_{23}^U,a_{14}^U\\&+a_{24}^U;\min\left(H_1\left(\widetilde{A}_1^U\right),H_1\left(\widetilde{A}_2^U\right)\right),\min\left(H_2\left(\widetilde{A}_1^U\right),H_2\left(\widetilde{A}_2^U\right)\right)),(a_{11}^L\\&+a_{21}^L,a_{12}^L+a_{22}^L,a_{13}^L+a_{23}^L,a_{14}^L\\&+a_{24}^L;\min\left(H_1\left(\widetilde{A}_1^L\right),H_1\left(\widetilde{A}_2^L\right)\right),\min\left(H_2\left(\widetilde{A}_1^L\right),H_2\left(\widetilde{A}_2^L\right)\right)))\end{aligned}\tag{4}$$

$$\begin{aligned}\widetilde{A}_1\ominus\widetilde{A}_2=\left(\widetilde{A}_1^U,\right.&\left.\widetilde{A}_1^L\right)\ominus\left(\widetilde{A}_2^U,\widetilde{A}_2^L\right)\\&=((a_{11}^U-a_{24}^U,a_{12}^U-a_{23}^U,a_{13}^U-a_{22}^U,a_{14}^U\\&-a_{21}^U;\min\left(H_1\left(\widetilde{A}_1^U\right),H_1\left(\widetilde{A}_2^U\right)\right),\min\left(H_2\left(\widetilde{A}_1^U\right),H_2\left(\widetilde{A}_2^U\right)\right)),(a_{11}^L\\&-a_{24}^L,a_{12}^L-a_{23}^L,a_{13}^L-a_{22}^L,a_{14}^L\\&-a_{21}^L;\min\left(H_1\left(\widetilde{A}_1^L\right),H_1\left(\widetilde{A}_2^L\right)\right),\min\left(H_2\left(\widetilde{A}_1^L\right),H_2\left(\widetilde{A}_2^L\right)\right)))\end{aligned}\tag{5}$$

$$\begin{aligned}\widetilde{A}_1\oplus\widetilde{A}_2=\left(\widetilde{A}_1^U,\right.&\left.\widetilde{A}_1^L\right)\oplus\left(\widetilde{A}_2^U,\widetilde{A}_2^L\right)\\&=((a_{11}^U\times a_{21}^U,a_{12}^U\times a_{22}^U,a_{13}^U\times a_{23}^U,a_{14}^U\\&\times a_{24}^U;\min\left(H_1\left(\widetilde{A}_1^U\right),H_1\left(\widetilde{A}_2^U\right)\right),\min\left(H_2\left(\widetilde{A}_1^U\right),H_2\left(\widetilde{A}_2^U\right)\right)),(a_{11}^L\\&\times a_{21}^L,a_{12}^L\times a_{22}^L,a_{13}^L\times a_{23}^L,a_{14}^L\\&\times a_{24}^L;\min\left(H_1\left(\widetilde{A}_1^L\right),H_1\left(\widetilde{A}_2^L\right)\right),\min\left(H_2\left(\widetilde{A}_1^L\right),H_2\left(\widetilde{A}_2^L\right)\right)))\end{aligned}\tag{6}$$

$$k\widetilde{A}_1 = (k \times a_{11}^U, \quad k \times a_{12}^U, k \times a_{13}^U, k \times a_{14}^U; H_1\left(\widetilde{A}_1^U\right), H_2\left(\widetilde{A}_1^U\right)\Big), (k \times a_{11}^L, k \times a_{12}^L, k \times a_{13}^L, k \times a_{14}^L; H_1\left(\widetilde{A}_1^L\right), H_2\left(\widetilde{A}_1^L\right)\Big) \tag{7}$$

$$\frac{\widetilde{A}_1}{k} = \left(\frac{1}{k} \times a_{11}^U, \quad \frac{1}{k} \times a_{12}^U, \frac{1}{k} \times a_{13}^U, \frac{1}{k} \times a_{14}^U; H_1\left(\widetilde{A}_1^U\right), H_2\left(\widetilde{A}_1^U\right)\right), \left(\frac{1}{k} \times a_{11}^L, \frac{1}{k} \times a_{12}^L, \frac{1}{k} \times a_{13}^L, \frac{1}{k} \times a_{14}^L; H_1\left(\widetilde{A}_1^L\right), H_2\left(\widetilde{A}_1^L\right)\right) \tag{8}$$

3.2. IT2 Fuzzy Decision Making Trial And Evaluation Laboratory (DEMATEL)

DEMATEL represents the expression of "decision making trial and evaluation laboratory". The main purpose of this methodology is to understand the significance of the different variables. Also, the interdependence among the items can be identified by using the DEMATEL method [32,33]. This methodology can be used with interval type-2 fuzzy logic [34,35]. The evaluations of the experts are obtained and converted to internal fuzzy sets in the first step. In addition, the second step includes the generation of the initial direct relation matrix. Moreover, pairwise comparison is performed and average scores of this comparison are computed by using interval type-2 fuzzy numbers. As a result, the initial direct-relation fuzzy matrix $\widetilde{Z}$ is constructed and demonstrated in Equation (9).

$$\widetilde{Z} = \begin{bmatrix} 0 & \widetilde{z}_{12} & \cdots & \cdots & \widetilde{z}_{1n} \\ \widetilde{z}_{21} & 0 & \cdots & \cdots & \widetilde{z}_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{z}_{n1} & \widetilde{z}_{n2} & \cdots & \cdots & 0 \end{bmatrix} \tag{9}$$

In this process, average fuzzy scores are used, and they are explained in the Equation (10).

$$\widetilde{Z} = \frac{\widetilde{Z}^1 + \widetilde{Z}^2 + \widetilde{Z}^3 + \ldots \widetilde{Z}^n}{n} \tag{10}$$

Furthermore, the third step is related to the normalization of this matrix. In order to reach this objective, Equations (11)–(13) are considered.

