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Analyzing Primary Sector Selection for Economic Activity in Romania: An Interval-Valued Fuzzy Multi-Criteria Approach

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Abstract: This study presents an in-depth analysis of the selection process for primary sectors impacting the economic activity in Romania, employing an interval-valued fuzzy (IVF) approach combined with multi-criteria decision-making (MCDM) methodologies. This research aims to identify eight key criteria influencing the selection of Romanian primary sectors, including technology adaptation, infrastructure development and investment, gross domestic product (GDP), sustainability, employment generation, market demand, risk management and government policies. The current analysis evaluates eight primary sector performances against these eight criteria through the application of three MCDM methods, namely, Simple Additive Weighting (SAW), Weighted Product Model (WPM), and Weighted Aggregated Sum Product Assessment (WASPAS). Ten economic experts comprising a committee have been invited to provide their views on the criteria's importance and the alternatives' performance. Based on the decision-maker's qualitative judgement, GDP acquires the highest weightage, followed by environmental impact and sustainability, thus indicating the most critical factors among the group. The IVF-MCDM hybrid model indicates the energy sector as Romanian primary sector with the most potential, followed by the agriculture and forestry sector among the list of eight alternatives. It also explores the robustness of results by considering sensitivity analysis and the potential impacts of political and international factors, such as pandemics or armed conflicts, on sector selection. The findings indicate consistency in sector rankings across the different methodologies employed, underscoring the importance of methodological choice and criteria weighting. Additionally, this study sheds light on the potential influence of political and international dynamics on sector prioritization, emphasizing the need for comprehensive decision-making frameworks in economic planning processes.

Keywords: interval-valued fuzzy sets (IVFS); multi-criteria decision-making (MCDM); SAW; WPM; WASPAS; primary sector; Romanian economy

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1. Introduction

The primary sector (PS), a cornerstone of Romania's economic activity, significantly shapes its economic landscape. Situated in south-eastern Europe with abundant natural resources, fertile lands, and a favorable climate for agriculture, Romania's primary sector, including agriculture, forestry, fishing, and mining, has historically driven economic growth and sustainability [1]. The primary sector selection process holds critical significance for

Romania's economic development, given its pivotal role in driving growth, employment, and sustainability. Against a backdrop of evolving economic challenges and opportunities, understanding the dynamics of primary sector selection becomes imperative. Romania, as an emerging market economy, faces distinct challenges in optimizing its primary sector activities to maximize economic productivity and resilience. This section delves into the crucial role the primary sector plays in Romania's economy, encompassing its historical significance and implications for economic development [2]. From the lush fields of Transylvania to the mineral-rich Carpathian Mountains, Romania's dynamic primary sector continues to mold the nation's economic destiny. The significance of this study lies in its exploration of the nuanced factors influencing primary sector selection and the methodologies employed to address them. Romania's economic landscape is characterized by a diverse range of primary sector activities, spanning agriculture, manufacturing, energy, and natural resource extraction. However, navigating the complexities of sectoral prioritization amidst fluctuating market dynamics, technological advancements, and geopolitical uncertainties presents a formidable challenge [3]. The significance of this research can be described as follows.

- Economic development: The primary sector plays a crucial role in Romania's economy, contributing significantly to GDP, employment, and overall economic activity. Understanding which primary sectors drive economic activity in Romania is important for fostering economic growth and development [4]. By identifying key sectors and understanding their contributions, policymakers can formulate targeted strategies to strengthen these sectors and enhance overall economic performance.
- Resource allocation: Effective resource allocation is essential for maximizing productivity and efficiency within primary sectors [5]. This research identifies key criteria influencing sector selection and evaluates sector performance against these criteria, allowing policymakers and stakeholders to optimize resources more strategically, directing investments, subsidies, and support towards sectors with the greatest potential for growth and impact on the economy.
- Diversification: Romania's economy may benefit from diversifying its primary sector activities to reduce dependence on a narrow range of industries [6]. Studying sector selection can reveal opportunities for diversification into new sectors or value chains, thereby spreading risk and enhancing economic resilience against external shocks or market fluctuations.
- Employment opportunities: The primary sector is a significant source of employment in Romania, particularly in rural areas [7]. Understanding which sectors contribute most to job creation and income generation can inform policies aimed at promoting employment growth and improving livelihoods, especially in regions with high unemployment rates or limited economic opportunities.
- Sustainability: As sustainability becomes increasingly important globally, studying the selection of primary sectors can help identify opportunities to promote environmentally friendly practices and sustainable development. By prioritizing sectors with lower environmental impacts and higher resource efficiency, Romania can contribute to environmental protection and meet its international commitments towards sustainable development goals [8]. This research evaluates primary sector performance with respect to criteria such as environmental impact and income distribution, facilitating the identification of sustainable development pathways and the promotion of green growth strategies.
- Policy formulation: Insights from studying sector selection can inform the formulation of economic policies and strategies at the national and regional levels [9]. Decision-makers can use this knowledge to design policies that support the growth and competitiveness of priority sectors, foster innovation and technological advancement, and create an enabling environment for business development and investment.

Hence, it is very important to study the primary sectors that directly or indirectly influence the Romanian economy. This research aims to identify the potential primary sectors and rate them according to their effect on the Romanian economy. Romania faces unique challenges and opportunities in its primary sector activities, ranging from agricultural modernization and industrial diversification to environmental sustainability and technological innovation [10]. This research seeks to address these challenges and leverage opportunities by providing insights into sectoral performance and identifying areas for improvement. In an increasingly globalized and uncertain economic landscape, enhancing the resilience of primary sectors is essential for mitigating risks and adapting to changing market conditions. By analyzing sectoral performance under different scenarios and considering external factors such as political events or international trade dynamics, this research aims to contribute to the development of robust and adaptive economic strategies. Moreover, the selection of primary sectors involves complex decision-making processes that consider various economic, social, environmental, and political factors. By employing an IVF-MCDM approach, this research aims to provide a structured framework for analyzing and prioritizing primary sectors effectively [11]. Therefore, the motivation behind this research is to provide actionable insights and decision support tools that can inform strategic interventions aimed at strengthening Romania's primary sector activities, driving economic growth, and promoting sustainable development.

1.1. Historical Significance of the Primary Sector in Romania

Centuries of agrarian and extractive activities form the historical foundation of Romania's primary sector [3]. Agriculture, a cornerstone of the country's culture and economy, thrived owing to its fertile plains, extensive river systems, and temperate climate, enabling the cultivation of crops like wheat, corn, barley, and sunflowers. Romania's historical agricultural output played a crucial role in sustaining its population and establishing its prominence as a regional agricultural producer. Simultaneously, the Carpathian Mountains' vast forests provided timber and forest products, supporting local communities and serving as valuable resources for construction, fuel, and export [4]. Forestry activities became more regulated during the late medieval period. Additionally, Romania's rich mining history involved the extraction of gold, silver, salt, coal, and other minerals. This mining heritage expanded during the 19th century industrialization, contributing significantly to Romania's primary sector and its broader European importance. The historical significance of the eight primary sectors in Romania highlights their pivotal roles in shaping the country's economy, society, and identity over time. Let us delve deeper into historical information about each of the primary sectors in Romania.

- Energy sector: Romania's energy sector has historical significance dating back to the late 19th century, when oil fields were discovered in Ploiești. This discovery propelled Romania into the ranks of major oil-producing nations, fueling industrialization and economic growth. Throughout the 20th century, Romania invested in expanding its energy infrastructure, including the development of hydropower plants, coal mines, and nuclear reactors. The energy sector played a crucial role during periods of political change, providing a source of national revenue and energy independence.
- Agriculture and forestry: Agriculture and forestry have been central to Romania's economy and culture for centuries. Historically, Romania's fertile plains and favorable climate supported diverse agricultural activities, including wheat, corn, grapes, and orchards. Traditional farming methods, such as crop rotation and transhumance, were practiced for generations. Similarly, Romania's vast forests have been a vital source of timber, fuel, and biodiversity, contributing to rural livelihoods and environmental conservation efforts.
- Manufacturing and construction: Romania's manufacturing and construction sectors have undergone significant transformations throughout history. Industrialization gained momentum in the late 19th and early 20th centuries, with the establishment of textile mills, metallurgical plants, and machinery factories. The construction industry boomed during periods of urbanization and infrastructure development, with notable

projects including roads, railways, and buildings. These sectors played pivotal roles in shaping Romania's modern economy and urban landscape.
- Information technology: The Information Technology (IT) sector in Romania has evolved rapidly since the late 20th century. Following the fall of communism, Romania embarked on economic reforms and invested in technology and telecommunications infrastructure. The IT industry experienced exponential growth, driven by a skilled workforce, favorable business environment, and government support. Today, Romania is known for its thriving IT sector, with strengths in software development, IT services, and innovation.
- Mining: Romania's mining industry has ancient origins, with evidence of mining activities dating back to Roman times. Throughout history, Romania has been known for its rich mineral deposits, including gold, silver, copper, salt, and coal. Mining played a vital role in the country's economy, attracting investment, generating revenue, and supporting industrialization. However, the mining sector also faced challenges related to environmental degradation, labor conditions, and economic fluctuations.
- Automobile industry: The automobile industry in Romania emerged in the mid-20th century, with the establishment of manufacturing plants and assembly lines. Initially focused on producing vehicles for domestic consumption, Romania later attracted foreign investment from multinational automakers. This led to the expansion of the automobile industry, with the production of passenger cars, commercial vehicles, and automotive components. The sector became a significant contributor to Romania's GDP and exports.
- Textile industry: Romania's textile industry has a long history dating back centuries, rooted in traditional craftsmanship and artisanal production. Textile manufacturing flourished during the Industrial Revolution, with the establishment of factories and mills in urban centers. Romania's textile sector boomed in the 20th century, producing a wide range of fabrics, garments, and textiles for domestic and international markets. The industry provided employment opportunities and contributed to Romania's export earnings.
- Fishing industry: Romania's fishing industry has ancient origins, supported by its extensive coastline along the Black Sea and numerous rivers and lakes. Historically, fishing was a vital source of food, trade, and livelihoods for coastal communities and inland regions. Traditional fishing techniques and practices were passed down through generations, sustaining local economies and cultural traditions. Today, the fishing industry continues to play a significant role in Romania's coastal regions, albeit facing challenges related to overfishing, environmental degradation, and regulatory issues.

These historical insights highlight the enduring importance of Romania's primary sectors, reflecting a rich tapestry of traditions, innovations, and socio-economic developments over the centuries.

1.2. The Current State of Romania's Primary Sector

In contemporary Romania, the primary sector remains vital to the economy, especially agriculture, which constitutes a major part of the GDP and employs a significant portion of the population. The fertile plains yield diverse crops, and Romania is renowned for its quality wine, sunflower oil, and maize production [5,8]. Despite these strengths, the agricultural sector grapples with modern challenges, such as the imperative for increased mechanization and technological advancements to boost productivity and sustainability. Historical land reforms have left a legacy of land fragmentation, hindering economies of scale in agriculture. Ongoing efforts focus on modernizing the sector, adopting sustainable farming practices, and promoting rural development to enhance competitiveness in the global market.

