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## Metody i zastosowania badań operacyjnych



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## Wstęp

Kolejna, XXXIV Ogólnopolska Konferencja Naukowa im. Profesora Władysława Bukiełyńskiego, organizowana corocznie przez najważniejsze ośrodki naukowe zajmujące się dziedziną badań operacyjnych, w roku 2015 odbyła się w pięknym, zabytkowym i świeżo odremontowanym zespole pałacowo-parkowym w Łagowie koło Zgorzelca. Konferencję zrealizowaną pod nazwą *Metody i Zastosowania Badań Operacyjnych* przygotowała Katedra Badań Operacyjnych Uniwersytetu Ekonomicznego we Wrocławiu pod kierownictwem dr. hab. Marka Nowińskiego, prof. UE.

Konferencje te mają już długoletnią tradycję – są to coroczne spotkania pracowników nauki specjalizujących się w badaniach operacyjnych. Głównym celem konferencji było, podobnie jak w latach ubiegłych, stworzenie (przede wszystkim dla młodych teoretyków, a także praktyków dyscypliny) forum wymiany myśli na temat najnowszych osiągnięć dotyczących metod ilościowych wykorzystywanych do wspomagania procesów podejmowania decyzji, a także prezentacja nowoczesnych zastosowań badań operacyjnych w różnych dziedzinach gospodarki. Ten cenny dorobek naukowy nie może być zapomniany i jest publikowany po konferencji w postaci przygotowywanego przez organizatorów zeszytu naukowego zawierającego najlepsze referaty na niej zaprezentowane.

W pracach Komitetu Naukowego Konferencji uczestniczyli czołowi przedstawiciele środowisk naukowych z dziedziny badań operacyjnych w Polsce; byli to: prof. Jan B. Gajda (Uniwersytet Łódzki), prof. Stefan Grzesiak (Uniwersytet Szczeciński), prof. Bogumił Kamiński (SGH w Warszawie), prof. Ewa Konarzewska-Gubała (Uniwersytet Ekonomiczny we Wrocławiu), prof. Donata Kopańska-Bródka, prof. Maciej Nowak i prof. Tadeusz Trzaskalik (Uniwersytet Ekonomiczny w Katowicach), prof. Dorota Kuchta (Politechnika Wrocławska), prof. Krzysztof Piasecki (Uniwersytet w Poznaniu) i prof. Józef Stawicki (Uniwersytet Mikołaja Kopernika w Toruniu).

Zakres tematyczny konferencji obejmował teoretyczne i praktyczne zagadnienia dotyczące przede wszystkim:

- modelowania i optymalizacji procesów gospodarczych,
- metod wspomagających proces negocjacji,
- metod oceny efektywności i ryzyka na rynku kapitałowym i ubezpieczeniowym,
- metod ilościowych w transporcie i zarządzaniu zapasami,
- metod wielokryterialnych,
- optymalizacji w zarządzaniu projektami oraz analizy ryzyka decyzyjnego.

W konferencji wzięło udział 43 przedstawiciele różnych środowisk naukowych, licznie reprezentujących krajowe ośrodki akademickie. W trakcie sześciu sesji ple-

narych, w tym dwóch sesji równoległych, przedstawiono 27 referatów, których poziom naukowy w przeważającej części był bardzo wysoki. Zaprezentowane referaty, po pozytywnych recenzjach, zostają dziś opublikowane w Pracach Naukowych Uniwersytetu Ekonomicznego we Wrocławiu w postaci artykułów naukowych w specjalnie wydany zeszycie konferencyjnym.

Przypominając przebieg konferencji, nie można nie wspomnieć o konkursie zorganizowanym dla autorów referatów niebędących samodzielnymi pracownikami nauki. Dotyczył on prezentacji najciekawszego zastosowania badań operacyjnych w praktyce gospodarczej. Komitet Organizacyjny Konferencji powołał kapitułę konkursu, w której skład weszli: prof. Ewa Konarzewska-Gubała – przewodnicząca, prof. Jan Gajda, prof. Stefan Grzesiak i prof. Donata Kopańska-Bródka. Członkowie Komisji Konkursowej oceniali referaty ze względu na:

- innowacyjność, oryginalność metody będącej przedmiotem zastosowania,
- znaczenie zastosowania dla proponowanego obszaru,
- stopień zaawansowania implementacji metody w praktyce.

Spośród 15 referatów zgłoszonych wyróżniono: 1. miejsce: dr Michał Jakubiak i dr hab. Paweł Hanczar (Uniwersytet Ekonomiczny we Wrocławiu), *Optymalizacja tras zbiórki odpadów komunalnych na przykładzie MPO Kraków*; 2. miejsce: mgr Dagmara Piesiewicz i dr hab. Paweł Hanczar (Uniwersytet Ekonomiczny we Wrocławiu), *Logistyka odzysku – optymalizacja przepływów w systemie gospodarki komunalnej*; 3. miejsce: dr Dorota Górecka i dr Małgorzata Szałucka (Uniwersytet Mikołaja Kopernika w Toruniu), *Wybór sposobu wejścia na rynek zagraniczny – wieloaktorska analiza wielokryterialna a podejście oparte na dominacjach stochastycznych*.

Przy okazji prezentowania opracowania poświęconego XXXIV Konferencji *Metody i Zastosowania Badań Operacyjnych* i jej bardzo wartościowego dorobku nie możemy nie podziękować członkom Komitetu Organizacyjnego Konferencji, w którego skład wchodził młodzi, acz doświadczeni pracownicy Katedry Badań Operacyjnych Uniwersytetu Ekonomicznego we Wrocławiu: dr Piotr Peternek (sekretarz), dr hab. Marek Kośny, dr Grzegorz Tarczyński oraz mgr Monika Stańczyk (biuro konferencji). Zapewnili oni w sposób profesjonalny sprawne przygotowanie i przeprowadzenie całego przedsięwzięcia oraz zadbali o sprawy administracyjne związane z realizacją konferencji, a także byli odpowiedzialni za dopilnowanie procesu gromadzenia i redakcji naukowych materiałów pokonferencyjnych, które mamy okazję Państwu dziś udostępnić.

Już dzisiaj cieszymy się na nasze kolejne spotkanie w ramach jubileuszowej XXXV Ogólnopolskiej Konferencji Naukowej im. Profesora Władysława Bukietyńskiego, która tym razem będzie organizowana przez naszych przyjaciół z Katedry Badań Operacyjnych Uniwersytetu Ekonomicznego w Poznaniu pod kierownictwem prof. dr. hab. Krzysztofa Piaseckiego.

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**FOREIGN MARKET ENTRY MODE DECISION –  
APPROACH BASED ON STOCHASTIC DOMINANCE  
RULES VERSUS MULTI-ACTOR  
MULTI-CRITERIA ANALYSIS**

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**WYBÓR SPOSOBU WEJŚCIA  
NA RYNEK ZAGRANICZNY –  
PODEJŚCIE OPARTE NA DOMINACJACH  
STOCHASTYCZNYCH A WIELOAKTORSKA  
ANALIZA WIELOKRYTERIALNA**

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**Summary:** The choice of entry mode is a critical decision for a company and numerous empirical studies have focused on this issue. However, most of them refer to the determinants of the entry mode choice and relatively few of them explore methods of selecting the appropriate entry mode considering the huge amount of various factors that determine the foreign market entry mode choice. The high complexity of the decision-making process and the huge number of factors that affect the entry mode decision mean that the entry mode choice is considered as a multi-criteria decision-making problem. The study in this paper compares the application of two multi-criteria decision aiding (MCDA) approaches that can be employed to solving the problem of entry mode selection: outranking methods with stochastic dominance (SD) rules and multi-actor multi-criteria analysis (MAMCA). The problem is illustrated by the case of a dynamically developing company that manufactures and distributes hygiene, cosmetic and medical products for women, children and adults.