$$\widetilde{X} = \begin{bmatrix} \widetilde{x}_{11} & \widetilde{x}_{12} & \cdots & \cdots & \widetilde{x}_{1n} \\ \widetilde{x}_{21} & \widetilde{x}_{22} & \cdots & \cdots & \widetilde{x}_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{x}_{n1} & \widetilde{x}_{n2} & \cdots & \cdots & \widetilde{x}_{nn} \end{bmatrix} \tag{11}$$

where

$$\widetilde{x}_{ij} = \frac{\widetilde{z}_{ij}}{r} = \left(\frac{Z_{\acute{a}_{ij}}}{r}, \frac{Z_{\acute{b}_{ij}}}{r}, \frac{Z_{\acute{c}_{ij}}}{r}, \frac{Z_{\acute{d}_{ij}}}{r}; H_1\left(z_{ij}^U\right), H_2\left(z_{ij}^U\right)\right), \left(\frac{Z_{\acute{e}_{ij}}}{r}, \frac{Z_{\acute{f}_{ij}}}{r}, \frac{Z_{\acute{g}_{ij}}}{r}, \frac{Z_{\acute{h}_{ij}}}{r}; H_1\left(z_{ij}^L\right), H_2\left(z_{ij}^L\right)\right) \tag{12}$$

$$r = max\left(max_{1 \le i \le n} \sum_{j=1}^{n} Z_{\acute{d}_{ij}}, max_{1 \le i \le n} \sum_{j=1}^{n} Z_{\acute{d}_{ij}}\right) \tag{13}$$

On the other hand, the total influence fuzzy matrix ($\widetilde{T}$) is calculated in the fourth step. In this process, Equations (14)–(18) are taken into the consideration.

$$X_{\acute{a}}=\begin{bmatrix} 0 & a'_{12} & \cdots & \cdots & a'_{1n} \\ a'_{21} & 0 & \cdots & \cdots & a'_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a'_{n1} & a'_{n2} & \cdots & \cdots & 0 \end{bmatrix}, \ldots, X_{\acute{h}}=\begin{bmatrix} 0 & h'_{12} & \cdots & \cdots & h'_{1n} \\ h'_{21} & 0 & \cdots & \cdots & h'_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ h'_{n1} & h'_{n2} & \cdots & \cdots & 0 \end{bmatrix} \tag{14}$$

$$\widetilde{T} = \lim_{k\to\infty} \widetilde{X} + \widetilde{X}^2 + \ldots + \widetilde{X}^k \tag{15}$$

$$\widetilde{T}=\begin{bmatrix} \widetilde{t}_{11} & \widetilde{t}_{12} & \cdots & \cdots & \widetilde{t}_{1n} \\ \widetilde{t}_{21} & \widetilde{t}_{22} & \cdots & \cdots & \widetilde{t}_{2n} \\ \vdots & \vdots & \ddots & \cdots & \cdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \widetilde{t}_{n1} & \widetilde{t}_{n2} & \cdots & \cdots & \widetilde{t}_{nn} \end{bmatrix} \tag{16}$$

$$\widetilde{t}_{ij} = \left(a''_{ij}, b''_{ij}, c''_{ij}, d''_{ij}; H_1\left(\widetilde{t}_{ij}{}^U\right), H_2\left(\widetilde{t}_{ij}{}^U\right)\right), \left(e''_{ij}, f''_{ij}, g''_{ij}, h''_{ij}; H_1\left(\widetilde{t}_{ij}{}^L\right), H_2\left(\widetilde{t}_{ij}{}^L\right)\right) \tag{17}$$

$$\left[a''_{ij}\right] = X_{\acute{a}} \times \left(I - X_{\acute{a}}\right)^{-1}, \ldots \left[h''_{ij}\right] = X_{\acute{h}} \times \left(I - X_{\acute{h}}\right)^{-1} \tag{18}$$

The final step is related to the calculation of the influence degrees. In this circumstance, the sums of all vector rows and columns of the total relation matrix are used. Equations (19) and (20) explain this process.

$$\widetilde{D}_i = \left[\sum_{j=1}^{n} \widetilde{t}_{ij}\right]_{n\times 1} \tag{19}$$

$$\widetilde{R}_i = \left[\sum_{i=1}^{n} \widetilde{t}_{ij}\right]'_{1\times n} \tag{20}$$

In Equation (19), $\widetilde{D}_i$ represents the sum of all vector rows. In addition, the sum of all vector columns is named as $\widetilde{R}_i$. By considering them, the total degree of the influence among criteria is explained with $\left(\widetilde{D}_i + \widetilde{R}_i\right)$.

To compute the weighting results of criteria, the defuzzified values are calculated by the Formulas (21)–(24).

$$Def_T = \frac{\frac{(u_U - l_U) + (\beta_U \times m_{1U} - l_U) + (\alpha_U \times m_{2U} - l_U)}{4} + l_U + \left[\frac{(u_L - l_L) + (\beta_L \times m_{1L} - l_L) + (\alpha_L \times m_{2L} - l_L)}{4} + l_L\right]}{2} \tag{21}$$

$$Def_T = T = \left[t_{ij}\right]_{n\times n}, i, j = 1, 2, \ldots, n \tag{22}$$

$$\widetilde{D}_i{}^{def} = r = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} = (r_i)_{n\times 1} = (r_1, \ldots, r_i, \ldots, r_n) \tag{23}$$

$$\widetilde{R}_i{}^{def} = y = \left[\sum_{i=1}^{n} t_{ij}\right]'_{1\times n} = (y_j)'_{1\times n} = (y_1, \ldots, y_i, \ldots, y_n) \tag{24}$$

3.3. IT2 Fuzzy Qualitative Flexible Multiple Criteria Method (QUALIFLEX)

Paelinck [36] developed the QUALIFLEX method with the aim of decision making under complex situations. It represents the "qualitative flexible multiple criteria method". This approach provides flexibility in this process. This methodology can be extended by considering interval type-2 fuzzy logic [37]. There are mainly four different steps in this analysis. Firstly, the decision matrix is generated by using decision-makers' evaluations. The details of this matrix are given on the Equation (25).

$X_{1,}\ X_2\ X_3 \ldots\ X_n$

$$\mathrm{D} = \begin{matrix} A_1 \\ A_2 \\ A_3 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} A_{11} & A_{12} & A_{13} & & \cdots & A_{1n} \\ A_{21} & A_{22} & A_{23} & & \cdots & A_{2n} \\ A_{31} & A_{32} & A_{33} & & \cdots & A_{3n} \\ \vdots & \vdots & \vdots & \ddots & & \vdots \\ A_{m1} & A_{m2} & A_{m3} & & \cdots & A_{mn} \end{bmatrix}$$

$$A_{ij} = \frac{1}{k}\left[\sum_{e=1}^{k} A_{ij}{}^{e}\right] \tag{25}$$

Furthermore, the second step is related to the calculation of the signed distance $d\left(A_{ij}, \widetilde{0}\right)$. This process is demonstrated on the Equations (26) and (27).