Forestry is pivotal in Romania's primary sector, contributing to domestic and export revenues. The country's diverse forests, prized for biodiversity and esthetics, serve as both a tourist attraction and a timber resource. Emphasis on sustainable forest management aims to balance economic gains with environmental conservation. Mining remains a significant economic force, leveraging Romania's wealth in minerals like coal, salt, copper, and industrial minerals [3,4]. Despite facing environmental and modernization challenges, the mining industry remains crucial for GDP and export revenue [6]. In the primary sector, the fishing industry, though less prominent than agriculture and forestry, utilizes Romania's extensive Black Sea coastline and inland waters for sustainable freshwater fishing. However, Romania also faces several specific challenges in primary sector selection, which may include the following points.

- Romania's transition from a centrally planned to a market economy has left a legacy of inefficiencies and structural challenges in its primary sectors [7]. The legacy of state-owned enterprises, outdated infrastructure, and bureaucratic barriers can hinder effective sector selection and impede the competitiveness of certain industries.
- Agriculture is a significant primary sector in Romania, but the prevalence of small-scale farming and land fragmentation presents challenges for modernization and efficiency [8]. Fragmented land ownership makes it difficult to implement large-scale agricultural projects, adopt modern technologies, and achieve economies of scale.
- Access to financing is a challenge for many primary sector businesses in Romania, particularly small and medium-sized enterprises (SMEs) [5,6]. Limited access to capital constrains investment in modernization, technology adoption, and value-added activities, hindering the competitiveness of primary sectors.
- Many primary sector industries in Romania lag behind in terms of technology adoption and innovation [10,11]. Outdated equipment, inadequate infrastructure, and limited investment in research and development (R&D) hamper productivity and competitiveness, making it challenging to compete in global markets.
- Ensuring the environmental sustainability of primary sector activities is a growing challenge for Romania. Agriculture, forestry, and mining activities can have significant environmental impacts, including soil degradation, deforestation, and pollution [12]. Balancing economic development with environmental protection requires careful sector selection and the implementation of sustainable practices.
- Romania's primary sectors, including agriculture, forestry, and mining, are heavily dependent on natural resources [8,9]. Overexploitation of natural resources can lead to environmental degradation, resource depletion, and vulnerability to external shocks such as climate change and fluctuations in commodity prices.
- Primary sector businesses in Romania face challenges in accessing international markets due to trade barriers, tariffs, and non-tariff barriers [1,2]. Limited market access restricts export opportunities and exposes primary sector industries to competition from imports, affecting their competitiveness and profitability.

Addressing these challenges requires targeted policies and interventions to promote modernization, technological innovation, access to finance, environmental sustainability, and market access for Romania's primary sectors. By overcoming these challenges, Romania can enhance the competitiveness and sustainability of its primary sector activities and drive economic growth and development.

1.3. Implications for Romania's Economic Development

Romania's evolving primary sector, while maintaining historical significance, plays a multifaceted role in economic development. It remains a crucial source of employment, especially in rural areas, supporting communities and contributing to regional development and stability. The sector, encompassing agriculture and mining, generates valuable export revenue, with agricultural products like grains and sunflower oil contributing to foreign exchange earnings. Sustainable resource management practices are increasingly prioritized, emphasizing responsible agriculture, forestry, and mining for long-term viability [7]. Investment in the primary sector aligns with rural development initiatives, focusing on improving infrastructure, education, and healthcare to enhance living conditions and encourage community residency. Modernizing agriculture and mining through technology adoption is essential for productivity and competitiveness, prompting Romania's investments in research and innovation to stay abreast of global trends. Balancing economic interests with environmental conservation is a vital concern, emphasizing the need for sustainable practices and responsible resource management to preserve natural beauty and biodiversity.

Romania's primary sector, rooted in a rich historical legacy, remains pivotal in shaping the country's present-day economic activity. Agriculture, forestry, mining, and fishing contribute significantly to employment, export earnings, and rural development [8]. In the pursuit of sustainable growth and development, the primary sector serves as a cornerstone, harmonizing tradition with innovation and economic progress with environmental responsibility. Let us discuss in detail the key important roles that the primary sector plays in developing the Romanian economy.

- The primary sector, which includes agriculture, forestry, mining, and fishing, contributes significantly to Romania's gross domestic product (GDP) [4]. Although the share of the primary sector in GDP has declined over the years due to industrialization and the service sector growth, it remains an essential component of the economy.
- The primary sector is a major source of employment in Romania, particularly in rural areas where agriculture and forestry activities are prevalent [5,6]. The sector provides livelihoods for a significant portion of the population, contributing to poverty reduction and rural development.
- Agriculture plays a crucial role in ensuring food security for Romania's population. The country has fertile agricultural land and favorable climatic conditions for crop cultivation and livestock rearing [7]. The primary sector contributes to domestic food production, reducing reliance on imports and enhancing food self-sufficiency.
- Romania's primary sector generates export revenue through the export of agricultural products, timber, minerals, and other natural resources [10]. Export earnings from primary sector commodities contribute to the country's trade balance and foreign exchange reserves, supporting economic stability and growth.
- The primary sector is closely linked to rural development in Romania, where many agricultural and forestry activities take place [11]. Investment in primary sector infrastructure, agricultural extension services, and rural development programs can stimulate economic growth, improve living standards, and reduce regional disparities.
- Romania's natural landscapes, traditional agriculture, and rural way of life attract tourists and contribute to cultural heritage preservation [4,5]. Agriculture-related tourism, agro-tourism, and eco-tourism activities in rural areas provide additional income opportunities for farmers and support local economies.
- The primary sector plays a role in environmental stewardship and biodiversity conservation in Romania [12]. Sustainable agriculture practices, reforestation efforts, and responsible mining practices help mitigate environmental degradation and preserve natural habitats and ecosystems.

The primary sector is of paramount importance to the Romanian economy, contributing to GDP, employment, food security, export earnings, rural development, tourism, cultural heritage preservation, and environmental sustainability. Ensuring the viability and competitiveness of the primary sector is essential for achieving balanced and sustainable economic development in Romania.

1.4. Outlining the Issue for Solution

The primary sector, which includes agriculture, forestry, fishing, and mining, is crucial in shaping a nation's economic landscape. In Romania, with its rich agricultural heritage and diverse resource base, understanding the selection of primary sector activities and their impact on economic activity is paramount [9]. This research paper aims to explore the multifaceted relationship between the primary sector and economic activity in Romania, utilizing advanced MCDM techniques, specifically the IVF version of SAW, WPM, and

WASPAS. It is the firm belief of the authors that the developed model of IVF integrated with SAW, WPM, and WASPAS MCDM techniques can significantly contribute to addressing the challenges that Romania faces in primary sector selection in the following ways.

- These techniques incorporate IVF sets to represent uncertainty and imprecision in decision-making. In the context of challenges such as land fragmentation, limited access to capital, and environmental sustainability, where data may be uncertain or imprecise, interval-valued fuzzy techniques provide a robust framework for analyzing and prioritizing primary sectors.
- Primary sector selection involves evaluating multiple criteria, including economic, social, environmental, and technological factors. IVF integrated with SAW, WPM, and WASPAS techniques allow for the integration of diverse criteria and their respective importance weights, enabling a comprehensive assessment of sector performance against multiple dimensions.
- These techniques offer flexibility in modeling decision-making preferences and adapting to different decision contexts. In the face of challenges such as technological obsolescence and market access barriers, where decision criteria may evolve over time, interval-valued fuzzy techniques allow decision-makers to update criteria weights and adjust their decision models accordingly.
- IVF-MCDM techniques facilitate sensitivity analysis to assess the robustness of decision outcomes to changes in criteria weights and input data [13]. This capability is particularly valuable in addressing challenges such as dependence on natural resources and environmental sustainability, where uncertainties and fluctuations in input parameters may affect decision outcomes.
- IVF-MCDM techniques allow for the incorporation of expert judgment and subjective preferences into decision-making processes. In the context of challenges such as the legacy of communism and bureaucratic barriers, where qualitative insights and expert knowledge play a crucial role in decision-making, these techniques enable decision-makers to capture and integrate expert opinions effectively.
- IVF-MCDM techniques provide transparent and interpretable decision models, enabling decision-makers to understand the rationale behind decision outcomes and identify areas for improvement. This transparency is essential for building consensus among stakeholders and gaining buy-in for primary sector selection decisions.

IVF integrated with SAW, WPM, and WASPAS MCDM techniques offer a comprehensive and flexible framework for addressing the challenges that Romania faces in primary sector selection [12,13]. By providing robust decision support tools that handle uncertainty, integrate multiple criteria, facilitate sensitivity analysis, and incorporate expert judgment, these techniques empower decision-makers to make informed and effective decisions that drive economic growth and development in Romania's primary sectors.

1.4.1. Problem Statement

The selection and development of Romania's primary sector depends on different critical determinants of the nation's economic stability and growth. Despite ongoing policy initiatives and economic reforms, effective allocation of resources, investments, and attention to the primary sector remains a significant challenge [10]. The primary sector selection process in Romania lacks a systematic framework for evaluating sectoral performance and guiding strategic decisions. This deficiency hinders the country's ability to optimize resource allocation, promote sustainable development, and enhance overall economic prosperity. Specifically, the lack of clarity regarding which primary sectors to prioritize and the criteria for evaluating their performance poses challenges for policymakers, investors, and stakeholders. Eight sectors have been identified in this research that are believed to have the greatest influence on the Romanian economy. These primary sectors include Fishing (A1), Automobile (A2), Agriculture and Forestry (A3), Energy (A4), Manufacturing and Construction (A5), Textile (A6), Information Technology (A7) and Mining (A8). The central question guiding this research is as follows: "To what extent does the strategic choice of primary sector activities impact economic activity in Romania, and how can advanced MCDM methods, specifically IVF combined with techniques such as SAW, WPM and WASPAS, assist in assessing and optimizing resource allocation and policy interventions in this sector?"

This research paper proposes investigating the use of interval-valued fuzzy MCDM to address the primary sector selection challenge, emphasizing inclusivity in economic activity. IVF logic allows decision-makers to express preferences as intervals, accommodates imprecision and diverse perspectives [11]. This approach effectively navigates the complexity and uncertainty inherent in economic problems, defining primary sector options within a desirability range. IVF logic provides a flexible and precise framework, aligning with the nuanced nature of the economy and incorporating uncertainty and subjectivity into decision-making. This research aims to improve primary sector selection decision-making, promoting economic inclusivity and robustness in Romania. The main objective involves facilitating a multi-criteria discussion with ten economic experts assessing eight primary sectors based on eight factors including Technological Adaptation and Innovation (TAI), Infrastructure Development and Investment (IDI), Gross Domestic Product Contribution (GDP), Environmental Impact and Sustainability (EIS), Employment Generation (EG), Market Demand and Export Opportunities (MDE), Risk Management and Resilience (RMR), and Government Policies and Subsidies (GPS).

The primary sectors under examination form the foundation for the selection criteria in shaping the evaluation framework meticulously identified through expert discussions and an extensive literature review. Figure 1 depicts a hierarchical structure, visually conveying interrelationships and relative importance among these criteria [12]. These parameters have garnered favorable feedback, indicating strong economic preferences for their inclusion. By synthesizing insights from decision-makers and the existing literature, this research aims to create an economic framework aligned with objectives and positively resonant with the populace, enhancing engagement and effectiveness in economic processes for the benefit of the nation.