**Keywords:** foreign entry mode selection, MCDA, MAMCA, PROMETHEE IIv with SD rules, EXPROM IIv with SD rules.

**Streszczenie:** Przedsiębiorstwo, decydując się na ekspansję zagraniczną, staje w obliczu konieczności podjęcia wielu decyzji strategicznych, w tym między innymi decyzji dotyczących wyboru rynku, na który chce wejść, wyboru produktu, który chce na tym rynku umieścić, a także wyboru najlepszego sposobu obsługi tego rynku. W efekcie właściwy wybór rynku, produktu i sposobu wejścia staje się kluczowym elementem decydującym o przyszłym sukcesie przedsiębiorstwa. Wybór sposobu wejścia na rynek zagraniczny jest procesem złożonym, uwarunkowanym między innymi ogólną charakterystyką poszczególnych państw, różnicami

kulturowymi między rynkami zagranicznymi a rynkiem macierzystym, poziomem ryzyka związanego z działalnością w różnych krajach, a także wielkością firmy. Ponieważ w procesie tym pod uwagę brane są zwykle opinie osób znajdujących się na różnych szczeblach struktury organizacyjnej przedsiębiorstwa, a sposoby wejścia różnią się znacznie pod względem zaangażowania zasobów, stopnia ryzyka i kontroli, a także potencjalnej zyskowności, konieczne jest przeprowadzenie dokładnej analizy ich zalet i wad z punktu widzenia wielu różnych czynników i z uwzględnieniem niekoniernie zgodnych opinii uczestników procesu decyzyjnego. Celem pracy jest porównanie zastosowania dwóch podejść, które mogą zostać wykorzystane w procesie wyboru sposobu wejścia na rynek zagraniczny: wieloaktorskiej analizy wielokryterialnej i metod wielokryterialnych opartych na relacji przewyższania połączonych z regułami dominacji stochastycznych. Poruszany problem zostanie zilustrowany przykładem dotyczącym firmy zajmującej się produkcją i dystrybucją artykułów higienicznych, kosmetycznych oraz wyrobów medycznych.

**Słowa kluczowe:** wybór sposobu wejścia na rynek zagraniczny, MCDA, MAMCA, PROMETHEE IIv z dominacjami stochastycznymi, EXPROM IIv z dominacjami stochastycznymi.

## 1. Introduction

The globalization process and the accompanying liberalization, competition intensification and technology development have caused many companies to internationalize their operations. This is a complex decision for a firm which has a long-term and significant effect on the future firm's growth and its profitability. When a firm starts increasing its involvement in international operations it must take a number of strategic decisions. The first positive decision about entering foreign markets leads to defining the objectives for internationalization. When goals and objectives are set, a firm must decide on the products or services it wants to deliver to a foreign market. This decision leads to the question of which country or countries to enter. There is rich literature on the international market selection [Root 1994; Koch 2001; Kumar et al. 1994; Cavusgil 1985; Russow, Okoroafo 1996; Papadopoulos et al. 2002; Sakarya et al. 2007; Górecka, Szałucka 2013]. When the market is selected, the company must face the question of which entry mode to apply entering the chosen market. The foreign entry mode decision is one of the core topics in the international business literature [Wind, Perlmutter 1977; Werner 2002].

Choosing the best entry mode for the foreign market is a crucial decision for the company because it has implications for the level of resource commitments, risk and control, and may affect the performance and the survival potential of a foreign operation [Root 1994; Woodcock et al. 1994; Li 1995]. A firm seeking to run business operations abroad has a large array of choices (modes) to apply. It chooses between non-equity modes, such as exporting and licensing, and equity-based entry modes with either full ownership (wholly-owned subsidiary) or shared ownership (joint venture). This highly complex entry mode decision requires the firm to consider a huge range of factors from the environment and the company itself which may affect



the entry mode choice for a target foreign market. The literature identifies around 200 different independent variables used in various entry mode studies [Canabal, White 2008], among them can be distinguished the market potential of the target country, the cultural distance between the target country and the home market, the political risk of the target country, the size of the company taking up international expansion, its international experience and/or R&D intensity. Managers can be overwhelmed by the diversity and complexity of the required information, particularly when the different variables taken into consideration (factors) indicate opposite solutions. This is why it is so important to make a conscious, deliberate cost/benefit analysis of the different entry mode options including the various external and internal factors affecting the entry mode choice and the managers' opinions about them, not always consistent with each other.

The objective of this paper is to compare the application of two multi-criteria decision aiding (MCDA) approaches to the complex problem of foreign market entry mode selection, namely: (1) outranking methods with stochastic dominance (SD) rules (see [Górecka, Szałucka 2014]) and (2) multi-actor multi-criteria analysis (MAMCA). The problem we considered will be illustrated by a real-life example of a company seeking new markets that is a leading producer and deliverer of hygiene, cosmetic and medical products. Section Two of this paper reviews the theoretical background to the entry mode choice decision, discussing possible foreign entry modes and the factors that affect the entry mode choice. In Section Three the methodology applied in the study and the description of the case study are presented. Section Four presents the main results of the study, while Section Five provides a summary and conclusions.

## **2. The foreign market entry mode choice – a theoretical framework**

A firm entering a foreign market has to find a suitable entry mode in order to manage its business activities abroad effectively. The entry mode has been defined as an institutional agreement that allows the company to enter a market with its products, technology, human skills, management, or other resources [Root 1994]. Firms can choose among different entry modes, ranging from exporting, contractual agreements such as licensing, franchising or subcontracting, to investment entry modes (equity-based modes) such as joint-venture or a wholly-owned subsidiary formed either by establishing greenfield investment from scratch or by acquiring an existing local firm. Each entry mode has been characterized along several dimensions. The firm's degree of resource commitment to a foreign market, the risk to which the firm is exposed running foreign activities in a host country, and the level of the control a firm has over its foreign operations have been frequently applied [Hill, Hwang, Kim 1990; Anderson, Gatignon 1986]. They are highly correlated; higher control requires higher resource commitment, and higher resource commitment is related

with higher risk. Table 1 shows the relationships between the three most common characteristics.

**Table 1.** Characteristics of different entry modes

Entry mode	Control	Resource commitment	Dissemination risk
Exporting	Low to high	Low to high	Medium to low
Licensing	Low	Low	High
Franchising	Low	Low	High
Joint venture	Medium to high	Medium to high	Medium
Wholly owned subsidiary	High	High	Low

Source: own elaboration based on [Hill, Hwang, Kim 1990].

A number of theories have been applied to explain a firm's international entry mode choice in foreign markets [Canabal, White 2008; Laufs, Schwens 2014]. Theories most often used to explain entry mode choice include transaction costs theory, eclectic theory of international production, internationalization theory, institutional theory and the resource-based view theory. There are also many studies which do not employ any particular theoretical framework and just simply focus on testing a set of variables which may affect the entry mode decision.

The abundant research on determinants of entry modes indicates the large number of variables that are expected to influence the entry mode choice. Canabal and White [2008], identified around 200 different independent variables used in various entry mode studies. The most commonly employed variables were MNE/international experience, cultural distance, risk, firm size, host restriction/host policies (host country variables), R&D intensity, host country experience, industry competition/concentration, size of operation/scale and advertising intensity. The factors (determinants) are often classified into the groups to facilitate their analysis. Several groups of variables have been proposed in the literature [Root 1994; Hill et al. 1990; Gannon 1993; Sarkar, Cavusgil 1996; Luo 1999]. In this paper we have decided to adopt the framework proposed by Root [1994], and we have identified four main sets of variables: target country environmental factors, target country industry factors, company factors and company product factors. We strongly believe that home country factors in the case of some countries may also be critical, however in our case they do not play a significant role. For each group we have decided to include in the study the factors commonly indicated by the literature. Their importance in the entry mode decision process is determined mainly by the goals and objectives of the company's international expansion and verified by the firm's capacity. When analysing the factors it must be remembered that each one should be considered in terms of whether it encourages or discourages a particular entry mode [Górecka, Szałucka 2014].

The choice of an appropriate entry mode is an important strategic decision which can negatively impact the firm's performance if applied wrongly [Root 1994; Woodcock et al. 1994; Li 1995; Kim, Gray 2008]. In addition, it is difficult to change the entry mode when established, and changing it is a costly and time-consuming process with long-term consequences. When exploring the performance implications of the entry mode it is important to emphasize that the chosen entry mode may affect not only the performance of the foreign market activity in the selected country, but it may also have significant implications for the performance of the entire internationalizing firm. That is why managers should thoroughly consider all the advantages and disadvantages of each entry mode and cautiously assimilate a huge amount of information referring to various internal and external factors that determine the foreign market entry mode choice.

