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SIMILARITIES AND DIFFERENCES BETWEEN THE DEVELOPMENT STRATEGIES OF POLAND AND CANADA AS COMPARED TO THE EUROPEAN UNION COUNTRIES

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Abstract

The objective of this article is to expose the results of a research using DRSA (Dominance-based Rough Set Approach) to help the European Union (EU) identifying political, economical, sociological and technological strategic objectives. Using the proposed methodology, politicians and leaders will be able to prioritize strategic development objectives according to Political, Economical, Sociological and Technological (PEST) needs of a specific candidate country to the EU. More precisely, the proposed methodology classifies all the European Union's countries in the following three categories: [A] EU countries that are doing well according to the selected indicators; [B] EU countries that need support to acquire category A status; [C] EU countries ranked the lowest and needing special support with regard to the criterion or criteria considered. The three categories are delimited by tertiles relative to the average ranking of all EU countries separately and including Canada. Afterwards, the DRSA provides decision rules based on this classification. These decision rules thus focus on the PEST needs of countries and aim at improving their development and classification by pointing out what is needed to be included in the different categories. The case of Canada and Poland are of particular interest because Canada's trade turnover is dominated by exchange with the United States and is currently threatened by the protectionist policy of President Trump. Canadian politicians are increasingly proposing to change Cana-

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da's trade strategy towards joining the European Union. According to Thomas Lukaszuk Vice Prime Minister of Alberta, Poland could play an important role in this endeavor.

Keywords: international development, European Union countries, international aid, economic growth, strategic objectives, Rough Set Theory, Dominance-based Rough Set Approach (DRSA), selection of portfolio projects, multi-criteria analysis, sustainable development.

1 Introduction

This research suggests to use a systematic approach using a combination of statistics and DRSA to help Canada, Poland and the European Union identifying strategic objectives to improve itself compared to similar economies. The systematic approach begins with a selection of statistical data taken from the World Bank and various indexes. These variables are separated over four different perspectives (Political, Economic, Sociological and Technological). The ranking of all selected countries according to these perspectives is then performed with the weighted average. The final step is the use of DRSA to identify decision rules and conditions for each country. These conditions represent strategic objectives which have to be achieved to improve the country development as compared to others. This research deals with all countries of the European Union and the focus is a comparison of Poland and Canada. Therefore, the systematic approach will categorize all countries within the European Union and determine decision rules used to improve their development through the identified conditions which should be considered as their own strategic objectives.

2 Literature review

Proposed by Pawlak (1991; 2002) and by Pawlak and Slowinski (1994), the Rough Set Theory is a mathematical tool which aims at supporting decision-making processes. Since its development, it has been used in many fields such as medicine, banking, engineering, learning, location selection, pharmacology, finance, market analysis and economics. It was later extended by Greco, Matarazo and Slowinski (2001) and renamed the "Dominance-based Rough Set Approach" (DRSA). Then, Zaras enlarged it for mixed data (deterministic, probabilistic and fuzzy) (Zaras, 2004). This research is the fourth in the series of three studies: Trudel, Marin, Zaras (2018); Marin, Zaras, Trudel (2014) and Zaras, Marin, Trudel (2019) to cope with strategic development objectives using Dominance-based Rough Set Approach (DRSA). The purpose of the present study is to use DRSA for developing strategic objectives for all EU countries in order to help their decision makers and leaders to target specific objectives to

improve the political, economic, sociological and technological development of the EU. To do so 20 variables were selected which were categorized in four different perspectives (Political, Economic, Sociological and Technological). DRSA will be able to prioritize strategic objectives to help the decision makers with the actual data and results from Poland.

3 Political, Economic, Sociological and Technological indicators

To obtain the data of the 20 variables considered in this research we navigated and searched through the websites of the World Bank, the United Nations and also the International Institute for Strategic Studies (World Bank, 2025; United Nations, 2025; IISS, 2025) during January 2025. Data were distributed into four perspectives, namely Political, Economic, Sociological and Technological (PEST) as summarized in Table 1.