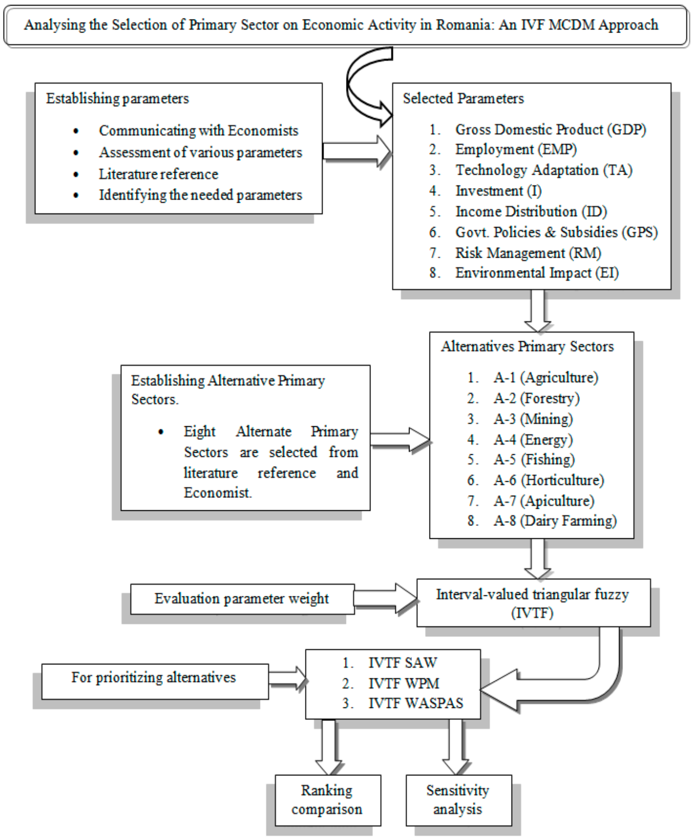

Figure 1. Flow chart of the proposed study. (Source: author's own elaboration).

1.4.2. Research Objectives

The objectives of the current research can be formulated as follows.

1. To identify the key factors and criteria influencing the selection and performance of the primary sector in Romania, encompassing economic, environmental, and policy-related dimensions.
2. To apply advanced MCDM techniques, including IVF-embedded SAW, WPM, and WASPAS, to evaluate the performance of eight primary sectors based on eight economic factors in Romania while considering the inherent uncertainty and imprecision in decision-making.
3. Assess the robustness of decision outcomes and the sensitivity of results to changes in criteria weights, input data, and external factors such as geopolitical uncertainties, market dynamics, and environmental regulations.
4. To develop a decision support framework that can assist policymakers and investors in making informed decisions related to the development, resource allocation and driving economic growth in Romania's primary sector.

By addressing these objectives, this research aims to contribute to a deeper understanding of the dynamics of primary sector selection and development in Romania and provide practical guidance for policymakers, stakeholders, and researchers involved in economic planning and decision-making processes.

2. Literature Review

Since the end of communism in 1989, Romania's south-eastern European economy has transformed significantly, transitioning from a centrally planned to a market-oriented system and joining the EU in 2007, shaping its economic landscape [13]. Key indicators, including GDP growth, inflation rates, and employment trends, reflect its economic performance, influenced by foreign direct investment, government policies, and external factors.

Understanding Romania's economic dynamics is crucial for assessing its growth prospects and evolving role in broader European and global contexts.

2.1. Past Studies on Economical Role of Primary Sectors

Throughout history, the primary sector has been a vital aspect of human economies, serving as the main livelihood for early agrarian societies and playing a pivotal role in their development. Scholars like Siksnelyte-Butkiene et al. [14] emphasize agriculture's central role in transitioning from nomadic lifestyles to settled communities, enabling food surplus, population growth, and complex societies. The Industrial Revolution witnessed a significant shift away from agriculture toward industrialization in Western countries, leading to structural transformation. Nasri et al. [15] note the declining share of agriculture in national income and employment during this period. Despite these shifts, the primary sector remains crucial, especially in low-income and developing nations, with agriculture seen as a pathway out of poverty. Hsueh et al.'s [16] research underscores the link between agricultural productivity and poverty reduction, highlighting the importance of modernizing agricultural practices.

The primary sector acts as a catalyst for economic growth by supplying inputs to other sectors, such as the mining sector, and providing raw materials to manufacturing industries, thus fostering industrialization [17]. The interdependence between the primary and secondary sectors underscores its significance in economic development. However, it faces challenges, particularly in environmental sustainability. Agriculture, linked to deforestation and soil erosion, prompts discussions on sustainable practices [18]. The mining sector faces concerns like resource depletion and environmental degradation, emphasizing the need for sustainable resource management [19]. Globalization brings opportunities for new markets and increased demand but exposes primary sector producers to international competition and market fluctuations.

The global agricultural trade regime, marked by subsidies and tariffs, sparks debate about its impact on the primary sector's development [20]. Technological advancements, like the Green Revolution and innovations in farming and mining, have boosted productivity [21]. However, these innovations pose challenges, such as declining employment in the primary sector, especially in transitioning economies. Urbanization raises concerns about the sustainability of rural communities [22]. Some propose policies that create non-farm jobs in rural areas to alleviate pressure on urban centers [23]. Despite challenges, the primary sector remains a critical component of the modern economy, playing a pivotal role in development, sustaining livelihoods, and addressing food needs. Technological advancements reshape the sector, and rural–urban dynamics continue to evolve.

2.2. Past Studies on Interval-Valued Fuzzy MCDM Method Application

MCDM is essential in diverse fields like engineering, economics, environmental science, and management, helping decision-makers choose the best alternative from multiple criteria. Interval-valued fuzzy MCDM, an extension dealing with uncertainty, uses interval-valued fuzzy numbers for effective handling of imprecise information. Researchers, including Opreana et al. [24] in 2023, have extensively explored its application, leading to various methodologies and practical uses. IVF sets have become a prominent tool due to their ability to capture uncertainty. The widely used Interval-Valued Fuzzy Analytic Hierarchy Process (IVF-AHP) method, introduced by Martín et al. [25] in 2020, extends AHP by utilizing interval-valued fuzzy numbers for more realistic and flexible decision modeling.

Another notable method is the Technique for Order of Preference by Similarity to Ideal Solution (IVF-TOPSIS) developed by Makarevic and Stavrou [26] in 2022, integrating fuzzy set theory and TOPSIS to rank alternatives based on their closeness to the ideal solution. Interval-valued fuzzy preference relations have led to the IVF Preference Programming (IVFPP) method, enabling comprehensive representation of decision-makers' preferences. Interval-valued fuzzy MCDM methods find applications in various domains, addressing uncertain decision-making problems. In environmental decision-making, they assess the impact of projects, considering fuzzy intervals to account for uncertainties in input data. In healthcare, these methods optimize medical treatment and provider selection, considering both qualitative and quantitative factors to inform decisions amid uncertainties in patient preferences and medical outcomes.

IVF-MCDM is pivotal in energy planning and resource allocation, evaluating alternatives considering economic, environmental, and social criteria for sustainable energy development [27]. In transportation planning, IVF-MCDM assesses complex trade-offs in infrastructure projects, aiding decision-makers in making robust choices amid uncertainties [28]. Financial decision-making, particularly in portfolio selection and risk assessment, benefits from IVF-MCDM by incorporating fuzzy intervals for better risk management [29]. As a potent tool for dealing with complex problems characterized by uncertainty, IVF-MCDM finds applications in various domains, including environmental management, healthcare, energy planning, transportation, and financial management [30]. The continual development and refinement of these methods have the potential to significantly contribute to more informed and robust decision-making processes across diverse fields.

2.3. Comparative Studies on SAW, WPM, WASPAS MCDM Method

MCDM methods play a pivotal role in addressing complex decision problems by considering multiple criteria simultaneously. Among the various MCDM techniques, SAW, WPM and WASPAS are widely recognized and applied in diverse decision-making contexts. These methods offer distinct approaches to evaluating alternatives based on their performance across multiple criteria, each with its own strengths and limitations [19]. In recent years, there has been growing interest in the application of SAW, WPM, and WASPAS to better understand their relative merits and applicability in different decision scenarios. Such studies aim to provide insights into the performance, robustness, transparency, and computational efficiency of these methods, thereby aiding decision-makers in selecting the most suitable approach for their specific needs. This section presents a comprehensive review and comparative analysis of SAW, WPM, and WASPAS MCDM methods. By examining key characteristics such as ease of implementation, transparency, flexibility, consideration of criteria interactions, robustness, and computational efficiency, this discussion seeks to elucidate the strengths and weaknesses of each method [22]. Additionally, it also discusses real-world applications and case studies where these methods have been successfully employed, highlighting their effectiveness in addressing practical decision-making challenges. Through a systematic comparison of SAW, WPM, and WASPAS, this argument aims to provide valuable insights for decision-makers, researchers, and practitioners involved in MCDM applications. By understanding the unique features and performance attributes of each method, stakeholders can make informed choices and enhance the effectiveness of their decision-making processes.

To provide a detailed comparative analysis of SAW, WPM and WASPAS methods with other MCDM methodologies, let us consider several key aspects.

- Complexity and ease of use: SAW, WPM, and WASPAS are relatively simple and easy to understand compared to some other MCDM techniques such as AHP, TOPSIS, and ELECTRE (Elimination and Choice Translating Reality). These three methods typically involve straightforward calculations and do not require complex pairwise comparisons or extensive data manipulation, making them more accessible to practitioners and decision-makers with limited technical expertise. They also offer a balance between computational complexity and analytical rigor, making them suitable choices for the research context [23].
- Transparency and interpretability: SAW, WPM, and WASPAS provide transparent results that are easy to interpret, as they directly assign weights to criteria and alternatives based on predetermined preferences or performance metrics [15]. In contrast, methods like AHP and ELECTRE involve subjective judgments in pairwise comparisons or complex mathematical formulations, which can introduce ambiguity and make it challenging to understand the rationale behind the final rankings.

- Flexibility and adaptability: SAW, WPM, and WASPAS offer flexibility in handling various types of criteria and decision contexts. They can accommodate both quantitative and qualitative data and allow for the incorporation of stakeholder preferences through adjustable weighting schemes [20,21]. Some MCDM methods like PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations) and AHP may have more rigid structures or require specific data formats, limiting their applicability in diverse decision-making scenarios.
- Computational efficiency: SAW, WPM, and WASPAS are computationally efficient and can be implemented using simple spreadsheet-based tools or software packages. They require minimal computational resources and are suitable for analyzing large datasets or conducting sensitivity analyses [6,7]. By contrast, methods like PROMETHEE and AHP may involve iterative calculations or complex algorithms, leading to longer processing times and potentially higher computational costs.
- Robustness and stability: SAW, WPM, and WASPAS are robust methods that generally produce consistent results across different decision scenarios and datasets. They rely on additive or multiplicative aggregation principles, which are mathematically well-founded and less sensitive to variations in input parameters. These methods are more preferable because they are well-established and widely used in the MCDM literature, indicating their robustness and stability in decision-making contexts [17,18]. Researchers may have confidence in the reliability of results obtained using these methods. Other MCDM techniques such as TOPSIS and ELECTRE may be more sensitive to changes in criteria weights or alternative rankings, leading to greater variability in outcomes and potentially less reliable decision support.
- Applicability to real-world problems: SAW, WPM, and WASPAS have been widely used in various practical applications across industries and domains, ranging from project selection and supplier evaluation to resource allocation and strategic planning [10,11]. While other MCDM methodologies offer specialized features or address specific decision contexts (e.g., uncertainty handling in Fuzzy TOPSIS or group decision-making in Group ELECTRE), SAW, WPM, and WASPAS are versatile techniques that can be applied effectively in a wide range of decision problems.