Unfortunately there are relatively few studies directly focusing on the entry mode decision process. Those which can be found mainly refer to the foreign direct investment decision process [Aharoni 1966; Larimo 1995; Levary, Wan 1999]. However, there is a general agreement in the literature that the entry mode decision process is a complicated process with organizational and behavioural dimensions, where a number of factors that influence the entry mode decision should be taken into consideration and various variations of the decision process should be considered. Y. Aharoni [1966], stresses that "(...) a foreign investment decision process is a very complicated social process... It contains various elements of individual and organizational behaviour, influenced by the past and perception of the future as well as the present. It is composed of a large number of decisions, made by different people at different points in time."

The decision-making activity usually starts with determining a set of unique criteria reflecting the objectives for internationalization and the possible entry modes alternatives to serve a foreign market. The selected criteria are based on determinants of the entry modes. Because the decision requires gathering and analysing a huge amount of information referring to the target market, the firm itself and potential entry mode alternatives and it implies a certain commitment of resources, the risk and the level of control over foreign operation, several people representing the firm, executives, representatives from various departments as well as external consultants, are usually involved in the decision making process [Levary, Wan 1999].

The involvement of a group of people in the decision making process on the one hand, allows to explore different opinions of the group members on various aspects of evaluating entry modes and later to integrate them into a single optimal proposal, and on the other hand, helps to engage people into the project and get its better acceptance and understanding, which can later have an impact on the implementation of the project.

Once the criteria are identified the set of indicators for each criterion must be defined. There is no agreement among scholars as to which criteria should be used and how they should be measured. However as it was mentioned above, they all

must refer to the objectives of the firm's internationalization. For each indicator, data must be gathered and analysed in order to identify its level on the evaluation scale. The next each entry mode alternative should be evaluated using identified criteria and their indicators. This makes the entry mode choice process take the form of a multi-dimensional assessment and is considered as a multi-criteria decision-making problem [Levary, Wan 1999]. Unfortunately there is still no comprehensive and easy to apply tool which will allow managers to assimilate the huge amount of information referring to the internal and external factors in order to make the right decision about the choice of the entry mode. Research within this field is still very fragmented and limited in scope. That is why this paper attempts to provide a comprehensive method to fill in the blanks in the field by applying/verifying multi-criteria decision aiding techniques for determining the most appropriate entry mode.

### 3. Case study and methodology

The present study compares the possibility of applying two MCDA approaches – outranking methods with SD rules [Zaraś, Martel 1994; Martel, Zaraś 1995] and MAMCA [Macharis 2000; Macharis 2005] – to aid decision-makers in the entry mode selection process. It is based on the example of a company that has grown from a local business to a global holding group<sup>1</sup> and nowadays is a leading European manufacturer and distributor of modern hygienic, cosmetic and medical products for women, children and adults, for instance: creams, perfumes, sanitary pads, panty liners, tampons, baby diapers and wet wipes. The company, established in 1951, is an enterprise with entirely Polish capital, operating in 18 countries. The capital group is composed of 55 companies including manufacturing companies (in Poland, Russia, Ukraine and India), trading companies (in Europe, India and the USA) and service (medical and IT technology) companies (in Poland and Russia). It employs over 7.5 thousand people and markets its products in 80 countries worldwide ( in Europe, Asia, Africa, America, and Australia). Thanks to the firm's own Research and Development Centre that cooperates closely with experienced scientific institutions, its products are based on cutting edge technologies. This helps the company to compete successfully with powerful global concerns in the highly competitive markets in which it operates<sup>2</sup>.

The current simulation of an entry mode selection<sup>3</sup> refers to a project already carried out by the company, namely the investment made in India where in 2002 the company established a joint-venture company with its Indian partner, and where a new

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<sup>1</sup> The same case was used in [Górecka, Szalucka 2014].

<sup>2</sup> Information about the company comes from its brochure and its website: [http://www.tzmo-global.com/en\\_GLO](http://www.tzmo-global.com/en_GLO) (25 July 2016).

<sup>3</sup> Please note that the views and opinions expressed in this study are those of its participants and the article's authors, and do not necessarily reflect the official position of the company considered.

factory began manufacturing hygiene and medical products in 2005. Hence, it is assumed that the target market had been already selected by the firm.

After considering a variety of alternatives, six entry modes which seemed reasonable to apply in the case considered, have been selected, namely: indirect export, agent/distributor export, licensing, branch/subsidiary export, joint venture and wholly owned subsidiary. The factors affecting the company's choice of the entry mode, amounting to 15 in number, have been determined through the literature review. They are presented in Table 2. As mentioned above, they should be considered from the point of view of encouraging or discouraging a particular entry mode.

**Table 2.** Factors influencing the company's choice of the entry mode

Factors (criteria)	Measures (units)	Evaluation scale
1	2	3
Target country environmental factors		
Market potential	Total population (number of inhabitants)	<ul style="list-style-type: none"> <li>• Very low</li> <li>• Low</li> <li>• Medium</li> <li>• High</li> <li>• Very high</li> </ul>
	Urban population (number of inhabitants)	
	GDP growth rate (annual %)	
	GDP per capita (GDP per capita constant 2000;US\$)	
Production factors	Cotton production (thousand bales)	<ul style="list-style-type: none"> <li>• Low (unattractive)</li> <li>• Medium</li> <li>• High (attractive)</li> </ul>
	Labour cost (US\$ per hour)	
Geographical distance	Distance between capital cities (kilometres)	<ul style="list-style-type: none"> <li>• Low (up to 1500 km)</li> <li>• Medium</li> <li>• High (over 3000 km)</li> </ul>
Cultural distance	Cultural distance: power distance, individualism, masculinity, uncertainty avoidance, pragmatism, indulgence (index)	<ul style="list-style-type: none"> <li>• Low</li> <li>• Medium</li> <li>• High</li> </ul>
Political risk	Political risk: corruption, government non-payments/non-repatriation, government stability, information access/ transparency, institutional risk, regulatory and policy environment (index)	<ul style="list-style-type: none"> <li>• Very low</li> <li>• Low</li> <li>• Medium</li> <li>• High</li> <li>• Very high</li> </ul>
Government policies and regulations	Economic freedom: property rights, freedom from corruption, fiscal freedom, government spending, business freedom, labour freedom, monetary freedom, trade freedom, investment freedom, financial freedom (index)	<ul style="list-style-type: none"> <li>• Repressed</li> <li>• Mostly unfree</li> <li>• Moderately free</li> <li>• Mostly free</li> <li>• Free</li> </ul>
Target country industry factors		
Demand uncertainty	Product-market development: growth rate, number of competitors, competitive structure, technologies, sector access	<ul style="list-style-type: none"> <li>• Birth stage</li> <li>• Growth stage</li> <li>• Maturity stage</li> <li>• Decline stage</li> </ul>

Table 2, cont.

1	2	3
Marketing infrastructure	Outlet density (number per 1,000 inhabitants)	<ul style="list-style-type: none"> <li>• Poor</li> <li>• Moderate</li> <li>• Good</li> </ul>
	Modern Trade density (number of retail stores per million population)	
Company factors		
Size of the company	Employment (number of employees)	<ul style="list-style-type: none"> <li>• Small</li> <li>• Medium</li> <li>• Large</li> </ul>
	Sales turnover (thousand PLN)	
International experience	Sales on foreign markets (revenue in thousand PLN)	<ul style="list-style-type: none"> <li>• Very low</li> <li>• Low</li> <li>• Medium</li> <li>• High</li> <li>• Very high</li> </ul>
	Number of markets served	
	Number of projects abroad	
Corporate strategy	Corporate strategy analysis (based on cost pressure, local responsiveness and global integration)	<ul style="list-style-type: none"> <li>• Global</li> <li>• Mostly global</li> <li>• Mostly multi-domestic</li> <li>• Multi-domestic</li> </ul>
Generic marketing strategies	Generic marketing strategy analysis (based on number of markets and time horizon)	<ul style="list-style-type: none"> <li>• Concentration</li> <li>• Mostly concentration</li> <li>• Mostly diversification</li> <li>• Diversification</li> </ul>
Nature of the strategic assets	R&D intensity	<ul style="list-style-type: none"> <li>• Low</li> <li>• Medium</li> <li>• High</li> </ul>
	Product technical complexity	
Company product factors		
Product adaptation	Degree of product customization	<ul style="list-style-type: none"> <li>• Very low</li> <li>• Low</li> <li>• Medium</li> <li>• High</li> <li>• Very high</li> </ul>
Product lifecycle	PLC analysis (based on proprietary content)	<ul style="list-style-type: none"> <li>• Introduction stage</li> <li>• Growth stage</li> <li>• Maturity stage</li> <li>• Decline stage</li> </ul>

Source: own elaboration.