$$d\left(A_{ij}, \widetilde{0}\right) = \frac{1}{8}\left(a^L_{1ij} + a^L_{2ij} + a^L_{3ij} + a^L_{4ij} + 4a^U_{1ij} + 2a^U_{2ij} + 2a^U_{3ij} + 4a^U_{4ij} + 3(a^U_{2ij} + a^U_{3ij} - a^U_{1ij} - a^U_{4ij})\frac{h^L_{ij}}{h^U_{ij}}\right) \tag{26}$$

$$A_{ij} = \left[A^L_{ij}, A^U_{ij}\right] = \left[\left(a^L_{1ij}, a^L_{2ij}, a^L_{3ij}, a^L_{4ij}; h^L_{ij}\right), \left(a^U_{1ij}, a^U_{2ij}, a^U_{3ij}, a^U_{4ij}; h^U_{ij}\right)\right] \tag{27}$$

Moreover, the concordance/discordance index (I^l_j) is computed in the third step by using the Equations (28)–(31).

$$I^l_j = \sum_{A_\rho, A_\beta \in A} I^l_j(A_\rho, A_\beta) = \sum_{A_\rho, A_\beta \in A}\left(d\left(A_{\rho j}, \widetilde{0}_1\right) - d\left(A_{\beta j}, \widetilde{0}_1\right)\right) \tag{28}$$

where $A_{\rho j} = \left[A^L_{\rho j}, A^U_{\rho j}\right] = \left[\left(a^L_{1\rho j}, a^L_{2\rho j}, a^L_{3\rho j}, a^L_{4\rho j}; h^L_{\rho j}\right), \left(a^U_{1\rho j}, a^U_{2\rho j}, a^U_{3\rho j}, a^U_{4\rho j}; h^U_{\rho j}\right)\right]$ and

$$A_{\beta j} = \left[A^L_{\beta j}, A^U_{\beta j}\right] = \left[\left(a^L_{1\beta j}, a^L_{2\beta j}, a^L_{3\beta j}, a^L_{4\beta j}; h^L_{\beta j}\right), \left(a^U_{1\beta j}, a^U_{2\beta j}, a^U_{3\beta j}, a^U_{4\beta j}; h^U_{\beta j}\right)\right] \tag{29}$$

$$P_l = (\ldots, A_\rho, \ldots, A_\beta \ldots) \text{ for } l = 1, 2, \ldots, m! \tag{30}$$

On the other hand, the final step includes the calculation of the comprehensive concordance/discordance index.

$$I^l = \sum_{A_\rho, A_\beta \in A}\sum_{j=1}^{n} I^l_j(A_\rho, A_\beta).W_j = \sum_{A_\rho, A_\beta \in A}\sum_{j=1}^{n}\left(d\left(A_{\rho j}, \widetilde{0}_1\right) - d\left(A_{\beta j}, \widetilde{0}_1\right)\right).W_j \tag{31}$$

3.4. IT2 Fuzzy VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR)

VlseKriterijumska Optimizacija I Kompromisno Resenje called VIKOR was introduced by Opricovic [38]. The calculation process of IT2 fuzzy VIKOR starts with defining the decision matrix to rank the alternatives. For this purpose, averaged values are used for the decision matrix. After that, the values are defuzzified by the ranking method for the trapezoidal interval type-2 fuzzy sets as considered with the Equations (32)–(35).

$$\begin{aligned} Def(x_{ij}) = Rank\quad & (\widetilde{x}_{ij})_{m\times n} \\ & = M_1\left(\widetilde{A}^U_i\right) + M_1\left(\widetilde{A}^L_i\right) + M_2\left(\widetilde{A}^U_i\right) + M_2\left(\widetilde{A}^L_i\right) + M_3\left(\widetilde{A}^U_i\right) + M_3\left(\widetilde{A}^L_i\right) \\ & -\tfrac{1}{4}\left(S_1\left(\widetilde{A}^U_i\right) + S_1\left(\widetilde{A}^L_i\right) + S_2\left(\widetilde{A}^U_i\right) + S_2\left(\widetilde{A}^L_i\right) + S_3\left(\widetilde{A}^U_i\right) + S_3\left(\widetilde{A}^L_i\right)\right. \\ & \left. + S_4\left(\widetilde{A}^U_i\right) + S_4\left(\widetilde{A}^L_i\right)\right) + H_1\left(\widetilde{A}^U_i\right) + H_1\left(\widetilde{A}^L_i\right) + H_2\left(\widetilde{A}^U_i\right) + H_2\left(\widetilde{A}^L_i\right) \end{aligned} \tag{32}$$

$$M_p\left(\widetilde{A}_i^j\right) = \left(a_{ip}^j + a_{i(p+1)}^j\right)/2 \quad (33)$$

where $M_p\left(\widetilde{A}_i^j\right)$ is the average of the elements a_{ip}^j and $a_{i(p+1)}^j$, $1 \le p \le 3$,

$$S_q\left(\widetilde{A}_i^j\right) = \sqrt{\frac{1}{2}\sum_{k=q}^{q+1}\left(a_{ik}^j - \frac{1}{2}\sum_{k=q}^{q+1} a_{ik}^j\right)^2} \quad (34)$$

where $S_q\left(\widetilde{A}_i^j\right)$ is the standard deviation of the elements a_{iq}^j and $a_{i(q+1)}^j$, $1 \le q \le 3$,

$$S_4\left(\widetilde{A}_i^j\right) = \sqrt{\frac{1}{4}\sum_{k=1}^{4}\left(a_{ik}^j - \frac{1}{4}\sum_{k=1}^{4} a_{ik}^j\right)^2} \quad (35)$$

$H_p\left(\widetilde{A}_i^j\right)$ is the membership value of the element $a_{i(p+1)}^j$ in the trapezoidal membership function $\widetilde{A}_i^j$, $1 \le p \le 2$, $j \in \{U, L\}$ $1 \le i \le n$.

The fuzzy best value (*fj**) and worst value (f_J^-) are calculated as

$$f_J^* = \underset{i}{max}\ x_{ij}\ and\ f_J^- = \underset{i}{min}\ x_{ij} \quad (36)$$

S_i and R_i are calculated as follows

$$S_i = \sum_{i=1}^{n} w_j \frac{\left(\left|f_j^* - x_{ij}\right|\right)}{\left(\left|f_j^* - f_j^-\right|\right)} \quad (37)$$

$$R_i = \max j\left[w_j \frac{\left(\left|f_j^* - x_{ij}\right|\right)}{\left(\left|f_j^* - f_j^-\right|\right)}\right] \quad (38)$$

The value of Q_i is calculated

$$\widetilde{Q}_i = \frac{v(S_i - S^*)}{(S^- - S^*)} + (1 - v)\frac{(R_i - R^*)}{(R^- - R^*)} \quad (39)$$

where v is the maximum group utility. Two conditions called as acceptable advantage and acceptable stability should be satisfied

$$Q\left(A^{(2)}\right) - Q\left(A^{(1)}\right) \ge 1/(j-1) \quad (40)$$

$$Q\left(A^{(M)}\right) - Q\left(A^{(1)}\right) < \frac{1}{(j-1)} \quad (41)$$

where $A^{(2)}$ is the second rank of the alternatives and j is the number of alternative.