While each MCDM method has its strengths and weaknesses, SAW, WPM, and WASPAS stand out for their simplicity, transparency, flexibility, computational efficiency, robustness, and broad applicability, making them preferred choices in many decision-making situations. However, a detailed comparison of SAW, WPM and WASPAS with other widely used MCDM methodologies is provided in Table 1.

Table 1. Comparative analysis among different MCDM tools.

Criteria	SAW	WPM	WASPAS	TOPSIS	AHP	ELECTRE	PROMETHEE	ANP	TOPSIS	GRA
Methodology	Weighted sum	Weighted product	Weighted sum & weighted product	Ideal and anti-ideal	Pair-wise comparisons	Outranking	Outranking	Network of interdependent criteria	Ideal solution	Similarity to ideal solution
Weighting	Equal/ preassigned	Equal/ preassigned	Expert opinion	Equal/ importance hierarchy	Pair-wise comparisons	Importance ranks	Pair-wise comparisons	Pairwise and interactions	Equal/ preassigned	Correlation between factors
Sensitivity to weighting	Sensitive	Sensitive	Sensitive	Sensitive	Sensitive	Sensitive	Sensitive	Sensitive	Sensitive	Sensitive
Computation complexity	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Handling of objective functions	Linear/ Nonlinear	Linear/ Nonlinear	Linear/ Nonlinear	Linear/ Nonlinear	Pair-wise comparisons	Not applicable	Not applicable	Linear/ Nonlinear	Linear/ Nonlinear	Linear/ Nonlinear
Transparency and interpretability	Transparent	Transparent	Transparent	Transparent	Transparent	Interpretation may vary	Interpretation may vary	Interpretation may vary	Transparent	Interpretation may vary
Scalability	Small to medium	Small to medium	Small to medium	Small to medium	Small to medium	Small to medium	Small to medium	Small to medium	Small to medium	Small to medium
Decision space representation	Additive	Multiplicative	Additive	Geometric	Hierarchy	Relationship matrices	Preference functions	Network	Geometric	Relational
Ease of implementation	Relatively easy	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Relatively easy	Moderate
Flexibility	Limited	Moderate	Moderate	Limited	High	Moderate	Moderate	High	Limited	Moderate
Consideration of Criteria Interactions	Limited	Limited	Limited	Limited	Limited	Yes	Yes	Yes	Limited	Yes
Consideration of performance and Importance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Robustness	Moderate	Moderate	Moderate	Moderate	High	Moderate	Moderate	High	Moderate	Moderate
Computational efficiency	Low	Moderate	Moderate	Low	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Applicability	Generalized	Generalized	Generalized	Generalized	Generalized	Specialized	Specialized	Generalized	Generalized	Generalized

(Source: author's own elaboration.)

SAW, introduced in the early 1980s, is a widely applied MCDM method that assigns weights to criteria and calculates the weighted sum for each alternative. The highest sum identifies the best choice, and SAW is valued for its simplicity and ease of implementation. However, it has limitations in handling non-commensurate criteria and lacks consideration for trade-offs [31,32]. Another model from the same period, WPM, calculates the product of each alternative's performance raised to the power of the corresponding weight. WPM is useful for emphasizing deviations from the ideal solution, allowing for non-linear relationship modeling and flexible weight assignment. However, it assumes criteria independence and does not capture interactions.

WASPAS, a recent MCDM method addressing SAW and WPM limitations, combines the weighted sum and product to calculate the overall performance, accommodating additive and multiplicative interactions between criteria [33]. It is valuable for complex problems with significant criteria interactions, allowing for trade-offs' consideration while accounting for overall performance. SAW, WPM, and WASPAS are vital MCDM methods widely applied in various contexts. SAW is simple but may overlook interactions. WPM models non-linear relationships but assumes criterion independence. WASPAS combines SAW and WPM strengths, considering interactions and offering flexibility in decision modeling. The advantages and limitations of the three applied techniques SAW, WPM and WASPAS are summarized in Table 2.

Table 2. Strengths and weaknesses of SAW, WPM and WASPAS.

MCDM Tools	Strengths		Weakness	
	Criteria	**Explanation**	**Criteria**	**Explanation**
SAW	Ease of implementation	SAW is straightforward to implement and understand. It involves assigning weights to criteria and then calculating the overall performance score for each alternative by summing the weighted scores.	Subjectivity in weight assignment	SAW relies on the assignment of subjective weights to criteria, which can introduce bias and uncertainty into the decision-making process. If the weights are not assigned appropriately, it may lead to skewed results.
	Scalability	SAW is highly scalable, making it suitable for decision problems with a large number of alternatives and criteria. Its straightforward nature allows for efficient scaling without significant increases in computational complexity.		
	Transparency	The method provides transparent results, as the decision-making process is based on explicit criteria weights and performance scores. This transparency facilitates understanding and acceptance of the decision outcomes.	No consideration of criteria interactions	SAW assumes that criteria are independent of each other, ignoring potential interactions or dependencies among them. This simplification may not accurately reflect real-world decision scenarios where criteria may influence each other.
	Flexibility	SAW can accommodate various types of criteria, whether quantitative or qualitative, making it adaptable to different decision contexts.		
	Computational efficiency	SAW requires minimal computational resources, making it suitable for analyzing large datasets or conducting sensitivity analyses.	Scoring inconsistencies	Inconsistencies in scoring across different criteria or decision-makers can affect the reliability and validity of the results obtained through SAW.
	Versatility	SAW can be applied to a wide range of decision problems, including project selection, supplier evaluation, and performance assessment.		

Table 2. *Cont.*

MCDM Tools	Strengths		Weakness	
	Criteria	**Explanation**	**Criteria**	**Explanation**
WPM	Consideration of criteria interactions	WPM accounts for interactions between criteria by multiplying the normalized scores of alternatives across all criteria, weighted by their respective importance.	Difficulty in determining weights	Like SAW, WPM requires the assignment of weights to criteria, which can be challenging and subjective. Determining appropriate weights for each criterion may be difficult, especially when stakeholders have differing opinions or preferences.
	Emphasis on dominant alternatives	WPM tends to highlight dominant alternatives that perform exceptionally well across all criteria. This emphasis can help decision-makers identify and prioritize alternatives that excel in multiple aspects, leading to more robust decisions.		
	Transparency	Similar to SAW, WPM provides transparent results, enabling stakeholders to understand how each criterion contributes to the overall evaluation of alternatives.	Complexity with many criteria	WPM becomes increasingly complex and computationally intensive as the number of criteria increases. Calculating the weighted product of performance scores across numerous criteria may lead to computational challenges and longer processing times.
	Flexibility	WPM allows for the incorporation of stakeholder preferences through adjustable weighting schemes, providing flexibility in decision-making.		
	Robustness	WPM tends to produce stable and consistent results, as it considers both the importance of criteria and the performance of alternatives across all criteria.	Risk of oversimplification	WPM assumes that the relationship between criteria is purely multiplicative, which may oversimplify the decision problem and fail to capture more nuanced relationships among criteria.
	Applicability	WPM is applicable to decision problems where criteria interactions are significant, such as product selection, project prioritization, and resource allocation.		
WASPAS	Consideration of performance and importance	WASPAS integrates both the performance and importance of criteria in the decision-making process, ensuring a comprehensive evaluation of alternatives.	Difficulty in setting decision thresholds	WASPAS requires the specification of decision thresholds for each criterion, which can be arbitrary and difficult to determine objectively. Setting appropriate thresholds may require significant expertise and stakeholder input.
	Integration of qualitative and quantitative data	WASPAS effectively integrates qualitative and quantitative data in the decision-making process. This integration allows decision-makers to incorporate both objective performance metrics and subjective expert judgments, resulting in a more holistic assessment of alternatives.		

Table 2. *Cont.*

MCDM Tools	Strengths		Weakness	
	Criteria	Explanation	Criteria	Explanation
	Flexibility	Similar to SAW and WPM, WASPAS offers flexibility in handling diverse types of criteria and decision contexts.	Sensitivity to threshold selection	The choice of decision thresholds in WASPAS can significantly impact the ranking and selection of alternatives. Small variations in threshold values may lead to different outcomes, making the method sensitive to threshold selection.
	Robustness	WASPAS tends to produce robust results by aggregating weighted sums and products of criteria performance scores, reducing sensitivity to variations in criteria importance.		
	Ability to handle non-linear relationships	WASPAS can capture non-linear relationships between criteria and alternatives, allowing for more nuanced evaluations in complex decision problems.	Complexity in parameter setting	WASPAS involves multiple parameters, such as weights, decision thresholds, and aggregation functions, which need to be set appropriately. The complexity of parameter setting may pose challenges, particularly in decision problems with high uncertainty or ambiguity.
	Applicability	WASPAS is suitable for decision problems where both the performance and importance of criteria need to be considered, such as supplier selection, investment decision-making, and technology assessment.		

Source: Author's own elaboration.

While SAW, WPM, and WASPAS are valuable MCDM methods, it is important to recognize their limitations and consider them carefully when applying these techniques in real-world decision-making contexts [29]. The authors have made full efforts to address the limitations by integrating the interval-valued fuzzy concept, which can enhance the reliability and effectiveness of these three methods. Moreover, this study engages with a diverse group of experts through consultative workshops, interviews, and structured surveys to elicit their judgments on criteria weights and performance scores. By aggregating and synthesizing expert judgments, this analysis aims to capture a broad range of perspectives and insights while mitigating individual biases and uncertainties. Fuzzy logic and IVF numbers have been utilized to represent uncertainties associated with criteria weights and performance scores. Fuzzy numbers allow for the representation of imprecise or uncertain information, enabling us to capture the vagueness and ambiguity inherent in expert judgments. This approach acknowledges the uncertainty surrounding criteria assessments and provides a formal framework for their representation and analysis. The significances of the IVF concept towards the ongoing analysis may be interpreted as follows.

- Enhanced representation of uncertainty: IVF sets provide a robust framework and flexible representation of uncertainty compared to other fuzzy variants [34]. While triangular or trapezoidal fuzzy sets represent uncertainty with single membership values, interval-valued fuzzy sets capture uncertainty through intervals of membership values. This allows for a more flexible representation of vague or imprecise information.
- Better Handling of Ambiguity: The IVF concept excels in handling ambiguity by allowing for a broader range of membership possibilities [35]. Unlike other fuzzy variants that assign a single membership value to each element, IVF sets accommodate multiple membership degrees within an interval, providing a more comprehensive characterization of uncertainty.