Finally, five experts – specialists in the field of foreign investments (two researchers, two professionals from the FMCG sector and a scientist with practical experience) – scored the selected entry modes individually and independently according to their knowledge and experience on scales established by a main expert (the researcher with professional experience) and taking into account their own evaluation of the 15 factors affecting the company's choice of the entry mode. Table 3 provides

**Table 3.** Performance matrix

Factors (criteria), scale <sup>4</sup>	Entry modes					
	Indirect export	Agent/distributor export	Licensing	Branch/subsidiary export	Joint venture	Wholly owned subsidiary
1	2	3	4	5	6	7
Market potential (1-5)	1	2	2	4	5	5
	3	5	1	1	2	1
	1	2	2	3	5	4
	1	2	1	5	2	5
	1	1	3	2	5	5
Production factors (0/1)	0	0	0	0	1	1
	0	0	0	0	0	1
	0	0	0	0	1	1
	0	0	0	0	0	1
	0	0	1	0	1	1
Geographical distance (1-3)	1	1	2	1	3	3
	3	3	1	3	1	1
	1	2	3	2	3	3
	2	3	2	2	2	1
	1	1	3	2	3	3
Cultural distance (1-4)	3	4	4	2	3	1
	1	2	2	3	4	4
	2	3	3	3	4	3
	1	3	4	1	3	1
	3	4	3	2	3	2
Political risk (1-4)	4	4	4	3	2	1
	1	1	3	3	4	4
	2	4	4	3	4	3
	4	3	4	2	4	2
	3	3	4	2	2	2
Government policies and regulations (1-4)	4	4	3	2	1	1
	3	3	4	4	4	4
	2	2	2	1	4	2
	3	3	4	2	4	2
	2	3	3	3	2	2

<sup>4</sup> Higher values indicate that the entry mode is better tailored to the specific situation.

Table 3, cont.

1	2	3	4	5	6	7
Demand uncertainty (1-3)	1	1	1	3	2	3
	2	2	1	3	3	3
	2	3	3	2	3	3
	2	3	2	1	3	1
	2	3	3	2	2	2
Marketing infrastructure (0/1)	0	0	0	1	1	1
	0	0	0	1	1	1
	0	1	1	0	1	0
	0	0	0	0	1	0
	0	1	1	0	1	0
Size of the company (1-4)	1	2	2	3	3	4
	1	1	1	3	3	4
	1	1	1	3	4	3
	2	2	1	3	3	4
	1	1	2	3	4	4
International experience (1-4)	1	2	2	4	3	4
	1	1	1	2	2	4
	1	1	1	3	4	2
	1	1	2	3	3	4
	1	1	2	2	3	4
Corporate strategy (1-3)	1	2	1	3	2	3
	1	1	1	2	3	3
	1	1	1	3	2	3
	1	1	2	1	2	3
	1	1	2	3	2	3
Generic marketing strategies (1-3)	1	1	1	3	2	3
	1	1	1	2	2	3
	1	2	1	2	2	3
	1	1	1	2	1	3
	1	2	2	3	2	3
Nature of the strategic assets (1-3)	1	1	1	3	2	2
	1	1	1	2	2	3
	2	2	2	2	2	2
	1	1	2	2	1	3
	1	1	2	2	2	3



1	2	3	4	5	6	7
Product adaptation (1-3)	1	1	1	4	2	3
	1	1	1	2	3	3
	1	1	1	2	3	3
	1	2	2	1	3	1
	1	1	1	3	1	2
Product lifecycle (1-3)	1	1	1	3	2	3
	1	1	1	2	2	3
	1	2	2	3	3	3
	1	2	1	2	1	3
	1	1	2	2	1	3

Source: own elaboration.

The model of preferences for the decision-making problem is presented in Table 4.

**Table 4.** Model of preferences

Factors (criteria)	Vectors of weighting coefficients				Thresholds I			Thresholds II		
	I	II	III	IV	q	p	v	q	p	v
Market potential	0.11	0.1379	0.140	0.067	0	1	3	0	0	3
Production factors	0.11	0.1379	0.140	0.067	0	0	1	0	0	2
Geographical distance	0.04	0.0305	0.013	0.067	0	1	5	0	0	5
Cultural distance	0.06	0.0520	0.070	0.067	0	1	5	0	0	5
Political risk	0.09	0.0861	0.100	0.067	0	1	3	0	0	5
Government policies and regulations	0.04	0.0305	0.013	0.067	0	1	5	0	0	5
Demand uncertainty	0.09	0.0861	0.100	0.067	0	1	2	0	0	2
Marketing infrastructure	0.06	0.0520	0.070	0.067	0	0	1	0	0	2
Size of the company	0.09	0.0861	0.100	0.067	0	1	3	0	0	3
International experience	0.11	0.1379	0.140	0.067	0	1	3	0	0	3
Corporate strategy	0.06	0.0520	0.070	0.067	0	1	5	0	0	5
Generic marketing strategies	0.02	0.0195	0.005	0.067	0	1	6	0	0	6
Nature of the strategic assets	0.04	0.0305	0.013	0.067	0	1	5	0	0	5
Product adaptation	0.04	0.0305	0.013	0.067	0	1	5	0	0	5
Product lifecycle	0.04	0.0305	0.013	0.067	0	1	5	0	0	5

\* The first vector of weights (I) was determined arbitrarily, the second one (II) was created with the help of the AHP method [Saaty 2006; Saaty, Vargas 1991], and the third one (III) by using Hinkle's method [Hinkle 1965; Rogers, Bruen 1998]. In the last approach (IV) all the factors were presupposed to be equally important. The analyst and the main expert established also the values of indifference ( $q_1$  and  $q_2$ ), preference ( $p_1$  and  $p_2$ ) and veto ( $v_1$  and  $v_2$ ) thresholds.

Source: own elaboration.

the performance matrix for the six entry modes considered and the 15 criteria used to evaluate them.

In order to rank the entry modes from the best to the worst from the point of view of the expansion of the considered company to Indian market, firstly the PROMETHEE II method with SD rules and veto thresholds [Nowak 2005; Górecka 2009] and the EXPROM II method with SD rules and veto thresholds [Górecka 2010; Górecka 2011] were applied (for details – see Appendix). Subsequently, the MAMCA [Macharis 2004] approach with PROMETHEE IIv [Górecka, Muszyńska 2011; Górecka, Pietrzak 2012; Górecka 2014] and EXPROM IIv [Górecka, Szałucka 2013; Górecka 2014] methodology was used. While within the first approach all the experts' opinions are analysed together, the second one assumes that the analysis is conducted for each stakeholder (expert) separately. Furthermore, within the second approach each stakeholder can have a different preference model which is impossible within the first approach.

Since the MAMCA methodology is not very well known in Poland, therefore its steps are presented in Figure 1. In addition they are summarized below [Macharis et al. 2012]:

1. Defining the problem and the alternatives.
2. Conducting stakeholder analysis.

It is performed to identify properly the range of people who need to be consulted and whose opinions should be taken into account in the decision-making process.

3. Defining criteria and weights.

The choice of evaluation criteria is based on the stakeholders' objectives, not the effects or impacts of the alternatives as such. The weights are determined by the importance the stakeholder is ascribing to his or her objectives.

4. Determining indicators and measurement methods for criteria.

The formerly conceptualized evaluation criteria are 'operationalized' by constructing indicators that can be employed to measure whether or to what extent an alternative contributes to each criterion.