Table 1: Summary of the PEST indicators considered in this research

Perspectives and measurement	**Definition**	**Indicator**	**↑ = High is better ↓ = Low is better**
1	***2***	***3***	***4***
Political			
1.1 Political stability and Absence of Violence/ Terrorism: Estimation	Political stability and Absence of Violence/ Terrorism measures perception of likelihood of political instability and/or politically motivated violence, including Terrorism (2023)	Scale: –2.5 weak +2.5 strong	↓
1.2 Corruption perception index	A ranking of countries according to the extent to which corruption is believed to exist (2023)	Scale 1-100	↑
1.3 Global Peace Index	Number of battle deaths from internal conflict between at least one government armed forces (2023)	Scale 0-5	↑
1.4 Ease of doing business index	Ease of doing business index (2023)	Ranking of world country	↓
1.5 Women in government	Proportion of seats held by women in national parliaments (2023)	%	↑
Economic			
2.1 Exports of G&S	Exports of goods and services (% of GDP 2023)	%	↑
2.2 GDP per capita	Gross Domestic Product (USD Constant 2023) divided by capita	$	↑
2.3 GNI per capita	Gross National Income per capita Atlas method (Current USD 2023)	$	↑
2.4 Households	Final consumption expenditure (% of GDP 2023)	%	↓
2.5 Labor force participation	% of total participation ages 15+	%	↑
2.6 Manufactures exports	% of merchandise exports (2023)	%	↑

Table 1 cont.

1	*2*	*3*	*4*
Sociological			
3.1 Life expectancy	Life expectancy at birth (years 2023)	Number of years	↑
3.2 Adolescent fertility	Number of births per 1000 women ages 15-19 (2023)	Number	↓
3.3 Homicides	Intentional homicide refers to death deliberately inflicted on a person by another person (2023)	Number per 100K	↓
3.4 Unemployment	% of total Labor force (2023)	%	↓
3.5 Urban population	% of total population (2023)	%	↑
3.6 Population growth	Annual growth (2023)	%	↑
Technological			
4.1 High-technology exports	Percentage of manufactured exports (2023)	%	↑
4.2 Secure internet	Secure internet servers per million people (2023)	Number per million	↑
4.3 Academic papers	Annual articles published in scientific and technical journals per million (2023)	Number per million	↑

4 The Dominance-based Rough Set Approach (DRSA) applied to determine the strategic developmental objectives

In order to determine the strategic objectives of Canada and Poland for improving its overall classification, the methodology of the Dominance-based Rough Set Approach (DRSA) by Zaras, Marin, Trudel (2012), was carried out. This methodology begins with the classification of all the EU countries for each perspectives in category A, B or C: Category [A] EU countries that are doing well according to the selected indicators; [B] EU countries that need support to acquire category A status; [C] EU countries ranked the lowest and needing special support with regard to the criterion or criteria considered. These classifications are presented in Table 2, where all the 27 EU countries are categorized with respect to the four perspectives (PEST) and then for the 28 countries including Canada in Table 3. Next, decision rules are extracted for all the perspectives combined, and also for each individual perspective (PEST). Finally, we identify Canada's and Poland's strategic objectives with regard to their respective variables and performance.

4.1 Formulation of the multi-criteria problems

Our first task was to obtain the overall ranking of the 27 countries on the basis of the 20 criteria measured by 20 indicators. Secondly, we did the same but for each perspective according to its respective criteria. That approach can be described using the decision matrix formed by alternatives A in rows and criteria X in columns, where the compliance of an alternative with a criterion is reflected by its evaluation E, where:

- ***A*** is a finite set of countries a_i for i = 1, 2, …, 27,
- ***X*** is a finite set of criteria X_k for k = 1, 2,…, 20 and X_{kj} is a subset of criteria for each perspective j = 1, 2, 3, 4,
- ***E*** is the set of evaluations measured by indicators $e_{i,k}$ with respect to criterion X_k and indicators $e_{i,kj}$ with respect to criterion X_{kj} for each perspective j.

The weighted average rank method was used to obtain the ranking of countries. Thus, countries were ranked from the most to the least preferable with respect to each indicator in relation to each criterion. Afterward, since weights of indicators are considered equal, we calculated the weighted average rank for each country. This enables us to obtain the ranking of the countries with respect to a given perspective as well as for the overall classification, that is: the weighted average rank of country i for perspective j,

$$r_{ij} = \sum_{kj} w_{kj} r_{kij} \tag{1}$$

the overall weighted average rank of country i,

$$r_i = \sum_{k} w_k r_{ki} \tag{2}$$

where:
w_k is the weight of criterion k and w_{kj} is the weight of criterion k for perspective j;
r_{ki} is a rank of country i with respect to criterion k and $r_{ki\,j}$ is the rank of country i with respect to criterion k for perspective j.