- Increased expressiveness: IVF sets offer increased expressiveness in representing complex and multifaceted uncertainty [36]. By capturing the variability and fuzziness inherent in real-world data more accurately, the IVF concept enables richer and more in-depth descriptions of uncertain phenomena.
- Greater robustness: The IVF concept is often more robust in the face of noise or imprecision in data [15,16]. The interval-based representation allows for a degree of tolerance to fluctuations or errors in the input, enhancing the stability and reliability of fuzzy inference systems.
- Improved decision-making: The IVF concept facilitates more informed decision-making by providing decision-makers with a more comprehensive understanding of uncertainty [30,31]. The interval-based representation allows decision-makers to explore a wider range of possible outcomes and assess the robustness of their decisions under different scenarios.
- Flexibility in modeling: IVF concept offers greater flexibility in modeling complex systems and phenomena. It can accommodate varying degrees of uncertainty and ambiguity, making them suitable for a wide range of applications across different domains, including engineering, finance, and decision sciences [24]. It can also capture the gradual transition between membership degrees, allowing for a more detailed representation of uncertainty compared to binary approaches.
- Adaptability to changing conditions: IVF concepts are well-suited for dynamic environments where conditions and preferences may change over time [25]. Their flexible nature allows for an easy adaptation to evolving circumstances, ensuring that fuzzy models remain relevant and effective in dynamic decision-making scenarios. It also ensures decision-makers to update and revise fuzzy sets as new information becomes available.
- Handling of incomplete information: In many practical situations, information may be incomplete or ambiguous [11]. The IVF concept enables decision-makers to handle such incomplete information by allowing for partial memberships to different categories, thereby facilitating more informed decisions.
- Integration of multiple criteria: IVF concepts are well-suited for integrating multiple criteria or attributes in decision-making processes [11,12]. These provide a unified framework for aggregating diverse sources of information, including qualitative judgments, expert opinions, and quantitative data.

It is evident from the overall comparative analysis that the three applied tools are chosen for specific purposes, and offer significant benefits over the other available MCDM tools. After conducting profound research on these three tools, the decision-makers were impressed by their merits and found it suitable for the present analysis. All the expert members also agreed to integrate the IVF concept to overcome the challenges offered by SAW, WPM and WASPAS. Therefore, the hybrid model of IVF integrated with SAW-WPM-WASPAS is capable of making effective decisions under vague conditions, thereby improving the quality and reliability of decisions across diverse applications and domains.

2.4. Research Gaps and Novelty

Despite notable contributions, this research addresses critical gaps. While MCDM techniques are widely used, their application in analyzing the primary sector's role in a national economy is sparse. This study bridges this gap by applying advanced MCDM techniques to a specific economic context. Previous applications of fuzzy MCDM in economics often focused on individual techniques or methodologies. However, this study integrates the IVF concept with the MCDM frameworks, to provide a comprehensive approach. This integration allows for a more holistic analysis of primary sector selection in Romania, considering both qualitative and quantitative aspects in decision-making. Fuzzy logic is an underexplored topic in economic studies designed to handle uncertainty and imprecision in decision-making. However, previous applications have struggled to effectively model and incorporate uncertainty, leading to less robust decision outcomes. By employing an

IVF approach, this study addresses this limitation by representing uncertainty as IVF numbers, allowing for a more accurate representation of decision-maker preferences and uncertainties. Moreover, economic decision-making often involves evaluating multiple criteria or objectives. Previous applications of fuzzy MCDM have focused on a limited set of criteria or failed to adequately consider the interrelationships among criteria. This study addresses this limitation by incorporating a comprehensive set of criteria influencing primary sector selection in Romania and evaluating sector performance against these criteria using multiple MCDM techniques. Additionally, there is a lack of research on the primary sector's role in Romania's economic development. Choosing Romania as a case study, this research fills a literature gap on MCDM applications in a country-specific context. Many previous applications of fuzzy MCDM in economics have been theoretical or hypothetical in nature, lacking practical relevance or applicability to real-world decision problems. This study addresses the limitation by applying IVF-MCDM techniques to analyze the selection of primary sectors influencing the economic activity in Romania, a context of significant importance and relevance to policymakers, stakeholders, and researchers.

This research makes unique contributions by integrating three advanced MCDM approaches, SAW, WPM, and WASPAS, to analyze the primary sector's role in the Romanian economy. The interdisciplinary approach offers a novel perspective on decision-making. The incorporation of IVF logic addresses the uncertainty in economic activity analysis, where data can be imprecise. Focusing on the Romanian economy adds a specific and valuable dimension, contributing to understanding the role of the primary sector in a transitioning economy. This research aims to fill gaps by combining advanced MCDM techniques with fuzzy logic, providing insights into economic decision-making in a transitioning economy. In addition, the present research also aims at providing actionable insights and decision support tools that can inform strategic interventions aimed at strengthening Romania's primary sector activities and driving economic growth and development.

3. Listing of Primary Sectors and the Factors Influencing Them

In this section, let us discuss in detail the significance of the eight identified primary sectors and their contribution towards the development of Romanian economy. Simultaneously, this section also sheds light on the significance of eight chosen factors and their influence on the Romanian primary sectors. Let us begin with the eight primary sector alternatives.

1. Fishing: Fishing contributes to food security, employment, and economic development in coastal areas. While Romania's fishing industry is relatively small compared to other sectors, it provides employment opportunities, particularly in coastal regions [37]. Additionally, it contributes to domestic food supply and exports, supporting economic growth. Pandemics can disrupt fishing activities due to restrictions on movement, labor shortages, and changes in consumer behavior. Reduced demand for seafood products and logistical challenges may affect Romania's fishing industry. Armed conflict may restrict fishing activities in coastal areas or maritime zones due to security concerns. Damage to infrastructure and displacement of coastal populations may further impact the fishing sector.
2. Automobile: The automobile industry plays a crucial role in manufacturing, employment generation, and technological advancement. Romania has emerged as an important player in the European automobile manufacturing sector [2,3]. The presence of major automobile manufacturers and supply chain companies has boosted exports, provided employment opportunities, and attracted foreign direct investment, contributing significantly to the country's GDP. Pandemics can impact the automobile industry through reduced consumer demand, supply chain disruptions, and factory closures. Economic uncertainty may also affect purchasing power and consumer confidence, leading to lower vehicle sales. Armed conflict can disrupt automobile supply chains, hinder cross-border trade, and lead to market volatility. Security con-

cerns and geopolitical tensions may impact consumer sentiment and investment in the automotive sector.

3. Agriculture and Forestry: The agriculture and forestry sectors provide food security, raw materials, employment, and contribute to rural development. Agriculture and forestry are traditional sectors in Romania, supporting rural livelihoods and contributing to GDP [35,36]. These sectors provide employment, ensure food security, and supply raw materials for various industries such as food processing and wood products. Pandemics can disrupt agricultural supply chains, labor availability, and export markets, affecting Romania's agricultural exports and revenues. Reduced demand and logistical challenges may also impact forestry operations. Armed conflict in neighboring countries can lead to disruptions in trade routes and market access for Romanian agricultural products. Additionally, land degradation and displacement may affect agricultural productivity and rural livelihoods.
4. Energy: Energy is essential for economic activities, industrial production, and improving living standards. Romania has diverse energy resources including coal, natural gas, oil, and renewable energy sources such as hydro and wind [23]. The energy sector contributes significantly to GDP through energy production, exports, and investment in infrastructure, supporting industrial growth and domestic consumption. During pandemics, energy demand may fluctuate due to changes in industrial activity, transportation, and commercial sectors. Reduced economic activity can lead to lower energy consumption, affecting revenues for energy companies. In times of armed conflict, energy supply routes may be disrupted, affecting Romania's energy imports and exports. Geopolitical tensions can also impact energy prices and investment in the sector.
5. Manufacturing and Construction: The manufacturing and construction sectors drive industrialization, infrastructure development, and economic growth. Manufacturing and construction are key contributors to Romania's GDP, providing employment and generating revenue through exports [38]. These sectors encompass a wide range of industries including machinery, electronics, chemicals, and building materials, supporting economic diversification and development. Pandemics can disrupt manufacturing operations due to workforce shortages, supply chain disruptions, and reduced demand for goods. Construction projects may face delays or cancellations due to economic uncertainty and logistical challenges. Armed conflict can disrupt manufacturing supply chains, damage infrastructure, and pose risks to worker safety. Uncertainty and security concerns may deter investment in construction projects, affecting sectoral growth.
6. Textile: The textile industry is important for providing clothing, employment, and supporting local economies. The textile industry in Romania contributes to employment generation, exports, and value addition to raw materials [39]. It provides opportunities for small and medium enterprises (SMEs) and supports the country's integration into global supply chains. Pandemics can disrupt textile manufacturing operations due to workforce shortages, supply chain disruptions, and changes in consumer behavior. Reduced demand for apparel and textile products may affect Romania's textile exports. Armed conflict may disrupt textile supply chains, damage manufacturing facilities, and lead to workforce displacement. Security concerns may also impact access to raw materials and export markets.
7. Information Technology: Information technology drives innovation, productivity, and competitiveness in the digital age. Romania has a growing IT sector known for software development, outsourcing, and IT services [40]. The IT industry contributes to GDP growth, exports, and job creation, attracting foreign investment and fostering entrepreneurship and innovation. Pandemics can accelerate digital transformation and increase demand for IT solutions such as remote work technologies, online education platforms, and telemedicine services. However, economic downturns may lead to reduced IT spending by businesses and consumers. Armed conflict

may disrupt IT infrastructure, cybersecurity measures, and data centers, posing risks to digital operations and online services. Geopolitical tensions can also impact technology exports and collaborations.

8. Mining: Mining provides essential raw materials for industrial production and infrastructure development. Although the mining sector in Romania has declined in recent years, it still contributes to GDP through the extraction of minerals such as coal, metals, and salt. Mining activities support industrial sectors, provide employment in mining regions, and generate revenue through exports [41]. Additionally, efforts to modernize and diversify the mining sector can contribute to sustainable economic development. Pandemics can affect mining operations through workforce shortages, supply chain disruptions, and fluctuations in commodity prices. Reduced global demand for minerals and metals may impact Romania's mining exports and revenues. Armed conflict may disrupt mining operations and lead to damage to infrastructure, affecting production and exports. Geopolitical tensions can also impact mining investment decisions and trade relations.

Let us now focus on why the eight identified factors are considered significant for influencing the primary factors in Romania. These eight factors are considered to collectively shape a country's economic performance and development.

1. Technological Adaptation and Innovation (TAI): It helps to drive efficiency and competitiveness by enabling the adoption of modern technologies, improving production processes, and enhancing product quality. It also fosters innovation and leads to the development of new products, services, and business models, which can stimulate growth and create new market opportunities [2,3]. Political and international factors also influence TAI through policies, collaborations, and trade relations. For example, during pandemics or conflicts, governments may prioritize technological innovation in healthcare, cybersecurity, or defense industries to address emerging challenges or threats.
2. Infrastructure Development and Investment (IDI): It enhances connectivity, logistics efficiency, and transportation networks, reducing costs and improving accessibility to markets. It also attracts investment, stimulates economic growth, and improves living standards through better access to essential services such as energy, water, and telecommunications [6]. Political stability and international relations also play a crucial role in IDI. Conflicts or geopolitical tensions can disrupt infrastructure projects, while diplomatic relations and international agreements can facilitate cross-border investments and infrastructure development initiatives.
3. Gross Domestic Product Contribution (GDP): It reflects the overall economic health and size of the sectors, providing a crucial indicator for assessing economic performance and guiding policymaking. It also serves as a measure of the sector's contribution to national income and its importance in driving economic growth and development [16]. Moreover, political stability, trade policies, and international economic conditions impact GDP contribution. Pandemics or armed conflicts can disrupt economic activities, trade flows, and supply chains, affecting GDP growth rates and overall economic performance.
4. Environmental Impact and Sustainability (EIS): It mitigates environmental degradation, conserves natural resources, and protects ecosystems, ensuring the long-term viability of sectors and promoting sustainable development. It also responds to consumer demand for environmentally friendly products and practices, enhancing reputation and market competitiveness [14,15]. Political decisions and international agreements help to shape environmental policies and sustainability initiatives. Conflicts or geopolitical tensions may exacerbate environmental degradation, while international cooperation and agreements promote sustainable development goals and environmental conservation efforts.
5. Employment Generation (EG): It alleviates poverty, reduces inequality, and promotes social cohesion by providing job opportunities and income generation. It also stim-

ulates economic activity and consumption, driving demand for goods and services and contributing to overall economic growth [22]. Additionally, political stability, economic policies, and international relations influence EG. Pandemics or armed conflicts can lead to job losses, displacement, and labor market disruptions, while government policies and international assistance programs may support employment recovery and livelihood restoration efforts.