5. Conducting overall analysis and ranking.

Every alternative is assessed against the different criteria for each stakeholder. When the evaluation tables are filled in, any MCDA method can be used to choose, order or sort the alternatives considered. Stakeholders are free to have their own criteria, weights and preference structure, and only at the end of the analysis their points of view are confronted.

6. Obtaining results and conducting sensitivity analysis.

Once the critical stakeholders and their criteria are revealed in the previous step, the MAMCA approach helps the decision-maker in making his or her final decision by indicating which elements exert a clearly positive or a clearly negative influence on the sustainability of the alternatives considered in the case of each stakeholder. The MAMCA aims at providing insight into what is significant for each stakeholder, not just at summing up different points of view and coming to a final conclusion.

7. Implementation.

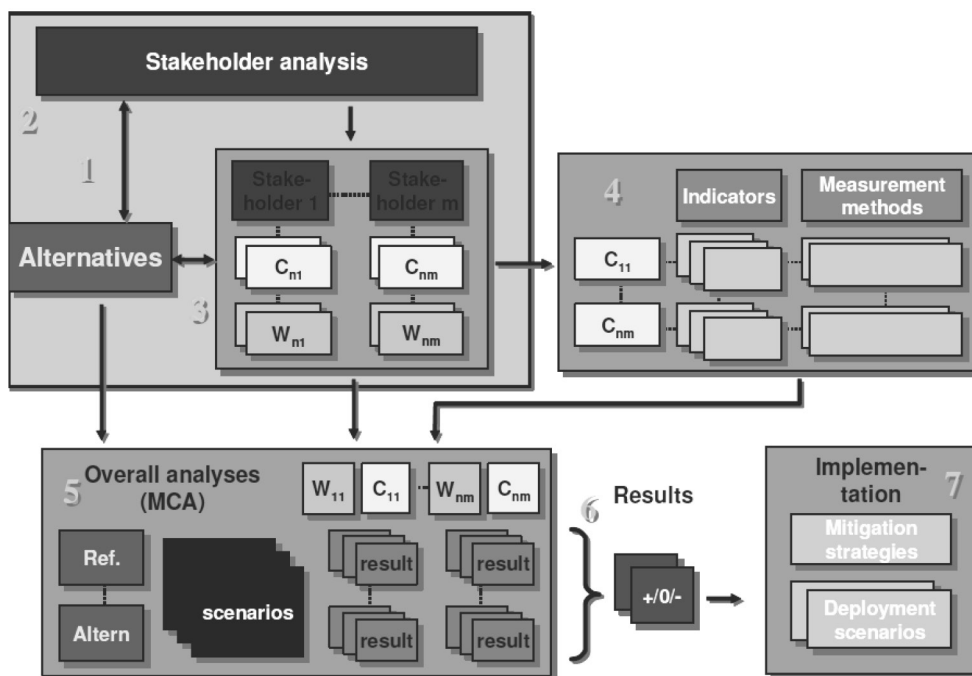


Fig. 1. The concept of the Multi-Actor Multi-Criteria Analysis

Source: [Macharis 2004].

## 4. Results

Tables 5 and 6 provide respectively a summary of the results obtained by applying the PROMETHEE IIv and EXPROM IIv techniques with SD rules using four different vectors of weighting coefficients and the first set of indifference, preference and veto thresholds (see [Górecka, Szałucka 2014]).

The rankings of the entry modes we have obtained, which are robust to the changes in the vector of weights as the modifications of the parameters' values do not lead (with only one exception) to alterations in the entry modes' rankings, are not in complete agreement. The best entry modes, taking into account its appropriateness as the institutional agreement allowing the considered company to enter an Indian market, is joint venture or wholly owned subsidiary. Branch/subsidiary export also turned out to be quite a good solution – the values of net flows determined for it are in all cases positive. In turn, licensing and agent/distributor export do not seem appropriate arrangements for organizing business activities in India by the examined company as the values of net flows determined for them are in all cases negative. Finally, the worst mode to enter an Indian market is indirect export. To sum up,

**Table 5.** Rankings of the entry modes obtained using PROMETHEE IIv with SD rules for four different vectors of weights and thresholds I

No.	PROMETHEE II with SD rules and veto thresholds				No.
	Vector I	Vector II	Vector III	Vector IV	
1	Joint Venture	Joint Venture	Joint Venture	Joint Venture	1
2	Wholly Owned Subsidiary	Wholly Owned Subsidiary	Wholly Owned Subsidiary	Wholly Owned Subsidiary	2
3	Branch/ Subsidiary Export	Branch/ Subsidiary Export	Branch/ Subsidiary Export	Branch/ Subsidiary Export	3
4	Licensing	Licensing	Licensing	Licensing	4
5	Agent/ Distributor Export	Agent/ Distributor Export	Agent/ Distributor Export	Agent/ Distributor Export	5
6	Indirect Export	Indirect Export	Indirect Export	Indirect Export	6

Source: own elaboration.

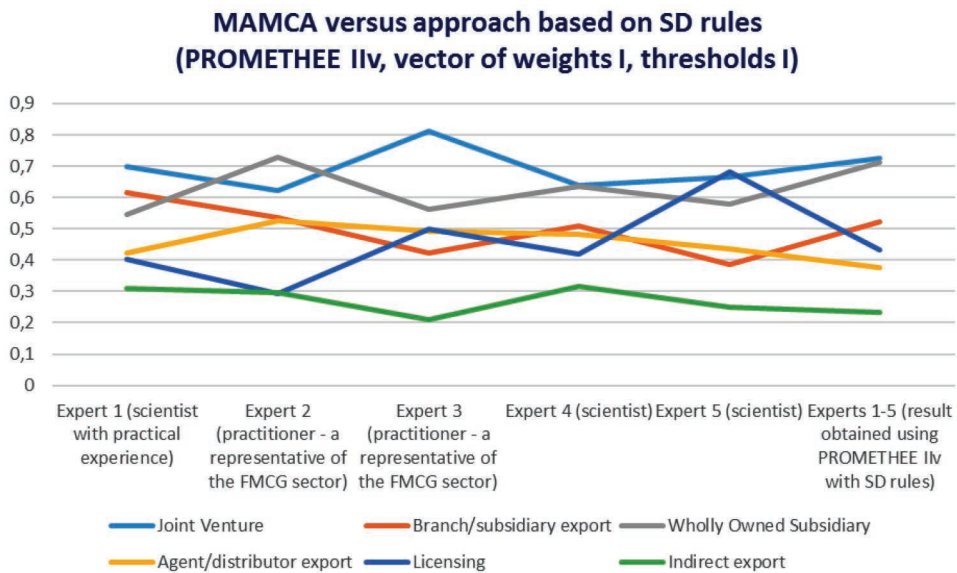
**Table 6.** Rankings of the entry modes obtained using EXPROM IIv with SD rules for four different vectors of weights and thresholds I

No.	EXPROM II with SD rules and veto thresholds				No.
	Vector I	Vector II	Vector III	Vector IV	
1	Wholly Owned Subsidiary	Wholly Owned Subsidiary	Joint Venture	Wholly Owned Subsidiary	1
2	Joint Venture	Joint Venture	Wholly Owned Subsidiary	Joint Venture	2
3	Branch/ Subsidiary Export	Branch/ Subsidiary Export	Branch/ Subsidiary Export	Branch/ Subsidiary Export	3
4	Licensing	Licensing	Licensing	Licensing	4
5	Agent/ Distributor Export	Agent/ Distributor Export	Agent/ Distributor Export	Agent/ Distributor Export	5
6	Indirect Export	Indirect Export	Indirect Export	Indirect Export	6

Source: own elaboration.