With the classifications of 27 countries, overall and for each perspective, the next step is to group them into three categories A, B and C. Table 2 presents these classifications of the 27 European Union countries according to the four perspectives as well as for the overall one presented in first column.

Table 2: Overall and partial classifications of the UE countries according to the four perspectives

Decision	Countries	Political	Economical	Sociological	Technological
1	*2*	*3*	*4*	*5*	*6*
A	Ireland	A	A	A	A
A	Danemark	A	A	A	A
A	Netherlands	A	A	A	A
A	Luxembourg	A	A	A	B
A	Sweden	A	A	A	A
A	Malta	B	A	A	B
A	Austria	A	A	B	B
A	Czechia	B	A	A	A
A	Finland	A	B	B	A
B	Germany	A	A	B	A
B	Slovenia	A	B	B	B
B	Belgium	B	B	A	B
B	Estonia	B	B	C	A
B	France	B	B	B	B
B	Portugal	A	C	B	C

Table 2 cont.

1	*2*	*3*	*4*	*5*	*6*
B	Cyprus	C	B	B	A
B	Italy	C	C	A	B
B	Lithuania	B	B	C	B
C	Spain	B	C	B	C
C	Hungary	C	B	C	B
C	Poland	C	C	B	C
C	Slovakia	C	B	C	C
C	Latvia	B	C	C	C
C	Croatia	C	C	C	C
C	Bulgaria	C	C	C	C
C	Greece	C	C	C	C
C	Romania	C	C	C	C

Table 3: Overall and partial classifications of the UE countries including Canada according to the four perspectives

Countries	**No**	**Decision**	**Political**	**Economical**	**Sociological**	**Technological**
Ireland	1	A	A	A	A	A
Danemark	2	A	A	A	A	A
Netherlands	3	A	B	A	A	A
Luxembourg	4	A	A	A	B	A
Sweden	5	A	A	A	A	B
Malta	6	A	B	A	B	A
Austria	7	A	A	A	B	B
Czechia	8	A	B	A	A	A
Finland	9	A	A	B	A	B
Canada	10	B	A	B	A	B
Germany	11	B	A	A	A	B
Slovenia	12	B	A	B	B	B
Belgium	13	B	B	B	B	A
Estonia	14	B	B	B	A	C
France	15	B	B	B	B	B
Portugal	16	B	A	C	C	B
Cyprus	17	B	C	B	A	B
Italy	18	B	C	C	C	A
Lithuania	19	C	B	C	B	C
Spain	20	C	B	C	C	B
Hungary	21	C	C	B	B	C
Poland	22	C	C	C	C	C
Slovakia	23	C	C	B	C	C
Latvia	24	C	B	C	C	C
Croatia	25	C	C	C	C	C
Bulgaria	26	C	C	C	C	C
Greece	27	C	C	C	C	C
Romania	28	C	C	C	C	C

In Table 2, the classification of Poland is C and in Table 3, the classification of Canada is B. Decision makers may select decision rules to take actions to improve their ranking versus the rest of the European Union. The proposed DRSA explanatory method allows us to identify these criteria as well as their critical values, through the extraction of decision rules. Comparing the classifications in Table 2 with those in Table 3, we can see the consequences of Canada's accession for EU countries. Lithuania drops from class B to class C. The partial classifications of countries such as Netherlands, Luxembourg, Sweden, Malta, Finland, Germany, Belgium, Estonia, Portugal, Italy, Lithuania, Spain, Hungary and Poland also change.

4.2 The decision rules

To obtain the decision rules we used the 4eMka2 software, developed by the Intelligent Decision Support Systems laboratory (IDSS) at the Computing Science Institute of the Poznan University of Technology.

It is in the interest of Poland, which in Table 2 is classified in category C from three political, economic and technological perspectives, to move to category B. This is why in Table 4 we extracted eight decision rules to be at least B for these perspectives with a minimal strength of 25% to get stronger combinations of criteria.