6. Market Demand and Export Opportunities (MDE): It drives revenue growth and expansion opportunities for sectors by responding to consumer preferences and accessing new markets. It also enhances competitiveness and diversifies revenue streams, reducing dependency on domestic demand and improving resilience to economic fluctuations [29]. Political stability, trade policies, and geopolitical dynamics also affect MDE opportunities. Conflicts or diplomatic tensions can disrupt trade relations and market access, while international cooperation and trade agreements open up new export markets and opportunities for economic growth.
7. Risk Management and Resilience (RMR): It helps to mitigate risks associated with market volatility, natural disasters, and regulatory changes, ensuring business continuity and sectoral stability. It also enhances resilience by implementing risk management strategies, diversifying operations, and building adaptive capacity to withstand disruptions [19,20]. Furthermore, political stability, crisis management capabilities, and international alliances determine RMR strategies. Pandemics or armed conflicts pose significant risks to sectors and economies, requiring effective risk mitigation measures, contingency planning, and international cooperation to enhance resilience.
8. Government Policies and Subsidies (GPS): These help to shape sectoral development, stimulate investment, and address market failures through targeted policies, regulations, and financial incentives. These also support innovation, research and development, and capacity building, fostering competitiveness and sustainable growth across sectors [8,9]. Political decisions, regulatory frameworks, and international agreements assist in shaping GPS. During pandemics or conflicts, governments may implement emergency measures, stimulus packages, or subsidies to support affected sectors, promote recovery, and mitigate socio-economic impacts.

These parameters collectively shape a country's economic landscape. A well-rounded economy aims for balance, fostering growth, job creation, technological advancement, income equality, and environmental sustainability. Government policies play a vital role in influencing and regulating these factors for a healthy economy [40]. In addition, incorporating political and international factors into the analysis allows decision-makers to assess the broader context in which primary sector selection occurs. By considering these factors alongside the eight criteria, policymakers can develop more robust strategies, policies, and interventions to navigate complex geopolitical dynamics, mitigate risks, and promote sustainable economic development in Romania.

4. Methodology

The expected primary sector platforms, with eight competing criteria, are listed in the following subsection. Using the IVF tool, parameter weights are calculated to rank the primary sectors, representing fuzzy values to address decision-making uncertainty. The IVF SAW, WPM, and WASPAS processes, and MCDM techniques are employed to determine the ranking of primary sectors based on set standards.

4.1. Brainstorming Session

The following research work starts with the formation of an expert committee comprising ten economists who can offer their relevant views on the topic. The formation of this committee comprising ten economists from various fields aims to identify the most important Romanian sectors and to evaluate different factors influencing the respective primary sectors and their impact on Romanian economic activity. The evaluation criteria and their respective weights are determined through a structured process involving expert consultations, a literature review, and stakeholder engagement. Initially, we conduct interviews and workshops with a diverse group of experts, including economists, industry professionals, and policymakers, to identify and prioritize the key criteria relevant to each primary sector. These criteria are then refined through iterative discussions and consensus-building exercises to ensure their relevance and comprehensiveness. The weighting of criteria is achieved through a combination of expert judgment, where experts assign relative importance to each criterion based on their expertise and experience. The committee will conduct cross-sectoral analysis to identify interdependencies and synergies among different primary sectors and factors influencing them. In addition, the committee will also provide insights and recommendations to policymakers and stakeholders to optimize resource allocation and promote sustainable development in primary sectors. Experts with a minimum of ten years of relevant experience are selected based on their expertise in specific sectors related to the Romanian economy. Diversity in specialization ensures a comprehensive understanding of the factors influencing primary sectors. The demographic details of the ten expert committee members are provided in Table 3. The names of the experts are kept completely anonymous to avoid any future conflict of interest issues.

Table 3. Demographic details of the expert members.

Expert Groups	Experts	Field	Experience (In Years)	Description
EG-1	Expert 1	Agricultural economist	13	With extensive experience in agricultural economics, expert 1 specializes in analyzing factors affecting crop production, land use, and agricultural policy.
	Expert 2	Forestry economist	12	Expert 2 is a leading expert in forestry economics, focusing on sustainable forest management, timber production, and environmental conservation.
EG-2	Expert 3	Mining economist	15	Expert 3 brings expertise in mining economics, including mineral resource extraction, mine development, and regulatory frameworks.
	Expert 4	Energy economist	14	Expert 5's expertise lies in energy economics, including energy production, consumption patterns, renewable energy adoption, and energy policy.
EG-3	Expert 5	Manufacturing economist	13	Expert 4 specializes in manufacturing economics, analyzing factors such as industrial production, technology adoption, and supply chain management.
	Expert 6	Construction economist	13	Expert 6 focuses on construction economics, examining factors influencing building construction, infrastructure development, and real estate markets.
EG-4	Expert 7	Information Technology economist	11	Expert 7 brings expertise in information technology economics, focusing on factors influencing technology adoption, digital innovation, and IT industry competitiveness.
	Expert 8	Environmental economist	15	Expert 8's expertise lies in environmental economics, examining factors such as resource utilization, pollution control, and sustainable development strategies.
EG-5	Expert 9	Fisheries economist	11	Expert 9 specializes in fisheries economics, analyzing factors affecting fishery management, aquaculture development, and marine resource conservation.
	Expert 10	Textile economist	12	Expert 10 specializes in textile economics, focusing on factors influencing textile production, supply chain dynamics, and international trade in textiles.

Source: Author's own elaboration.

The first stage of the session began with a discussion to identify the primary sectors that have the most significant influence on the Romanian economy. Data for this analysis were sourced from reputable sources, including government statistics, industry reports, academic publications, and expert assessments. Quantitative and qualitative data on various indicators related to the evaluation criteria were gathered, such as production volumes, employment rates, technological adoption levels, environmental impact assessments, and socioeconomic indicators. The experts' panel mainly relied on the Scopus and WoS databases to access numerous research articles on the field. After applying various filters and a thorough analysis of the abstracts, the committee found 200 research articles that suited the best related to the main theme, "Romanian economy". The list of 200 articles was further narrowed down by eliminating some of the irrelevant research articles after in-depth research and discussions. Finally, around 100 research papers were short-listed and considered for the ongoing analysis. After detailed investigation, the panel members agreed that the sectors listed in Table 4 have the greatest contribution towards the Romanian economy.

Table 4. Mapping of the selected factors to different sectors.

Factors → ↓ Alternatives	Technological Adaptation and Innovation (TAI)	Infrastructure Development and Investment (IDI)	Gross Domestic Product Contribution (GDP)	Environmental Impact and Sustainability (EIS)	Employment Generation (EG)	Market Demand and Export Opportunities (MDE)	Risk Management and Resilience (RMR)	Govt. Policies & Subsidies (GPS)
Fishing (A1)		✓	✓	✓	✓	✓	✓	
Automobile (A2)	✓		✓	✓	✓	✓	✓	
Agriculture and forestry (A3)	✓	✓	✓	✓	✓	✓	✓	✓
Energy (A4)	✓	✓	✓	✓	✓	✓	✓	✓
Manufacturing and construction (A5)	✓	✓	✓	✓	✓			
Textile (A6)	✓		✓	✓	✓	✓		
Information technology (A7)	✓		✓	✓	✓			
Mining (A8)	✓	✓	✓	✓	✓	✓		✓

Source: Panel of expert members.

In the second stage of the session, each participant was asked to brainstorm factors that have the greatest effect on these primary sectors. The facilitator recorded and refined the suggestions from past studies. After thorough deliberation, the eight factors listed in Table 4 were identified. The group then mapped each factor to the primary sectors, considering their relevance and impact, as shown in Table 4. It should be noted that for the current analysis of Romanian primary sector selection, political and international factors were implicitly taken into consideration through the eight factors considered in the analysis. The expert committee systematically explored how these factors intersect with political and international dynamics, particularly in the context of pandemics and armed conflicts, such as the conflict in Ukraine or the Israel/Gaza conflict.

In the final stage, the facilitator reviewed and summarized all the factors and their mapping to the primary sectors, ensuring alignment with the objectives of the brainstorming session. The experts were encouraged to provide any additional feedback or insights before concluding the session.

4.2. Interval-Valued Fuzzy WSM Method

The IVF-SAW method combines interval-valued fuzzy sets with the SAW method to address decision-making issues. It employs interval-valued fuzzy numbers to represent ambiguous information. The decision issue involves alternatives and criteria, each with specific aims or traits [30,31]. The goal is to rate options for overall effectiveness considering all criteria. The process begins with a decision matrix, where rows represent courses of action and columns represent criteria, using IVF numbers to convey ambiguity and imprecision in performance assessments. IVF numbers are a representation of uncertainty in expert judgments, particularly in situations where qualitative assessments are made. Gathering IVF numbers from qualitative judgments of experts involves a systematic process to translate linguistic expressions or qualitative assessments into fuzzy numbers that capture the uncertainty associated with the judgments.

Step 1: Establish language-based criteria for performance assessment and weight. In a MCGDM problem, create a fuzzy decision matrix X_{ij}^{k} using linguistic specifications for criteria weights and performance ratings outlined in Table 5.

Table 5. Known linguistic specifications (criteria and alternative ratings).

Language Standards for Criteria		Language Standards for Alternatives	
Linguistic Specifications	**TFNs**	**Linguistic Specifications**	**TFNs**
Very Low (VL)	(0.0, 0.0, 0.1)	Very Poor (VP)	(0.0, 0.0, 0.1)
Low (L)	(0.0, 0.1, 0.3)	Poor (P)	(0.0, 0.1, 0.3)
Medium Low (ML)	(0.1, 0.3, 0.5)	Medium Poor (MP)	(0.1, 0.3, 0.5)
Medium (M)	(0.3, 0.5, 0.7)	Fair (F)	(0.3, 0.5, 0.7)
Medium High (MH)	(0.5, 0.7, 0.9)	Medium Good (MG)	(0.5, 0.7, 0.9)
High (H)	(0.7, 0.7, 1.0)	Good (G)	(0.7, 0.7, 1.0)
Very High (VH)	(0.9, 1.0, 1.0)	Very Good (VG)	(0.9, 1.0, 1.0)

Source: Panel of expert members.

Step 2: This will help to determine the fuzzy decision matrix X's weight and its 'm' alternative possibilities with 'n' features, and E-1, E-2, E-3, E-4,..., E_j economist experts (or groups) related to linguistic variables PA-1, PA-2, PA-3, PA-4,. . . PA_m. Therefore, as seen in Equation (1), the performance of alternative PA_m with regard to decision matrix is denoted by X_{ij}^{k}.

$$X_{ij}^{k} = \begin{pmatrix} X_{11}^{k} & \cdots & X_{1n}^{k} \\ \vdots & \ddots & \vdots \\ X_{m1}^{k} & \cdots & X_{mn}^{k} \end{pmatrix} \quad (1)$$

Linguistic variables serve the mentioned objectives but are not directly transformed into IVF integers. In this work [32], they are converted into conventional TFNs for better utilization of the opportunities presented by IVF numbers.