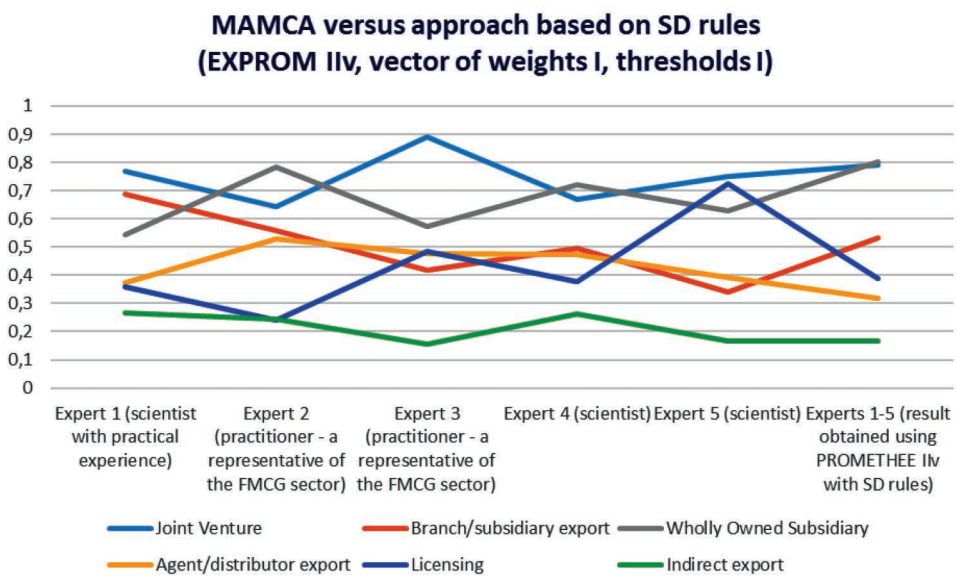
taking into account all the results we have obtained using the approach based on SD rules, joint venture is recommended for the analysed company (top-ranked five times). Alternatively, the firm may consider wholly owned subsidiary (top-ranked three times) or, at a pinch, branch/subsidiary export as the entry modes to explore the Indian market [Górecka, Szałucka 2014].

Figures 2-4 provide the selected results obtained using the MAMCA approach with the PROMETHEE IIv and EXPROM IIv methodology. This decision tool allows for thoughtful and thorough stakeholders' engagement in the decision-making process and leads to a more complete understanding of the different points of view as well as to a result that might be more advantageous for the majority of stakeholders.



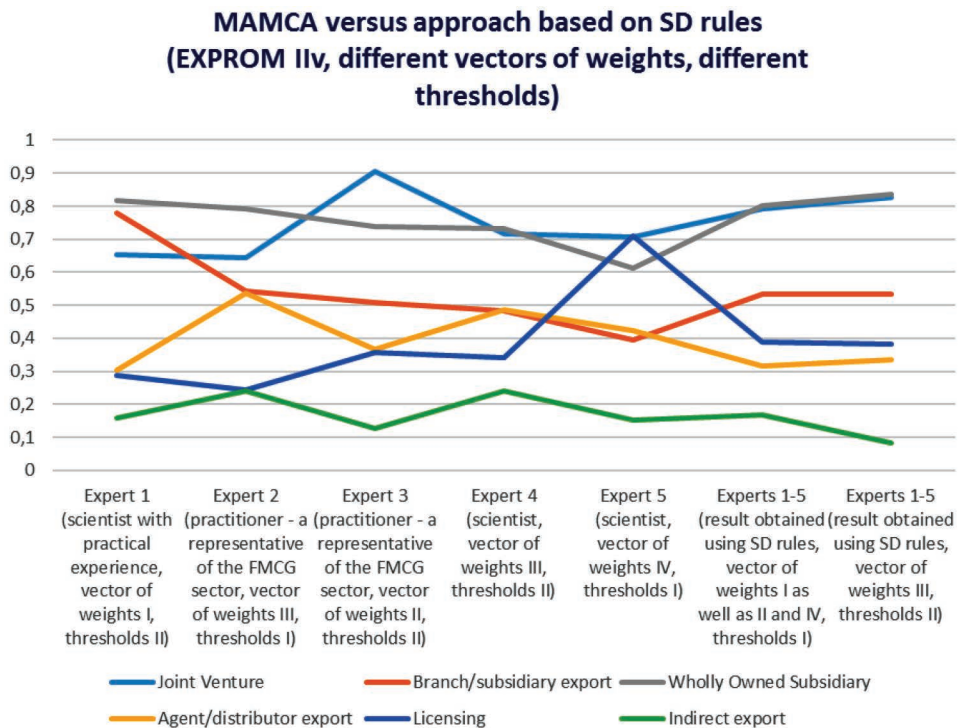
**Fig. 2.** Results of the MAMCA approach with PROMETHEE IIv (vector of weights I, thresholds I)

Source: own elaboration.



**Fig. 3.** Results of the MAMCA approach with EXPROM IIv (vector of weights I, thresholds I)

Source: own elaboration.



**Fig. 4.** Results of the MAMCA approach with EXPROM IIv (different preference model for each expert)

Source: own elaboration.

In trying to find a satisfying solution from the point of view of all experts in the case of Figure 2, we have come to the same conclusion as using the approach based on SD rules, namely that the company should use joint venture for organizing its business activities in India. An attempt to determine a compromise solution for all experts in the case of Figure 3 has led us to conclude that the best mode to enter the Indian market is once again joint venture, which is slightly incompatible with the results obtained with the help of SD rules, according to which the company should establish a wholly owned subsidiary abroad. In turn, the analysis of Figure 4 shows that there would be two widely accepted solutions, namely joint venture and wholly owned subsidiary, although the latter seems more appropriate for the majority of experts.

## 5. Conclusions

In the paper we have compared the application of two MCDA approaches that can be used in the decision-making process regarding the complex problem of entry

mode selection, namely: (1) outranking methods with SD rules and (2) MAMCA. Both tools have their own strengths and weaknesses. Whilst within the first approach a single value tree is built, all stakeholders' objectives are included in that single value tree and finally we obtain one common ranking, then within the second approach different value trees can be used for each separate stakeholder, alternatives are evaluated from the point of view of various participants of the decision-making process and results take the form of different rankings. The methodology based on SD rules is suitable when we need to obtain straightforwardly a global perspective, whereas the MAMCA methodology is suitable if we want to obtain a higher acceptance rate of the proposed alternative.

The approaches discussed can be applied to any company searching for a way to enter the target market and launch its products or services. Nevertheless, the criteria and measures should certainly be tailored to each firm's specific circumstances and challenges. The example presented in the article may serve as guidelines to other companies. The usefulness of the presented tools is confirmed by the fact that in reality the firm that formed the basis of our analysis of its international expansion chose joint venture as the entry mode to explore the Indian market and it has succeeded on it. From 2013 the company in India has been fully owned by Polish capital<sup>5</sup>.

## References

- Aharoni Y., 1966, *The Foreign Investment Decision Process*, Harvard University, Boston.
- Anderson E., Gatignon, H., 1986, *Modes of Foreign Entry: A Transaction Cost Analysis and Propositions*, *Journal of International Business Studies*, vol. 17, no. 3, pp. 1-26.
- Canabal A., White G.O., 2008, *Entry mode research: Past and future*, *International Business Review*, vol. 17, pp. 267-284.
- Cavusgil S.T., 1985, *Guidelines for Export Market Research*, *Business Horizons*, vol. 28, no. 6, pp. 27-33.
- Gannon M., 1993, *Towards a composite theory of foreign market entry mode choice: The role of marketing strategy variables*, *Journal of Strategic Marketing*, vol. 1, pp. 41-54.
- Górecka D., 2009, *Wielokryterialne wspomaganie wyboru projektów europejskich*, TNOiK „Dom Organizatora”, Toruń, pp. 263-277.
- Górecka D., 2010, *Zastosowanie metod wielokryterialnych opartych na relacji przewyższania do oceny europejskich projektów inwestycyjnych*, [in:] *Metody i zastosowania badań operacyjnych '10*, Nowak M. (ed.), Wydawnictwo Uniwersytetu Ekonomicznego w Katowicach, Katowice, pp. 117-120.
- Górecka D., 2011, *On the choice of method in multi-criteria decision aiding process concerning European projects*, [in:] *Multiple Criteria Decision Making '10-11*, Trzaskalik T., Wachowicz T. (eds.), Publisher of the University of Economics in Katowice, Katowice, pp. 97-101.
- Górecka D., 2014, *Metody PROMETHEE*, [in:] *Wielokryterialne wspomaganie decyzji. Metody i zastosowania*, Trzaskalik T. (ed.), PWE, Warszawa, pp. 117-118, 121.
- Górecka D., Muszyńska J., 2011, *Analiza przestrzenna innowacyjności polskich regionów*, *Acta Universitatis Lodzianensis. Folia Oeconomica*, no. 253, pp. 60-62.