Table 4: Decision rules for each perspective without Canada (PEST)

#	Decision rules	Condition 1	Condition 2	Condition 3
	Political Perspective			
1	Decision ≥ B	Corruption Index ≥ 57		
	Economic Perspective			
2	Decision ≥ B	Household ≤ 53.4%		
3	Decision ≥ B	Export of G&S ≥ 91.95%		
4	Decision ≥ B	Laborforce ≥ 62.16%		
	Technological Perspective			
5	Decision ≥ B	Security internet ≥ 60480.47		
6	Decision ≥ B	High-tech exportation ≥ 17.89%	Security internet ≥ 53717.79	
7	Decision ≥ B	Scientific articles ≥ 1436	High-tech exportation ≥ 9.9%	
8	Decision ≥ B	High-tech exportation ≥ 18.67%		

It is in the interest of Canada, which in Table 3 is classified in category B from two economic and technological perspectives, to move to category A. This is why in Table 5 we extracted six decision rules to be at least A for these perspectives with a minimal strength of 25%.

Table 5: Decision rules for each perspective with Canada (PEST)

#	Decision rules	Condition 1	Condition 2	Condition 3
	Economic Perspective			
C1	Decision ≥ A	GNI per capita ≥ 54.800 $		
C2	Decision ≥ A	Manufacture ≥ 90.08%		
C3	Decision ≥ A	Export of G&S ≥ 122.77%		
	Technological Perspective			
C4	Decision ≥ A	Security internet ≥ 112224		
C5	Decision ≥ A	Scientific articles ≥ 2110		
C6	Decision ≥ A	High-Tech exportation ≥ 20.30 %	Scientific articles ≥ 1424	

The conditions from the decision rules determine critical values needed to move to a higher category. By comparing them with the current values we obtain the increase in value needed to move to a higher category (which we call strategic objectives).

4.3 Strategic objectives and performance measures for Poland

Table 6 describes all the various strategic objectives for Poland. The decision rules from Table 4 dictate the targets they should be reached for each strategic objective. It may happen that some conditions on decision rules have been already met. In that case the strategic objective is to maintain their current value. All the other values become strategic objectives and which would allow Poland to be rank B instead of C. In order to improve its status compared to all other members of the EU, Poland should consider the decision rules that explain what was needed to be included in category B.

Table 6: Strategic objectives and targets for Poland

Political Perspective	**Strategic Objectives 1**	**Strategic Objectives 2**
In according to Decision rule #1	Improve the corruption perception index by 3 points	
Economical Perspective	**Strategic Objectives 1**	**Strategic Objectives 2**
In according to Decision rule #2	Reduce Household by 4%	
In according to Decision rule #3	Improve exports of goods and services by 34% of GDP	
In according to Decision rule #4	Improve the gross domestic product GDP by 37 000 (USD) per capita	
Technological Perspective	**Strategic Objectives 1**	**Strategic Objectives 2**
In according to Decision rule #5	Increase a number of Secure Internets servers by 24 000 per million people	
In according to Decision rule #6	Increase High-Technology exports by 8% of manufactured exports	Increase a number of Secure Internets servers by 17 250 per million people
In according to Decision rule #7	Increase a number of Scientific Articles by 500 per million people	
In according to Decision rule #8	Improve High-Technology exports by 9% of manufactured exports	

Analyzing Political perspective from Table 6, Poland should improve the Corruption Perception Index by 3 to be included in category B. From Economic perspective, Poland should improve the GDP by 37 000 (USD) per capita which is almost impossible in short time. The highest increase of GDP in Poland, from 2022 to 2023, was 3384 (USD) per capita. The same can be said about improving exports of goods and services by 34% of GDP when the highest increase of export in Poland from 2021 to 2022 was 5.4%. However, reduction of Household expenditure by 4% is possible. Recently, the highest reduction we observed from 2022 to 2023 was at the level 2.5%.

Analyzing the situation of Poland from Technological perspective in Table 6, moving to class B is more likely, provided that Poland increases High-Technology exports by 8% of Manufactured exports and the number of Secure Internets servers by 17 250 per million people which is an indicator related to cybersecurity. The increase in R&D expenditure efficiency is measured by the number of papers published in scientific and technical journals. In Poland, this number should increase by 500 per million people for the country to be included in category B.

4.4 Strategic objectives and performance measures for Canada

Table 7 describes all the various strategic objectives for Canada. The decision rules from Table 5 dictate the targets they should be reached for each strategic objective. In order to improve its status compared to all the members of the EU, Canada should consider decision rules that explain what was needed to move to category A.