3.5. IT2 Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The technique for order preference by similarity to ideal solution (TOPSIS) is introduced by Yoon and Hwang [39]. The positive and negative ideal solutions are identified to rank the alternatives.

Firstly, the fuzzy positive-ideal solution (A^+) and fuzzy negative ideal solution (A^-) are calculated.

$$A^+ = \max(v_1, v_2, v_3, \ldots v_n);\ A^- = \min(v_1, v_2, v_3, \ldots v_n) \quad (42)$$

where v_{ij} is the weighted values of the defuzzified matrix.

After that, the values of D^+ and D^- are calculated as follows

$$D_i{}^+ = \sqrt{\sum_{i=1}^{m} (v_i - A_i{}^+)^2} \tag{43}$$

$$D_i{}^- = \sqrt{\sum_{i=1}^{m} (v_i - A_i{}^-)^2} \tag{44}$$

Finally, the closeness coefficient (CC_i) is computed as

$$CC_i = \frac{D_i^-}{D_i^+ + D_i^-} \tag{45}$$

4. Results: An Application on the Baltic States

In the application process of this study, firstly, necessary information is given regarding the details of the model. In this context, the selected criteria regarding international business performance are explained. After that, analysis results are shared in the second part of this section.

4.1. Model Construction

A hybrid decision-making model, based on interval type 2 fuzzy sets, is proposed to measure the relative importance of the criteria for the internationalized firms and to rank the performance of the internationalized firms in the Baltic states. Accordingly, the IT2 fuzzy DEMATEL approach is applied for weighting each criterion and then IT2 fuzzy QUALIFLEX, VIKOR, and TOPSIS are used for ranking the Baltic states comparatively. For this purpose, in the first process of the decision-making problem, a set of the criteria is defined to understand the tendencies as well as the impact and relation between the determinants of the international business performance. The decision makers, acting as the experts in the field of international business management, were asked to indicate the criteria of international business performance. Considering the fact that domestic MNCs in the Baltic states represent different industries, the emphasis is put on the firm-level performance instead of particular industry. The selected criteria and their definitions are presented in Table 1.

Table 1. The criteria of international business performance.

Criteria	Definition
Criterion 1: Sales performance at the cross-country level	The degree of internationalization/foreign sales as a percentage of total sales
Criterion 2: International investment policy	Increase in the foreign direct investments (FDI) of firms
Criterion 3: Research and development (R&D) spending for global innovation	Internationally competitive services and products
Criterion 4: International networking of firms	Cooperation for the business growth
Criterion 5: Globalization of distribution channels	Omni-channel potential for global marketing
Criterion 6: Transferring technology internationally	Use of technology at the multinational level

The selected criteria reflect the financial and non-financial performance of internationalized firms operating in the Baltic states. While international sales express the effectiveness of international activities [40], the degree of internationalization appears to be a common criterion to consider [26]. Internationalization-driven motives determine the strategic decisions of the firms. Thus, international investment policy of the firms from emerging markets reflects two perspectives: (1) from efficiency-seeking to market-seeking or from technology-seeking to market-seeking [2]. Meanwhile, R&D is assumed to be the internal innovation that contribute to organizational capabilities. Thus, R&D investments into new products or services represent investment in knowledge and consequently, is positively interrelated to internationalization [41]. The networking perspective perceives international networks as the significant asset of the firm. The international networking of MNCs contributes to organizational capabilities such as resource leverage and constant learning [1]. Furthermore, the development of international relationships significantly enhances the performance of the firms. While international marketing channels significantly shape the firms' strategies [42], channel design may lead to economic efficiency and profit. Finally, MNCs acquire and manage knowledge through international networks of interdependent units. Thus, the efficiency and survival of the firms depend on cross-border technology transfer of relatively tacit and idiosyncratic knowledge [19].

In the second step, the linguistic scales and fuzzy numbers are examined to evaluate each criterion and alternative. Table 2 represents the linguistic definitions and their IT2 trapezoidal fuzzy sets for the evaluation.

Table 2. Linguistic scales and interval type-2 (IT2) trapezoidal fuzzy numbers for the criteria and alternatives.

Criteria	Alternatives	IT2TrFNs
Absolutely Low (AL)	Absolutely Poor (AP)	((0.0,0.0,0.0,0.0;1.0), (0.0,0.0,0.0,0.0;1.0))
Very Low (VL)	Very Poor (VP)	((0.0075,0.0075,0.015,0.0525;0.8), (0.0,0.0,0.02,0.07;1.0))
Low (L)	Poor (P)	((0.0875,0.12,0.16,0.1825;0.8), (0.04,0.10,0.18,0.23;1.0))
Medium Low (ML)	Medium Poor (MP)	((0.2325,0.255,0.325,0.3575;0.8), (0.17,0.22,0.36,0.42;1.0))
Medium (M)	Fair (F)	((0.4025,0.4525,0.5375,0.5675;0.8), (0.32,0.41,0.58,0.65;1.0))
Medium High (MH)	Medium Good (MG)	((0.65,0.6725,0.7575,0.79;0.8), (0.58,0.63,0.80,0.86;1.0))
High (H)	Good (G)	((0.7825,0.815,0.885,0.9075;0.8), (0.72,0.78,0.92,0.97;1.0))
Very High (VH)	Very Good (VG)	((0.9475,0.985,0.9925,0.9925;0.8), (0.93,0.98,1.0,1.0;1.0))
Absolutely High (AH)	Absolutely Good (AG)	((1.0,1.0,1.0,1.0;1.0), (1.0,1.0,1.0,1.0;1.0))

Source: [37].

The third step is to provide the linguistic evaluations for each criterion and alternative. For this purpose, three decision makers are appointed to obtain their linguistic priorities for the criteria of international business performance. The decision makers also present their opinions with respect to the selected criteria for the internationalized firms in the Baltic states. Tables 3 and 4 give the evaluation results for the criteria and alternatives, respectively.