The linguistic specification set-1 = "Very low (VL), Low (L), Medium Low (ML), Medium (M), Medium High (MH), High (H), and Very High (VH)" shown in Table 5 is used to rate the criteria performances and the linguistic specification set-2 = "Very poor (VP), Poor (P), Medium Poor (MP), Fair (F), Medium Good (MG), Good (G), and Very Good (VG)" represented in Table 5 is used by the economy experts to determine the alternatives performances with respect to each criteria. Experts are asked to provide their qualitative judgments using linguistic expressions such as "very low", "low", "medium", "high", and "very high" to describe the degree of membership or fulfillment of a criterion by an alternative. Each linguistic expression is mapped to a fuzzy linguistic term, typically represented by a triangular or trapezoidal membership function. However, Triangular Fuzzy Numbers (TFNs) were used in this article, which contains lower, middle and upper bound values as depicted in Table 5. The linguistic specification value of an expert opinion is converted into triangular fuzzy integers with interval values using Equations (2)–(6).

$$l = min_d\left(l^d\right) \quad (2)$$

$$l' = \left(\prod_{d=1}^{d} l^d\right)^{1/d} \quad (3)$$

$$m = \left(\prod_{d=1}^{d} m^d\right)^{1/d} \quad (4)$$

$$u' = \left(\prod_{d=1}^{d} u^d\right)^{1/d} \quad (5)$$

$$u = max_d\left(u^d\right) \quad (6)$$

where $\bar{x} = [(l, l'), m, (u', u)]$ represents the corresponding interval-valued triangular fuzzy number; $\bar{x}^d = \left(l^d, m^d, u^d\right)$ represents the triangular fuzzy number obtained on the basis of opinion of d^{th} decision maker, $d = 1 \ldots \ldots D$; and D is the number of decision makers.

Eight criteria are considered, and the ten economists clustered into five groups offered opinions regarding the criteria importance based on linguistic specifications $\bar{x}^d = \left(l^d, m^d, u^d\right)$ for each factor, as shown in Table 6. The linguistic values were converted to respective TFNs in Table 6 using scores from Table 5. Experts were able to discuss and calibrate their judgments to ensure consistency and coherence across the assessments. This could involve averaging or aggregating individual judgments or adjusting fuzzy numbers based on group consensus. The resulting fuzzy linguistic terms represent the uncertainty inherent in the qualitative judgments. The width of the fuzzy numbers reflects the degree of uncertainty or vagueness associated with the experts' assessments. The TFNs were then transformed into IVF numbers using Equations (2)–(6), as illustrated in Table 7. These weights were implemented in the SAW method to rank different pedagogy methods.

Table 6. Criteria rating by the expert members.

Specification	Criteria Rating Linguistic Specifications into TFNs							
Criteria	**TAI**	**IDI**	**GDP**	**EIS**	**EG**	**MDE**	**RMR**	**GPS**
EG-1	(0.7,0.7,1.0) H	(0.7,0.7,1.0) H	(0.7,0.7,1.0) H	(0.7,0.7,1.0) H	(0.5,0.7,0.9) MH	(0.9,1.0,1.0) VH	(0.3,0.5,0.7) M	(0.5,0.7,0.9) MH
EG-2	(0.5,0.7,0.9) MH	(0.5,0.7,0.9) MH	(0.7,0.7,1.0) H	(0.9,1.0,1.0) VH	(0.7,0.7,1.0) H	(0.7,0.7,1.0) H	(0.5,0.7,0.9) MH	(0.5,0.7,0.9) MH
EG-3	(0.5,0.7,0.9) MH	(0.7,0.7,1.0) H	(0.9,1.0,1.0) VH	(0.7,0.7,1.0) H	(0.5,0.7,0.9) MH	(0.5,0.7,0.9) MH	(0.3,0.5,0.7) M	(0.3,0.5,0.7) M
EG-4	(0.7,0.7,1.0) H	(0.5,0.7,0.9) MH	(0.7,0.7,1.0) H	(0.5,0.7,0.9) MH	(0.7,0.7,1.0) H	(0.7,0.7,1.0) H	(01,0.3,0.5) ML	(0.3,0.5,0.7) M
EG-5	(0.5,0.7,0.9) MH	(0.3,0.5,0.7) M	(0.7,0.7,1.0) H	(0.5,0.7,0.9) MH	(0.7,0.7,1.0) H	(0.3,0.5,0.7) M	(0.7,0.7,1.0) H	(01,0.3,0.5) ML

Source: Panel of expert members.

Table 7. Interval-valued triangular fuzzy weights of criteria.

Criteria	l	l′	m	u′	u	DNC_j
TAI	0.5000	0.5720	0.7000	0.9387	1.0000	0.1345
IDI	0.3000	0.5165	0.6544	0.8927	1.0000	0.1219
GDP	0.7000	0.7361	0.7518	1.0000	1.0000	0.1518
EIS	0.5000	0.6434	0.7518	0.9587	1.0000	0.1397
EG	0.5000	0.6119	0.7000	0.9587	1.0000	0.1367
MDE	0.3000	0.5809	0.7028	0.9117	1.0000	0.1267
RMR	0.1000	0.3160	0.5165	0.7391	1.0000	0.0968
GPS	0.1000	0.2954	0.5165	0.7237	0.9000	0.0919

Source: Panel of expert members.

Step 3: Rate optimum performance for each category by selecting the performance rating that best meets each criterion. Optimal performance ratings should be expressed as IVF numbers instead of precise ones. The formula below is used to determine these ratings.

$$\bar{x}_j = \left[\left(l_j, l'_j\right), m_j, \left(u'_j, u_j\right)\right] \tag{7}$$

Here, $\bar{x}_j$ stands for the j_{th} criterion's interval-valued fuzzy best performance rating.

$$l_j = \begin{cases} max_i l_{ij};\ j \in \omega_{max} \\ min_i l_{ij};\ j \in \omega_{min} \end{cases} \tag{8}$$

$$l'_j = \begin{cases} max_i l'_{ij};\ j \in \omega_{max} \\ min_i\ l'_{ij};\ j \in \omega_{min} \end{cases} \quad (9)$$

$$m_j = \begin{cases} max_i m_{ij};\ j \in \omega_{max} \\ min_i m_{ij};\ j \in \omega_{min} \end{cases} \quad (10)$$

$$u'_j = \begin{cases} max_i\ u'_{ij};\ j \in \omega_{max} \\ min_i u'_{ij};\ j \in \omega_{min} \end{cases} \quad (11)$$

$$u_j = \begin{cases} max_i u_{ij};\ j \in \omega_{max} \\ min_i u_{ij};\ j \in \omega_{min} \end{cases} \quad (12)$$

Maximum for benefit criteria (prefer higher values) and minimum for cost criteria (prefer lower values).

The five expert groups use the linguistic specifications from Table 5 to evaluate the performances of the eight primary sectors with respect to each factor, as shown in Table 8. Fuzzy numbers obtained from multiple experts for each criterion and alternative are aggregated using fuzzy arithmetic operations from Equations (2)–(6) to receive the alternative performance scores with respect to each criterion in terms of IVF values. These aggregated fuzzy numbers provide a comprehensive representation of the overall expert judgments, considering both the central tendency and the variability of the assessments. The final decision matrix, presented in Table 9 as IVF numbers, undergoes assessment using Equations (7)–(6) for the IVF extension of the SAW model. The initial step in this approach is to obtain the suitable performance ratings using Equation (7).

Table 8. Alternative performance rating of group discussion in linguistic terms.

PS	TAI	IDI	GDP	EIS	EG	MDE	RMR	GPS
A1	MG, G, M, MP, M	G, MG, M, M, MG	M, M, MG, MG, M	MP, M, P, G, MG	G, VG, G, MG, MG	MG, M, MP, P, M	M, MP, G, MG, MP	P, VP, VP, MP, MP
A2	G, MP, MG, G, MP	MP, MP, M, M, MG	MP, P, MP, MP, P	MP, MP, P, P, MP	M, MG, M, MG, MG	MG, M, MP, M, M	M, MP, M, MG.MP	MG, M, MP, M, M
A3	VG, G, VG, G, G	M, MG, MG, M, MG	M, M, MG, MG, M	MG, G, M, MG, G	MG, G, M, MP, MG	G, MG, G, MG, M	G, MG, G, G, G	VG, G, VG, VG, G
A4	MG, G, MG, MP, MG	MP, M, MG, MG, M	MG, G, G, G, G	M, MG, M, MG, MG	G, VG, G, G, MG	MG, G, G, MG, G	MG, G, MG, VG, G	G, MG, MG, MG, MG
A5	P, VP, VP, MP, P	P, P, VP, VP, P	M, MP, MP, M, M	MP, MP, P, P, VP	MP, P, VP, P, VP	M, MP, P, M, MP	MP, P, MP, M, MP	M, VP, MP, MP, MP
A6	MP, MP, M, MP, M	M, MG, M, MP, M	VP, VP, P, P, VP	MP, M, M, MP, M	P, MP, P, MP, P	VP, P, MP, MP, MP	MP, VP, P, MP, P	VP, P, MP, MP, P
A7	P, VP, MP, VP, P	VP, P, MP, MP, VP	MP, MP, VP, MP, P	MP, MP, VP, VP, P	VP, MP, MP, P, VP	P, MP, MP, VP, VP	VP, P, VP, MP, VP	VP, MP, P, MP, P
A8	M, M, MG, MG, G	M, MG, M, M, MG	MP, MP, M, M, MP	G, MG, G, MG, M	MG, M, MG, G, VG	G, MG, MG, MG, G	MG, G, M, G, MG	MP, MP, MP, MP, MP

Source: Author's own elaboration.

Table 9. Interval-valued performance ratings of the primary sectors.