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<sup>5</sup> [http://www.tzmo-global.com/en\\_GLO/location/bellapremier-happy-hygienecare-pl-1](http://www.tzmo-global.com/en_GLO/location/bellapremier-happy-hygienecare-pl-1) (25 July 2016).



- Górecka D., Pietrzak M.B., 2012, *Zastosowanie metody PROMETHEE II w procesie rankingowania projektów europejskich w ramach Regionalnego Programu Operacyjnego Województwa Kujawsko-Pomorskiego na lata 2007-2013*, Studia Ekonomiczne Modelowanie Preferencji a Ryzyko, 12. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach, no. 97, pp. 87-89.
- Górecka D., Szalucka M., 2013, *Country market selection in international expansion using multicriteria decision aiding methods*, Multiple Criteria Decision Making, vol. 8, pp. 31-55.
- Górecka D., Szalucka M., 2014, *Application Of MCDA Methods and Stochastic Dominance Rules in the Entry Mode Selection Process in International Expansion*, Multiple Criteria Decision Making, vol. 9, pp. 5-31.
- Hill Ch. et al., 1990, *An Eclectic Theory of the Choice of International Entry Mode*, Strategic Journal Management, vol. 11, no. 2, pp. 117-128.
- Hinkle D., 1965, *The Change of Personal Constructs from the Viewpoint of a Theory of Construct Implications*, Ph.D. Dissertation, Ohio State University, Ohio.
- Kim Y., Gray S.J., 2008, *The impact of entry mode choice on foreign affiliate performance: The case of foreign MNEs in South Korea*, Management International Review, vol. 48, no. 2, pp. 165-188.
- Koch A.J., 2001, *Selecting overseas markets and entry modes: Two decision process or one?*, Marketing Intelligence & Planning, vol. 19, no. 1, pp. 351-361.
- Larimo J., 1995, *The foreign direct investment decision process: Case studies of different types of decision processes in Finnish firms*, Journal of Business Research, vol. 33, pp. 25-55.
- Lauf K., Schwens Ch., 2014, *Foreign market entry mode choice of small and medium-sized enterprises: A systematic review and future research agenda*, International Business Review, vol. 23, pp. 1109-1126.
- Leshno M., Levy H., 2002, *Preferred by "all" and preferred by "most" decision makers: Almost stochastic dominance*, Management Science, 48, pp. 1074-1085.
- Levary R.R., Wan K., 1999, *An analytic hierarchy process based simulation model for entry mode decision regarding foreign direct investment*, Omega, vol. 27, no. 6, pp. 661-677.
- Li J., 1995, *Foreign entry and survival: Effects of strategic choices on performance in international markets*, Strategic Management Journal, vol. 20, no. 5, pp. 333-351.
- Luo Y., 1999, *Entry and Cooperative Strategies in International Business Expansion*, Quorum Books, Westport.
- Macharis C., 2000, *Strategic Modeling for Intermodal Terminals: Socio-Economic Evaluation of the Location of Barge/Road Terminals in Flanders*, PhD Thesis, Vrije Universiteit Brussel, Brussels.
- Macharis C., 2004, *The importance of stakeholder analysis in freight transport: The MAMCA methodology*, European Transport/Transporti Europei, no. 25-26, pp. 114-126.
- Macharis C., 2005, *The importance of stakeholder analysis in freight transport*, Quarterly Journal of Transport Law, Economics and Engineering, vol. 8 (25-26), pp. 114-126.
- Macharis C., Turcksin L., Lebeau K., 2012, *Multi actor multi criteria analysis (MAMCA) as a tool to support sustainable decisions: State of use*, Decision Support Systems, 54, pp. 610-620.
- Martel J.M., Zaráš K., 1995, *Stochastic dominance in multicriteria analysis under risk*, Theory and Decision, no. 39, pp. 31-49.
- Nowak M., 2005, *Investment project evaluation by simulation and multiple criteria decision aiding procedure*, Journal of Civil Engineering and Management, vol. 11, pp. 193-202.
- Papadopoulos N. et al., 2002, *Toward a tradeoff model for international market selection*, International Business Review, vol. 11, pp. 165-192.
- Rogers M., Bruen M., 1998, *A new system for weighting environmental criteria for use within ELECTRE III*, European Journal of Operational Research, vol. 107, issue 3, pp. 552-563.
- Root F.R., 1994, *Entry Strategies for International Markets*, Jossey-Bass, San Francisco.
- Russow L.C., Okoroafo S.C., 1996, *On the way towards developing a global screening model*, International Marketing Review, vol. 13, no. 1, pp. 46-64.



- Saaty T.L., 2006, *Fundamentals of Decision Making and Priority Theory with the Analytic Hierarchy Process*, vol. VI of the AHP Series, RWS Publications, Pittsburgh.
- Saaty T.L., Vargas L.G., 1991, *The Logic of Priorities. Applications of the Analytic Hierarchy Process in Business, Energy, Health & Transportation*, vol. III of the AHP Series, RWS Publications, Pittsburgh.
- Sakarya S. et al., 2007, *Market selection for international expansion. Assessing opportunities in emerging markets*, *International Marketing Review*, vol. 24, no. 2, pp. 208-238.
- Sarkar M., Cavusgil S.T., 1996, *Trends in international business thought and literature: A review of international market entry mode research: Integration and synthesis*, *The International Executive*, vol. 38, no. 6, pp. 825-847.
- Spector Y., Leshno M., Ben Horin M., 1996, *Stochastic dominance in an ordinal world*, *European Journal of Operational Research*, 93, pp. 620-627.
- Toruńskie Zakłady Materiałów Opatrunkowych, [www.tzmo-global.com](http://www.tzmo-global.com) (25 July 2016).
- Werner S., 2002, *Recent developments in international management research: a review of 20 top management journals*, *Journal of Management*, vol. 28, no. 3, pp. 277-305.
- Wind Y., Perlmutter H., 1977, *On the identification of frontier issues in international marketing*, *Columbia Journal of World Business*, vol. 12 (Winter), pp. 131-139.
- Woodcock C. et al., 1994, *Ownership-based entry mode strategies and international performance*, *Journal of International Business Studies*, vol. 25, no. 2, pp. 253-273.
- Zaraś K., Martel J.M., 1994, *Multiattribute Analysis Based on Stochastic Dominance*, [in:] *Models and Experiments in Risk and Rationality*, Munier B., Machina M.J. (eds.), Kluwer Academic Publishers, Dordrecht, pp. 225-248.

## APPENDIX

### PROMETHEE II AND EXPROM II WITH STOCHASTIC DOMINANCE RULES AND VETO THRESHOLDS

After introducing stochastic dominance rules and veto thresholds to PROMETHEE II and EXPROM II, these procedures consist of the following steps [Nowak 2005; Górecka 2009, Górecka, 2010; Górecka 2011]:

1. Identifying the stochastic dominances for all pairs of alternatives with respect to all criteria<sup>6</sup>. Because all the criteria are measured on the ordinal scale, the ordinal stochastic dominance approach proposed in Spector et al. [1996] is applied:

**Definition 1:** Ordinal First-Degree Stochastic Dominance (OFSD):

$$X_k^i \text{ OFSD } X_k^j \text{ if and only if } \sum_{l=1}^s p_{kl}^i \leq \sum_{l=1}^s p_{kl}^j \text{ for all } s = 1, \dots, z,$$

where:  $X_k^i$  – distribution of the evaluations of alternative  $a_i$  with respect to criterion  $f_k$ ;  $p_{kl}$  – probability of obtaining the given evaluation by the alternative in the case of criterion  $f_k$ .

**Definition 2:** Ordinal Second-Degree Stochastic Dominance (OSSD):

$$X_k^i \text{ OSSD } X_k^j \text{ if and only if } \sum_{r=1}^s \sum_{l=1}^r p_{kl}^i \leq \sum_{r=1}^s \sum_{l=1}^r p_{kl}^j \text{ for all } s = 1, \dots, z.$$

For modelling preferences the ordinal almost stochastic dominances are also utilized<sup>7</sup>:

**Definition 3:** Ordinal Almost First-Degree Stochastic Dominance (OAFSD):

$$X_k^i \varepsilon_1^* \text{-OAFSD } X_k^j, \text{ if for } 0 < \varepsilon_1^* < 0.5$$

$$\sum \left( \sum_{l=1}^{s_1} p_{kl}^i - \sum_{l=1}^{s_1} p_{kl}^j \right) \leq \varepsilon_1^* \|X_k^i - X_k^j\| \text{ for all } s_1 = 1, \dots, z,$$

<sup>6</sup> It is assumed that the decision-maker(s) is (are) risk-averse and all the criteria are maximized.