The final step is to provide the linguistic evaluations of each alternative. For that, three decision makers are appointed that are experts in the field of international business corporations for the Baltic states. Their choices are listed based on the criteria of internationalized firm performances in Table 4.

The next process continues with DEMATEL and QUALIFLEX, VIKOR, and TOPSIS based on interval type 2 sets, respectively. The analysis of the results is provided in the following section.

Table 3. Linguistic evaluations for the direct relation matrix.

	C1			C2			C3			C4			C5			C6		
	DM1	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**	**DM1**	**DM2**	**DM3**
C1	-	-	-	M	MH	MH	M	M	MH	M	H	H	H	MH	M	H	VH	H
C2	M	ML	M	-	-	-	MH	M	MH	H	M	M	H	VH	H	H	MH	H
C3	ML	M	M	M	MH	M	-	-	-	MH	H	H	ML	M	M	H	MH	MH
C4	ML	M	MH	MH	MH	M	H	H	MH	-	-	-	M	M	M	ML	M	MH
C5	ML	M	M	M	ML	M	M	MH	MH	M	M	M	-	-	-	MH	MH	M
C6	ML	ML	M	M	MH	M	M	M	MH	M	ML	ML	M	M	ML	-	-	-

Table 4. Linguistic evaluations for the decision matrix.

Criteria/Alternatives	A1 (Lithuania)			A2 (Latvia)			A3 (Estonia)		
	DM1	DM2	DM3	DM1	DM2	DM3	DM1	DM2	DM3
Sales performance at the cross-country level (C1)	MP	G	F	MP	MP	F	MP	MG	AG
International investment policy (C2)	G	G	MG	G	G	G	MG	G	AG
R&D spending for global innovation (C3)	MG	MP	G	MG	P	G	MG	MG	AG
International networking of firms (C4)	G	G	AG	G	F	G	G	G	AG
Globalization of distribution channels (C5)	MP	MG	AG	MP	MP	AG	P	G	AG
Transferring technology internationally (C6)	F	G	AG	F	F	AG	F	G	AG

4.2. Analysis of Results

The first stage of the integrated analysis is to weight the performance criteria of internationalized firms with IT2-Fuzzy DEMATEL. In the first step, the direct relation matrix has been defined and averaged values have been considered to normalize the matrix. The normalized and total relation matrices are presented in Tables 5 and 6, respectively.

Table 5. Normalized matrix.

	C1	C2	C3
C1	((0.0,0.0,0.0,0.0;1.0), (0.0,0.0,0.0,0.0;1.0))	((0.15,0.16,0.18,0.19;0.80), (0.13,0.14,0.19,0.21;1.00))	((0.13,0.14,0.16,0.17;0.80), (0.11,0.13,0.17,0.19;1.00))
C2	((0.09,0.10,0.12,0.13;0.80), (0.07,0.09,0.13,0.15;1.00))	((0.0,0.0,0.0,0.0;1.0), (0.0,0.0,0.0,0.0;1.0))	((0.15,0.16,0.18,0.19;0.80), (0.13,0.14,0.19,0.21;1.00))
C3	((0.09,0.10,0.12,0.13;0.80), (0.07,0.09,0.13,0.15;1.00))	((0.13,0.14,0.16,0.17;0.80), (0.11,0.13,0.17,0.19;1.00))	((0.0,0.0,0.0,0.0;1.0), (0.0,0.0,0.0,0.0;1.0))
C4	((0.11,0.12,0.14,0.15;0.80), (0.09,0.11,0.15,0.17;1.00))	((0.15,0.16,0.18,0.19;0.80), (0.13,0.14,0.19,0.21;1.00))	((0.19,0.20,0.22,0.23;0.80), (0.18,0.19,0.23,0.24;1.00))
C5	((0.09,0.10,0.12,0.13;0.80), (0.07,0.09,0.13,0.15;1.00))	((0.09,0.10,0.12,0.13;0.80), (0.07,0.09,0.13,0.15;1.00))	((0.15,0.16,0.18,0.19;0.80), (0.13,0.14,0.19,0.21;1.00))
C6	((0.08,0.08,0.10,0.11;0.80), (0.06,0.07,0.11,0.13;1.00))	((0.13,0.14,0.16,0.17;0.80), (0.11,0.13,0.17,0.19;1.00))	((0.13,0.14,0.16,0.17;0.80), (0.11,0.13,0.17,0.19;1.00))
	C4	**C5**	**C6**
C1	((0.17,0.18,0.20,0.21;0.80), (0.15,0.17,0.21,0.22;1.00))	((0.16,0.17,0.19,0.20;0.80), (0.14,0.16,0.20,0.22;1.00))	((0.22,0.23,0.24,0.24;0.80), (0.21,0.22,0.25,0.26;1.00))
C2	((0.14,0.15,0.17,0.18;0.80), (0.12,0.14,0.18,0.20;1.00))	((0.22,0.23,0.24,0.24;0.80), (0.21,0.22,0.25,0.26;1.00))	((0.19,0.20,0.22,0.23;0.80), (0.18,0.19,0.23,0.24;1.00))
C3	((0.19,0.20,0.22,0.23;0.80), (0.18,0.19,0.23,0.24;1.00))	((0.09,0.10,0.12,0.13;0.80), (0.07,0.09,0.13,0.15;1.00))	((0.18,0.19,0.21,0.22;0.80), (0.16,0.18,0.22,0.23;1.00))
C4	((0.0,0.0,0.0,0.0;1.0), (0.0,0.0,0.0,0.0;1.0))	((0.10,0.12,0.14,0.15;0.80), (0.08,0.11,0.15,0.17;1.00))	((0.11,0.12,0.14,0.15;0.80), (0.09,0.11,0.15,0.17;1.00))
C5	((0.10,0.12,0.14,0.15;0.80), (0.08,0.11,0.15,0.17;1.00))	((0.0,0.0,0.0,0.0;1.0), (0.0,0.0,0.0,0.0;1.0))	((0.15,0.16,0.18,0.19;0.80), (0.13,0.14,0.19,0.21;1.00))
C6	((0.08,0.08,0.10,0.11;0.80), (0.06,0.07,0.11,0.13;1.00))	((0.09,0.10,0.12,0.13;0.80), (0.07,0.09,0.13,0.15;1.00))	((0.0,0.0,0.0,0.0;1.0), (0.0,0.0,0.0,0.0;1.0))

Table 6. Total relation matrix.