Table 7: Strategic objectives and targets for Canada

Economical Perspective	**Strategic Objective**
In according to Decision rule #C1	Increase GNI per capita by 800 USD
In according to Decision rule #C2	Improve Manufacture by 46%
In according to Decision rule #C3	Improve Export of G&S by 90%
Technological Perspective	**Strategic Objective**
In according to Decision rule #C4	Increase the number of Secure Internet servers by 70 000 per million people
In according to Decision rule #C5	Increase the number of Scientific articles by 300
In according to Decision rule #C6	Improve High-Tech exportation by 6%

Analyzing the Economical perspective from Table 7, Canada should improve the Export of G&S by 90%, Manufacture by 46% and increase GNI per capita by 800 USD which is almost impossible in short time. High-technology exports (% of manufactured exports) in Canada was reported at 15.19% in 2023 and Manufacture was improved from 2022 to 2023 by 4%. It seems more likely that Canada could move to category A from the point of view of the Technological perspective by improving High-Tech exportations of 6% or increasing the number of scientific publications by 300 per million people which is more realistic.

5 Conclusions

In this presentation, it was shown that the DRSA allows us to explain the classification. The decision rules explain why a given country was classified in a particular category, what criteria were relevant in this classification and what are the critical values determining each category.

In relation to the Economic and Technological perspectives we observe similar trends in Poland and Canada but in Poland they occur in a category below. From the Economic perspective it is almost impossible for Canada to move to category A in short time; the same holds for Poland as regards its move to category B. From the Technological perspective it is more likely that Canada moves to category A and Poland, to category B. For Poland the most likely transition to category B is from the Political perspective. From this perspective Canada is in category A. The situation of Poland and Canada is relatively good, each is at its own level from the Sociological perspective: Poland belongs to category B and Canada to category A.

References

Greco S., Matarazzo B., Słowiński R. (2001), *Rough Sets Theory for Multi-Criteria Decision Analysis*, European Journal of Operational Research, 129, 1-47.

International Institute for Strategic Studies, IISS (2025), https://www.iiss.org (accessed: 4.01. 2025).

Marin J.-C., Zaras K., Boudreau-Trudel B. (2014), *Use of the Dominance-Based Rough Set Approach as a Decision Aid Tool for the Selection of Development Projects in Northern Quebec*, Modern Economy, 5, 723-741.

Pawlak Z. (1982), *Rough Set*, International Journal of Parallel Programming, 11, 341-356.

Pawlak Z. (1991), *Rough Sets: Theoretical Aspects of Reasoning about Data*, Kluwer Academic Publishing, Dordrecht. http://dx.doi.org/10.1007/978-94-011-3534-4

Pawlak Z. (2002), *Rough Set Theory and Its Applications*, Journal of Telecommunications and Information Theory, 3, 7-10.

Pawlak Z., Slowinski R. (1994), *Rough Set Approach to Multi-Attribute Decision Analysis*, European Journal of Operational Research, 72, 443-459. http://dx.doi.org/10.1016/0377-2217(94)90415-4

Trudel B., Marin J.-C., Zaras K. (2018), *Identifying Strategic Development Objectives for European Union's Potential Candidate States Using Dominance-Based Rough Set Approach: Case Study of Bosnia and Herzegovina*, Modern Economy, 9(8), 1452-1464.

United Nations (2025), UNData, http://data.un.org/Explorer.aspx?d=UNODC (accessed: 4.01.2025).

World Bank (2025), Indicators, https://data.worldbank.org/indicator (accessed: 4.01.2025).

Zaras K. (2004), *Rough Approximation of a Preference Relation by a Multi-Attribute Stochastic Dominance for Deterministic, Stochastic and Fuzzy Evaluation Problems*, European Journal of Operational Research, 159, 196-206.

Zaras K., Marin J.-C., Trudel B. (2012), *Dominance Rough Set Approach as a Decision-Making Method for the Selection of Sustainable Development Projects*, American Journal of Operational Research, 2, 506-508.

Zaras K., Marin J.-C., Trudel B. (2019), *Identifying Strategic Development Objectives for European Union States Using the Dominance-Based Rough Set Approach: The Case of Poland*, Multiple Criteria Decision Making, 14, 144-156.