<sup>7</sup> Almost stochastic dominances were proposed in [Leshno, Levy 2002].

where:  $s_1 = \left\{ s : \sum_{l=1}^s p_{kl}^j < \sum_{l=1}^s p_{kl}^i \right\}$ ,  $\|X_k^i - X_k^j\| = \sum \left( \left| \sum_{l=1}^s p_{kl}^i - \sum_{l=1}^s p_{kl}^j \right| \right)$ ,

$\varepsilon_1^*$  – allowed degree of OFSD rule violation, which reflects the decision-makers preferences;  $\varepsilon_1^* \geq \varepsilon_1$ , where  $\varepsilon_1$  – the actual degree of OFSD rule violation.

**Definition 4:** Ordinal Almost Second-Degree Stochastic Dominance (OASSD):

$X_k^i \varepsilon_2^* - OASSD X_k^j$ , if for  $0 < \varepsilon_2^* < 0.5$

$$\sum \left( \sum_{l=1}^{s_2} p_{kl}^i - \sum_{l=1}^{s_2} p_{kl}^j \right) \leq \varepsilon_2^* \|X_k^i - X_k^j\| \quad \text{for all } s_2 = 1, \dots, z \quad \text{and } \mu_k^i \geq \mu_k^j,$$

where  $s_2 = \left\{ s_1 : \sum_{r=1}^{s_1} \sum_{l=1}^r p_{kl}^j < \sum_{r=1}^{s_1} \sum_{l=1}^r p_{kl}^i \right\}$ ,

$$\|X_k^i - X_k^j\| = \sum \left( \left| \sum_{l=1}^s p_{kl}^i - \sum_{l=1}^s p_{kl}^j \right| \right),$$

$\mu_k^i$  and  $\mu_k^j$  – average performances (expected values of the evaluations’ distributions) of the alternatives  $a_i$  and  $a_j$  on the criterion  $f_k$ ,  $\varepsilon_2^*$  – allowed degree of OSSD rule violation, which reflects the decision-makers preferences;  $\varepsilon_2^* \geq \varepsilon_2$ , where  $\varepsilon_2$  – the actual degree of OSSD rule violation.

2. Calculation of concordance indices for each pair of alternatives  $(a_i, a_j)$ :

$$c(a_i, a_j) = \sum_{k=1}^n w_k \varphi_k(a_i, a_j)$$

where:

$$\sum_{k=1}^n w_k = 1$$

$$\varphi_k(a_i, a_j) =$$

$$= \begin{cases} 1 & \text{if } X_k^i SD X_k^j \quad \text{and} \quad \mu_k^i > \mu_k^j + p_k[\mu_k^i], \\ \frac{\mu_k^i - q_k[\mu_k^i] - \mu_k^j}{p_k[\mu_k^i] - q_k[\mu_k^i]} & \text{if } X_k^i SD X_k^j \quad \text{and} \quad \mu_k^j + q_k[\mu_k^i] < \mu_k^i \leq \mu_k^j + p_k[\mu_k^i], \\ 0 & \text{otherwise,} \end{cases}$$

$w_k$  – coefficient of importance for criterion  $f_k$ ;  $q_k[\mu_k^i], p_k[\mu_k^i]$  – indifference and preference threshold for criterion  $f_k$  respectively.

3. Calculation of discordance indices for each pair of alternatives and for each criterion:

$$d_k(a_i, a_j) = \begin{cases} 1 & \text{if } X_k^j \text{SD } X_k^i \text{ and } \mu_k^j > \mu_k^i + v_k[\mu_k^i], \\ \frac{\mu_k^j - p_k[\mu_k^i] - \mu_k^i}{v_k[\mu_k^i] - p_k[\mu_k^i]} & \text{if } X_k^j \text{SD } X_k^i \text{ and } \mu_k^i + p_k[\mu_k^i] < \mu_k^j \leq \mu_k^i + v_k[\mu_k^i], \\ 0 & \text{otherwise,} \end{cases}$$

where  $v_k[\mu_k^i]$  – veto threshold for criterion  $f_k$ .

4. Calculation of credibility indices for each pair of alternatives  $(a_i, a_j)$ :

$$\sigma(a_i, a_j) = c(a_i, a_j) \prod_{k \in D(a_i, a_j)} \frac{1 - d_k(a_i, a_j)}{1 - c(a_i, a_j)}$$

where:  $D(a_i, a_j) = \{k : d_k(a_i, a_j) > c(a_i, a_j)\}$ .

5. In the PROMETHEE II method with SD rules and veto thresholds a final complete ranking is constructed according to the descending order of the net flows  $\phi_p(a_i)$ , where  $\phi_p(a_i) = \phi_p^+(a_i) - \phi_p^-(a_i)$ . Outgoing flow  $\phi_p^+(a_i)$  and incoming flow  $\phi_p^-(a_i)$  for each alternative are calculated as follows:

$$\phi_p^+(a_i) = \frac{1}{m-1} \sum_{j=1}^m \sigma(a_i, a_j), \quad \phi_p^-(a_i) = \frac{1}{m-1} \sum_{j=1}^m \sigma(a_j, a_i).$$

In the EXPROM II method with SD rules and veto thresholds there are additional steps:

6. Determination of strict preference indices for each pair of alternatives  $(a_i, a_j)$ :

$$\pi(a_i, a_j) = v(a_i, a_j) \cdot \sum_{k=1}^n w_k \pi_k(a_i, a_j),$$

where:

$$v(a_i, a_j) = \begin{cases} 1, & \text{if } \forall k : d_k(a_i, a_j) \leq c(a_i, a_j), \\ 0, & \text{if } \exists k : d_k(a_i, a_j) > c(a_i, a_j), \end{cases}$$

$$\pi_k(a_i, a_j) = \begin{cases} \frac{(\mu_k^i - \mu_k^j) - p_k[\mu_k^i]}{(\mu_k^* - \mu_{k^*}) - p_k[\mu_k^i]} & \text{if } \varphi_k(a_i, a_j) = 1, \\ 0 & \text{otherwise,} \end{cases}$$

$$\mu_k^* = \max_{a_i \in A} \mu_k^i \quad \text{and} \quad \mu_{k^*} = \min_{a_i \in A} \mu_k^i.$$

The aim of the strict preference function  $\pi_k(a_i, a_j)$  is to differentiate the state of the strict preference found to be valid for more than one pair of alternatives at a given criterion  $f_k$ . Their values belong to the interval  $[0,1]$  and  $\pi_k(a_i, a_j) = 0$  denotes weak preference or indifference between two alternatives.

7. Calculation of a total preference index for each pair of alternatives  $(a_i, a_j)$ :

$$\omega(a_i, a_j) = \min \{1; \sigma(a_i, a_j) + \pi(a_i, a_j)\}.$$

The total preference index gives an accurate measure of the intensity of preference of alternative  $a_i$  over  $a_j$  for all the criteria. It combines two aspects: subjective – expressed by the credibility index and referring only to the relation between two examined alternatives, and objective – expressed by the strict preference index and representing the relation between two considered alternatives with regard to the other alternatives examined.

In the EXPROM II method with SD rules and veto thresholds a final complete ranking is constructed according to the descending order of the net flows  $\phi_E(a_i)$ , where  $\phi_E(a_i) = \phi_E^+(a_i) - \phi_E^-(a_i)$ . Outgoing flow  $\phi_E^+(a_i)$  and incoming flow  $\phi_E^-(a_i)$  for each alternative are calculated as follows:

$$\phi_E^+(a_i) = \frac{1}{m-1} \sum_{j=1}^m \omega(a_i, a_j), \quad \phi_E^-(a_i) = \frac{1}{m-1} \sum_{j=1}^m \omega(a_j, a_i).$$