	C1	C2	C3
C1	((0.19,0.26,0.54,0.74;0.80), (0.11,0.19,0.84,2.48;1.00))	((0.39,0.48,0.83,1.08;0.80), (0.27,0.38,1.21,3.18;1.00))	((0.41,0.51,0.89,1.16;0.80), (0.28,0.41,1.30,3.43;1.00))
C2	((0.27,0.34,0.62,0.83;0.80), (0.17,0.26,0.92,2.52;1.00))	((0.25,0.33,0.65,0.89;0.80), (0.14,0.24,1.01,2.90;1.00))	((0.42,0.51,0.88,1.14;0.80), (0.29,0.41,1.27,3.33;1.00))
C3	((0.25,0.32,0.58,0.77;0.80), (0.15,0.24,0.86,2.36;1.00))	((0.34,0.42,0.74,0.97;0.80), (0.23,0.33,1.08,2.87;1.00))	((0.26,0.34,0.66,0.91;0.80), (0.15,0.25,1.02,2.95;1.00))
C4	((0.27,0.33,0.60,0.79;0.80), (0.17,0.26,0.88,2.38;1.00))	((0.35,0.43,0.75,0.98;0.80), (0.24,0.34,1.09,2.89;1.00))	((0.42,0.50,0.85,1.09;0.80), (0.30,0.41,1.21,3.15;1.00))
C5	((0.22,0.29,0.53,0.71;0.80), (0.14,0.22,0.80,2.19;1.00))	((0.28,0.35,0.65,0.86;0.80), (0.17,0.27,0.96,2.64;1.00))	((0.35,0.43,0.75,0.98;0.80), (0.24,0.34,1.09,2.90;1.00))
C6	((0.20,0.25,0.48,0.64;0.80), (0.12,0.19,0.71,2.00;1.00))	((0.28,0.35,0.62,0.82;0.80), (0.19,0.28,0.91,2.45;1.00))	((0.31,0.38,0.67,0.89;0.80), (0.20,0.30,0.99,2.65;1.00))
	C4	**C5**	**C6**
C1	((0.42,0.51,0.87,1.12;0.80), (0.30,0.41,1.25,3.25;1.00))	((0.40,0.50,0.84,1.09;0.80), (0.28,0.40,1.21,3.17;1.00))	((0.52,0.62,1.01,1.29;0.80), (0.38,0.51,1.43,3.65;1.00))
C2	((0.38,0.47,0.82,1.06;0.80), (0.26,0.38,1.18,3.12;1.00))	((0.43,0.52,0.85,1.09;0.80), (0.33,0.43,1.20,3.09;1.00))	((0.48,0.58,0.96,1.23;0.80), (0.35,0.47,1.37,3.52;1.00))
C3	((0.39,0.48,0.90,1.03;0.80), (0.29,0.39,1.14,2.96;1.00))	((0.31,0.39,0.71,0.93;0.80), (0.19,0.30,1.04,2.82;1.00))	((0.43,0.52,0.89,1.14;0.80), (0.31,0.42,1.27,3.30;1.00))
C4	((0.24,0.31,0.62,0.85;0.80), (0.14,0.23,0.96,2.77;1.00))	((0.32,0.41,0.72,0.95;0.80), (0.21,0.32,1.06,2.84;1.00))	((0.39,0.48,0.84,1.10;0.80), (0.26,0.38,1.23,3.26;1.00))
C5	((0.30,0.38,0.68,0.88;0.80), (0.18,0.28,1.00,2.70;1.00))	((0.19,0.26,0.54,0.74;0.80), (0.11,0.19,0.84,2.49;1.00))	((0.37,0.46,0.80,1.04;0.80), (0.26,0.37,1.15,3.05;1.00))
C6	((0.25,0.32,0.60,0.79;0.80), (0.15,0.24,0.89,2.45;1.00))	((0.26,0.33,0.60,0.79;0.80), (0.16,0.25,0.88,2.40;1.00))	((0.22,0.29,0.58,0.80;0.80), (0.12,0.21,0.90,2.63;1.00))

The following step aims to construct the impact degrees of each criterion. For this purpose, all the vector rows and columns of the total relation matrix have been computed for weighting the criteria and the weight results are represented in Table 7. According to the results, Globalization of distribution channels (C5) is the weakest important criteria in the criterion set, while R&D spending for global innovation (C3) has the highest importance relatively.

Table 7. Impact degrees and weights of the criteria.

Criteria	$(\widetilde{D}_i+\widetilde{R}_i)$	Weights
C1	((3.73,4.67,8.33,10.98;0.80), (2.48,3.67,12.25,33.08;1.00))	0.160
C2	((4.11,5.11,9.02,11.83;0.80), (2.78,4.04,13.21,35.41;1.00))	0.173
C3	((4.14,5.13,9.08,11.91;0.80), (2.80,4.05,13.30,35.67;1.00))	0.174
C4	((3.96,4.93,8.75,11.50;0.80), (2.66,3.89,12.84,34.54;1.00))	0.168
C5	((3.62,4.58,8.21,10.82;0.80), (2.38,3.58,12.10,32.78;1.00))	0.158
C6	((3.91,4.86,8.61,11.33;0.80), (2.63,3.83,12.64,33.98;1.00))	0.166

The second stage of the analysis aims to rank the alternatives defined for the Baltic states by using IT2-Fuzzy QUALIFLEX, VIKOR, and TOPSIS comparatively. The first step of this stage is to construct the fuzzy decision matrix with the averaged fuzzy evaluations provided from the decision makers. Table 8 shows the decision matrix.

Table 8. Fuzzy Decision Matrix.

	A1	A2	A3
C1	((0.47,0.51,0.58,0.61;0.80), (0.40,0.47,0.62, 0.68;1.00))	((0.29,0.32,0.40,0.43;0.80), (0.22,0.28,0.43,0.50;1.00))	((0.63,0.64,0.69,0.72;0.80), (0.58,0.62,0.72,0.76;1.00))
C2	((0.74,0.77,0.84,0.87;0.80), (0.67,0.73,0.88,0.93;1.00))	((0.78,0.82,0.89,0.91;0.80), (0.72,0.78,0.92,0.97;1.00))	((0.81,0.83,0.88,0.90;0.80), (0.77,0.80,0.91,0.94;1.00))
C3	((0.56,0.58,0.66,0.69;0.80), (0.49,0.54,0.69,0.75;1.00))	((0.51,0.54,0.60,0.63;0.80), (0.45,0.50,0.63,0.69;1.00))	((0.77,0.78,0.84,0.86;0.80), (0.72,0.75,0.87,0.91;1.00))
C4	((0.86,0.88,0.92,0.94;0.80), (0.81,0.85,0.95,0.98;1.00))	((0.66,0.69,0.77,0.79;0.80), (0.59,0.66,0.81,0.86;1.00))	((0.86,0.88,0.92,0.94; 0.80), (0.81,0.85,0.95,0.98;1.00))
C5	((0.63,0.64,0.69,0.72; 0.80), (0.58,0.62,0.72,0.76;1.00))	((0.49,0.50,0.55,0.57;0.80), (0.45,0.48,0.57,0.61;1.00))	((0.62,0.65,0.68,0.70;0.80), (0.59,0.63,0.70,0.73;1.00))
C6	((0.73,0.76,0.81,0.83; 0.80), (0.68,0.73,0.83,0.87;1.00))	((0.60,0.64,0.69,0.71;0.80), (0.55,0.61,0.72,0.77;1.00))	((0.73,0.76,0.81,0.83;0.80), (0.68,0.73,0.83,0.87;1.00))

The signed distance $d\left(A_{ij},\widetilde{0}_1\right)$ for each $\left(A_{ij}\right)$ in the decision matrix has been assigned to calculate the concordance/discordance index and the signed distance results are seen in Table 9.

Table 9. Signed distance $d\left(A_{ij},\widetilde{0}_1\right)$

	A1	A2	A3
C1	1.088	0.717	1.339
C2	1.609	1.697	1.710
C3	1.238	1.136	1.622
C4	1.798	1.459	1.798
C5	1.339	1.056	1.325
C6	1.560	1.322	1.560

6 permutations of the ranking for the alternatives have been provided as $P_1 = (A_1,A_2,A_3)$, $P_2 = (A_1,A_3,A_2)$, $P_3 = (A_2,A_1,A_3)$, $P_4 = (A_2,A_3,A_1)$, $P_5 = (A_3,A_1,A_2)$, $P_6 = (A_3,A_2,A_1)$. And, the comprehensive index results for each pair of alternatives in the permutation have been defined in Table 10.

Table 10. Comprehensive concordance/discordance index.

P_1	$I_j^1(A_1, A_2)$	$I_j^1(A_1, A_3)$	$I_j^1(A_2, A_3)$	I^1	$d\left(I^1, \widetilde{0}_1\right)$
	((4.07,5.59,10.91,14.59;0.80), (0.30,3.86,16.34,44.75;1.00))	((−8.48,−6.43,−3.54,−2.79;0.80), (−25.56,−9.47,−2.71,−1.51;1.00))	((−22.29,−16.94,−9.53,−7.64;0.80), (−67.00,−24.88,−7.50,−5.11;1.00))	((−26.70,−17.78,−2.16,4.17;0.80), (−92.27,−30.50,6.13;38.13;1.00))	−29.54
P_2	$I_j^2(A_1, A_3)$	$I_j^2(A_1, A_2)$	$I_j^2(A_3, A_2)$	I^2	$d\left(I^2, \widetilde{0}_1\right)$
	((−8.48,−6.43,−3.54,−2.79;0.80), (−25.56,−9.47,−2.71,−1.51;1.00))	((4.07,5.59,10.91,14.59;0.80), (0.30,3.86,16.34,44.75;1.00))	((7.64,9.53,16.94,22.29;0.80), (5.11,7.50,24.88,67.00;1.00))	((3.22,8.69,24.31,34.09;0.80), (−20.15,1.88,38.51,110.24;1.00))	49.02
P_3	$I_j^3(A_2, A_1)$	$I_j^3(A_2, A_3)$	$I_j^3(A_1, A_3)$	I^3	$d\left(I^3, \widetilde{0}_1\right)$
	((−14.59,−10.91,−5.59,−4.07;0.80), (−44.75,−16.34,−3.86,−0.30;1.00))	((−22.29,−16.94,−9.53,−7.64;0.80), (−67.00,−24.88,−7.50,−5.11;1.00))	((−8.48,−6.43,−3.54,−2.79;0.80), (−25.56,−9.47,−2.71,−1.51;1.00))	((−45.35,−34.28,−18.66,−14.49;0.80), (−137.31,−50.69,−14.07,−6.92;1.00))	−78.56
P_4	$I_j^4(A_2, A_3)$	$I_j^4(A_2, A_1)$	$I_j^4(A_3, A_1)$	I^4	$d\left(I^4, \widetilde{0}_1\right)$
	((−22.29,−16.94,−9.53,−7.64;0.80), (−67.00,−24.88,−7.50,−5.11;1.00))	((−14.59,−10.91,−5.59,−4.07;0.80), (−44.75,−16.34,−3.86,−0.30; 1.00))	((4.71,4.51,5.46,6.56;0.80), (9.62,4.99,7.20,17.44;1.00))	((−32.16,−23.34,−9.66,−5.14;0.80), (−102.13,−36.23,−4.16,12.03;1.00))	−49.02
P_5	$I_j^5(A_3, A_1)$	$I_j^5(A_3, A_2)$	$I_j^5(A_1, A_2)$	I^5	$d\left(I^5, \widetilde{0}_1\right)$
	((2.79,3.54,6.43,8.48;0.80), (1.51,2.71,9.47,25.56;1.00))	((7.64,9.53,16.94,22.29;0.80), (5.11,7.50,24.88,67.00;1.00))	((4.07,5.59,10.91,14.59;0.80), (0.30,3.86,16.34,44.75;1.00))	((14.49,18.66,34.28,45.35;0.80), (6.92,14.07,50.69,137.31;1.00))	78.56
P_6	$I_j^6(A_3, A_2)$	$I_j^6(A_3, A_1)$	$I_j^6(A_2, A_1)$	I^6	$d\left(I^6, \widetilde{0}_1\right)$
	((7.64,9.53,16.94,22.29;0.80), (5.11,7.50,24.88,67.00;1.00))	((2.79,3.54,6.43,8.48;0.80), (1.51,2.71,9.47,25.56;1.00))	((−14.59,−10.91,−5.59,−4.07;0.80), (−44.75, −16.34,−3.86,−0.30;1.00))	((−4.17,2.16,17.78,26.70;0.80), (−38.13,−6.13,30.50,92.27;1.00))	29.54

The comprehensive concordance/discordance index with the maximum value is the optimal ranking order in a set of permutation for the alternatives. For that, P_5 has the best index value and optimal ranking order as A3 (Estonia), A1 (Lithuania) and A2 (Latvia) respectively. Considering the performance of internationalized firms, Estonia demonstrates the best results among all three Baltic states. Meanwhile, Latvia demonstrates the worst results. Additionally, for the robustness check, the analysis results of IT2 Fuzzy QUALIFLEX have been compared to the results of IT2 Fuzzy VIKOR and IT2 Fuzzy TOPSIS, respectively. Table 11 represents the values of S_i, R_i, and Q_i as well as ranking results for the alternatives.

Table 11. Analysis results by using IT2 Fuzzy VlseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR).

	S_i	R_i	Q_i	**Ranking**
A1	0.361	0.173	0.685	2
A2	0.827	0.174	1.000	3
A3	0.074	0.074	0.000	1

Table 12 illustrates the analysis results of IT2 Fuzzy TOPSIS and the details are seen below.

Table 12. Analysis Results by using IT2 Fuzzy technique for order preference by similarity to ideal solution (TOPSIS).

	D^+	D^-	C_i	**Ranking**
A1	0.215	0.319	0.598	2
A2	0.453	0.067	0.128	3
A3	0.028	0.454	0.941	1

The comprehensive analysis results demonstrate that ranking results are coherent by considering the methods of QUALIFLEX, VIKOR, and TOPSIS based on interval type fuzzy sets.

At the final stage, the sensitivity analysis has been applied to six cases and the results are represented comparatively in Table 13.

Sensitivity analysis results reveal that the ranking results are the same for each case and they are coherent based on the possible changes in the criteria weights.

Table 13. Ranking results by the cases.

Cases	**Methods**	**A1**	**A2**	**A3**
Case 1	IT2 Fuzzy QUALIFLEX	2	3	1
	IT2 Fuzzy VIKOR	2	3	1
	IT2 Fuzzy TOPSIS	2	3	1
Case 2	IT2 Fuzzy QUALIFLEX	2	3	1
	IT2 Fuzzy VIKOR	2	3	1
	IT2 Fuzzy TOPSIS	2	3	1
Case 3	IT2 Fuzzy QUALIFLEX	2	3	1
	IT2 Fuzzy VIKOR	2	3	1
	IT2 Fuzzy TOPSIS	2	3	1
Case 4	IT2 Fuzzy QUALIFLEX	2	3	1
	IT2 Fuzzy VIKOR	2	3	1
	IT2 Fuzzy TOPSIS	2	3	1
Case 5	IT2 Fuzzy QUALIFLEX	2	3	1
	IT2 Fuzzy VIKOR	2	3	1
	IT2 Fuzzy TOPSIS	2	3	1
Case 6	IT2 Fuzzy QUALIFLEX	2	3	1
	IT2 Fuzzy VIKOR	2	3	1
	IT2 Fuzzy TOPSIS	2	3	1

5. Discussion and Conclusions

Set in a small and open economies context, the study applied the IT2 hybrid decision-making approach to the firm-level performance measurement of internationalized firms in the Baltic states. These countries have demonstrated an increasing level of internationalization and economic growth in the last few years [10]. Considering the size of the countries, international activities and performance of the internationalized firms play a very significant role in economies of the Baltic states. First of all, international activities of domestic firms have a positive influence on employment, improvement of productivity, accumulation of foreign exchange reserves and prosperity of countries. Secondly, the internationalized firms contribute to the environmental socio-economic development and sustainability of their home countries. However, the institutional environment of the Baltic states appears to be different as compared to more advanced countries. Additionally, geographical location of the countries causes the challenges for the domestic firms effectively replicate know-how developed in advanced countries. These assumptions suggest that MNCs rely on unique resources and capabilities which influence firm-level performance. Thus, performance measurement of internationalized firms appears to be important from the support and policy making perspectives.

The research assessed performance of the internationalized firms in the Baltic states (Lithuania, Latvia and Estonia) by using the expert evaluation approach. Thus, six different performance criteria such as, sales performance at the cross-country level, international investment policy, R&D spending for global innovation, international networking of firms, globalization of distribution channels and transferring technology internationally were selected. Additionally, interval type-2 fuzzy DEMATEL is considered to weight these criteria. On the other hand, the interval type-2 fuzzy QUALIFLEX approach is used in order to rank the countries. The novel contribution of the paper is seen in enhanced understanding of performance measurement of MNCs in the Baltic states by suggesting a hybrid decision making model based on interval type-2 fuzzy sets.

Although all three countries are perceived as one region, the studies distinguish some differences and subsequently, deny "one size fit all" solutions to the prevailing challenges [43]. The ranking of all three countries enables us to conclude that Estonia demonstrates the best results of internationalized firms. Meanwhile, Latvia has the worst performance of internationalized firms. These results coincide with higher competitiveness level of Estonia among all three countries [22]. While being the smallest by size, Estonia is the most impacted by international factors [43]. Apparently, these factors contribute to the greater incentives of the firms for internationalization. Furthermore, the differences of trading partners provide the insights into the performance of the firms. While Finland and Sweden are the most important partners of Estonia, Lithuania and Latvia have closer relations with Poland [43]. These partnerships suggest that international networks with the partners from more advanced economies contribute to resource leverage, constant learning of the firms and subsequently, higher international performance.

Notably, the linguistic evaluations of decision makers are prominent and coherent with the business and economic policies of the countries. Accordingly, it is possible to provide policy recommendations for the sustainable development of the Baltic states. For instance, Latvia lagged behind other countries in the EU considering R&D spending in business sectors in 2016 [44]. Thus, policy makers have to continue supportive policies focused on R&D. Although country developed the main priorities in R&D areas, the narrow areas which help to achieve competitive advantage should be defined. In addition, consolidation of the fragmented public R&D system is needed, aiming to increase cooperation between the private sector and public universities. Meanwhile, the managers of MNCs have to understand the main conditions leading to the higher performance of the firms. Furthermore, the internationalization supporting agencies have to consider the necessity to improve distribution channels. Thus, additional training programmes have to be developed aiming to overcome this issue. Finally, investment by the firms into channel design is recommended.

This study provides few contributions to the extant knowledge on the performance measurement of internationalized firms. First, the investigation extends prevailing studies on EM-MNCs in the Baltic states' context. Second, the study complements the literature by focusing on the frameworks that explain international performance. Third, the study provides insights into performance improvement for particular countries defined as small and open economies.

Of course, our study is not without limitations. First, the research included six performance criteria. Thus, future research has to consider other performance related criteria. For instance, international reputation of the firms could be included in the future studies. Second, the research was carried out in the context of the Baltic states. Because interval type-2 fuzzy logic is firstly considered for this subject, it contributes to the originality of this study. On the other hand, in future studies, the analysis can be performed in the context of other countries. For example, it is believed that a comparative analysis between developing and developed countries provides very beneficial results in order to increase the performances of internationalized companies.

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