PS	TAI	IDI	GDP	EIS	EG	MDE	RMR	GPS
A1	0.1000	0.3000	0.3000	0.0000	0.5000	0.0000	0.1000	0.0000
	0.3160	0.4360	0.3680	0.0000	0.6434	0.0000	0.2537	0.0000
	0.5165	0.6119	0.5720	0.3743	0.7518	0.3500	0.4663	0.0000
	0.7391	0.8313	0.7740	0.6239	0.9587	0.5809	0.6910	0.2371
	1.0000	1.0000	0.9000	1.0000	1.0000	0.9000	1.0000	0.5000

Table 9. *Cont.*

PS	TAI	IDI	GDP	EIS	EG	MDE	RMR	GPS
A2	0.1000 0.3005 0.4988 0.7421 1.0000	0.1000 0.2141 0.4360 0.6434 0.9000	0.0000 0.0000 0.1933 0.4076 0.5000	0.0000 0.0000 0.1933 0.4076 0.5000	0.3000 0.5186 0.7028 0.8741 0.9000	0.1000 0.2667 0.4829 0.6882 0.9000	0.1000 0.2141 0.4360 0.6434 0.9000	0.1000 0.2667 0.4829 0.6882 0.9000
A3	0.7000 0.7740 0.8073 1.0000 1.0000	0.3000 0.4076 0.6119 0.8139 0.9000	0.3000 0.3680 0.5720 0.7740 0.9000	0.3000 0.5165 0.6544 0.8927 1.0000	0.1000 0.3500 0.5524 0.7772 1.0000	0.3000 0.5165 0.6544 0.8927 1.0000	0.5000 0.6544 0.7000 0.9791 1.0000	0.7000 0.8139 0.8670 1.0000 1.0000
A4	0.1000 0.3876 0.5909 0.8172 1.0000	0.1000 0.2954 0.5165 0.7237 0.9000	0.5000 0.6544 0.7000 0.9791 1.0000	0.3000 0.4076 0.6119 0.8139 0.9000	0.5000 0.6882 0.7518 0.9791 1.0000	0.5000 0.6119 0.7000 0.9587 1.0000	0.5000 0.6434 0.7518 0.9587 1.0000	0.5000 0.5348 0.7000 0.9192 1.0000
A5	0.0000 0.0000 0.0000 0.2141 0.5000	0.0000 0.0000 0.0000 0.1933 0.3000	0.1000 0.1933 0.4076 0.6119 0.7000	0.0000 0.0000 0.0000 0.2954 0.5000	0.0000 0.0000 0.0000 0.2141 0.5000	0.0000 0.0000 0.2954 0.5165 0.7000	0.0000 0.0000 0.2667 0.4829 0.7000	0.0000 0.0000 0.0000 0.3876 0.7000
A6	0.1000 0.1552 0.3680 0.5720 0.7000	0.1000 0.2667 0.4829 0.6882 0.9000	0.0000 0.0000 0.0000 0.1552 0.3000	0.1000 0.1933 0.4076 0.6119 0.7000	0.0000 0.0000 0.1552 0.3680 0.5000	0.0000 0.0000 0.0000 0.3272 0.5000	0.0000 0.0000 0.0000 0.2954 0.5000	0.0000 0.0000 0.0000 0.2954 0.5000
A7	0.0000 0.0000 0.0000 0.2141 0.5000	0.0000 0.0000 0.0000 0.2371 0.5000	0.0000 0.0000 0.0000 0.3272 0.5000	0.0000 0.0000 0.0000 0.2371 0.5000	0.0000 0.0000 0.0000 0.3758 0.5000	0.0000 0.0000 0.0000 0.2371 0.5000	0.0000 0.0000 0.0000 0.2724 0.5000	0.0000 0.0000 0.0000 0.2954 0.5000
A8	0.3000 0.4360 0.6119 0.8313 1.0000	0.3000 0.3680 0.5720 0.7740 0.9000	0.1000 0.1552 0.3680 0.5720 0.7000	0.3000 0.5165 0.6544 0.8927 1.0000	0.3000 0.5431 0.7028 0.8927 1.0000	0.5000 0.5720 0.7000 0.9387 1.0000	0.3000 0.5165 0.6544 0.8927 1.0000	0.1000 0.1000 0.3000 0.5000 0.5000

Source: Author's own elaboration.

Step 4: Normalize the decision matrix with Equations (13) and (14) based on parameter nature. Equation (13) is applied for benefit criteria, where larger values are expected.

$$N_{ij} = \left\{ \left(\frac{l_j}{max(l_j)}, \frac{l'_j}{max\left(l'_j\right)} \right), \frac{m_j}{max(m_j)}. \left(\frac{u'_j}{max\left(u'_j\right)}, \frac{u_j}{max(u_j)} \right) \right\} \tag{13}$$

Use the following Equation (14) for non-benefit criterion (minimum parameter) whose smaller values are anticipated.

$$N_{ij} = \left\{ \left(\frac{min(l_j)}{l_j}, \frac{min(l_j)}{l'_j} \right), \frac{min(l_j)}{m_j}. \left(\frac{min(l_j)}{u'_j}, \frac{min(l_j)}{u_j} \right) \right\} \tag{14}$$

Step 5: Determine the weighted normalized matrix using Equations (15) and (16).

$$WN_{ij} = N_{ij} \times DNC_j \tag{15}$$

$$DNC_j = \frac{l_c + l_c{}' + m_c + u_c{}' + u_c}{5} \quad (16)$$

Step 6: Defuzzification of IVF-weighted normalized performance rating using Equation (17) to calculate the defuzzification (DFW) and weighted sum (W_i^S) using Equation (18). The ranking of primary sectors and the corresponding values of ($W_i{}^S$) are shown in Table 10.

$$DFW_i = \frac{l + l' + m + u' + u}{5} \quad (17)$$

$$W_iP \;= W_i^S = DF_{GDPi} + DF_{EMPi} + DF_{TAi} + DF_{IVTi} + DF_{IDi} + DF_{GPSi} + DF_{RMi} + DF_{EIi} \quad (18)$$

Table 10. Prescribed rankings using IVF-SAW, IVF-WSM and IVF-WASPAS.

PS	WSM (W_i^s)	Rank	WPM (W_i^p)	Rank	WASPAS (Q_i)	Rank
A1	0.6063	4	0.0411	4	0.3237	4
A2	0.4304	5	0.0281	5	0.2293	5
A3	0.7220	2	0.1126	2	0.4173	2
A4	0.7427	1	0.1149	1	0.4288	1
A5	0.2350	7	0.0010	7	0.1180	7
A6	0.3451	6	0.0069	6	0.1760	6
A7	0.1994	8	0.0003	8	0.0999	8
A8	0.6907	3	0.1114	3	0.4010	3

Source: Author's own elaboration.

4.3. Interval-Valued Fuzzy WPM Method

In fuzzy MCDM problems, relative weights are often represented by fuzzy numbers. A fuzzy number is defined as a convex fuzzy set with a given interval of real numbers, each with a membership value between 0 and 1. To accommodate a situation where determining precise values is challenging, membership values can be expressed as an interval of real values. In this study, criteria weights are treated as linguistic variables, which is particularly useful for complex or poorly defined circumstances. These linguistic variables can be transformed into triangular fuzzy numbers with interval values [32]. Considering the difficulty in determining precise criteria levels in the physical world, we modify the WPM approach to address the MCGDM problem using linguistic criteria values.

Step 1: Define linguistic parameters for criteria weight and performance rating of eight alternatives in a fuzzy decision matrix for group decision, as outlined in Tables 6 and 8.

Step 2: Convert expert judgment to IVF numbers, following the same process as in IVF-SAW Step 2. IVF-WPM method uses the exact same data from IVF-SAW step 2.

Step 3: Rate optimal performance for each category, following the same process as in IVF-SAW Step 3. IVF-WPM method uses the data from IVF-SAW Step 3.

Step 4: Determine the normalized decision matrix, which is the same as in IVF-SAW Step 4. The same value is used for this step.

Step 5: Determine the weighted normalized matrix using Equation (19).

$$WN_{ij} = N_{ij}^{DNC_j} \quad (19)$$

Step 6: Defuzzify IVF-weighted normalized performance ratings using the same method as in IVF-SAW with Equations (17) and (18). The rank of pedagogy methods and corresponding values 'W_i^p' are presented in Table 10.

4.4. Interval-Valued Fuzzy WASPAS Method

Combining IVF-SAW and IVF-WPM creates IVF-WASPAS, ranking alternatives using the aggregated sum product weightage (Q_i). This method integrates the weighted summation (W_i^s) and multiplication (W_i^p) procedures, as shown in Equation (20).

$$Q_i = 0.5W_i^s + 0.5W_i^p = 0.5\sum_{j=1}^{n} N_{ij}W_j + 0.5\sum_{j=1}^{n} N_{ij}{}^{W_j} \quad (20)$$

where, Q_i is the aggregated sum product weightage of the i_{th} alternative (i = 1, 2, 3. . ., m; j = 1, 2, 3. . ., n)

5. Result and Discussion

Using the IVF-SAW, IVF-WPM, and IVF-WASPAS methodologies, the primary sectors are evaluated and compared. Defuzzified IVF values for SAW, WPM, and WASPAS are established for each model. The subsequent section provides a detailed discussion on the impact of these strategies. A-4 (Energy sector) receives the highest preference score in all three techniques, while the A-7 (Information Technology) alternative scores the lowest as per the expert judgements and opinions. The preferred order for various primary sector options is as follows.

- IVF-SAW: A-4 > A-3 > A-8 > A-1 > A-2 > A-6 > A- 5 > A-7
- IVF-WPM: A-4 > A-3 > A-8 > A-1 > A-2 > A-6 > A- 5 > A-7
- IVF-WASPAS: A-4 > A-3 > A-8 > A-1 > A-2 > A-6 > A- 5 > A-7

The discussion of the Romanian primary sectors ratings prescribed by the three MCDM methods offers valuable insights into the relative importance and performance of each sector. Let us discuss and justify these rankings in the context of the Romanian economy and real-world considerations with the help of Table 11, provided below.

Table 11. Aligning the alternatives' rating with the real-world application.

Rank	Primary Sectors	Justifications
1	Energy	Energy consistently ranks highest across all three MCDM methods. This ranking is justified by the sector's significant contributions to technological adaptation and innovation through advancements in renewable energy technologies and efficiency measures. Furthermore, energy infrastructure development and investment, such as power plants and transmission networks, play crucial roles in supporting economic growth and industrial activities. The energy sector also contributes substantially to GDP, employment generation, and market demand, while government policies and subsidies encourage investment in sustainable energy sources, further solidifying its top-ranking position.
2	Agriculture and Forestry	Agriculture and forestry consistently rank second among the primary sectors. These sectors contribute to technological adaptation and innovation through the adoption of modern farming practices and sustainable forestry management techniques. Infrastructure development and investment in rural areas, such as irrigation systems and forest management facilities, support agricultural and forestry activities. Moreover, agriculture and forestry make significant contributions to GDP, employment generation, and environmental sustainability by preserving ecosystems and providing renewable resources. Government policies and subsidies further promote growth in these sectors through incentives for sustainable practices and rural development initiatives.
3	Mining	Mining consistently ranks third across all MCDM methods. While the sector may lag behind in technological adaptation compared to other industries, it still contributes to innovation through advancements in mining technologies and extraction methods. Infrastructure development and investment in mining operations, such as mine infrastructure and transportation networks, support economic activities in mining regions. Mining contributes significantly to GDP through mineral extraction and processing, albeit with potential environmental impacts that require sustainable practices and mitigation measures. Employment generation, market demand, and government policies also influence the sector's ranking, with subsidies aimed at promoting responsible mining practices and community development.

Table 11. *Cont.*

Rank	Primary Sectors	Justifications
4	Fishing	Fishing consistently ranks fourth among the primary sectors. While the sector may have limited technological innovation compared to other industries, infrastructure development and investment in fishing fleets and processing facilities support maritime activities. Fishing contributes to GDP through seafood production and export opportunities, while employment generation and market demand drive the sector's importance in coastal communities. Environmental sustainability is crucial for the fishing industry, with regulations and conservation efforts aimed at preserving marine ecosystems. Government policies and subsidies support sustainable fishing practices and resource management, influencing the sector's ranking.
5	Automobile	The automobile industry consistently ranks fifth across all MCDM methods. Technological adaptation and innovation are significant drivers in the automotive sector, with advancements in electric vehicles and autonomous driving technologies. Infrastructure development and investment in automotive manufacturing plants and transportation networks support industry growth. The automobile industry contributes significantly to GDP through manufacturing and exports, while employment generation and market demand influence its importance in the economy. Government policies and subsidies incentivize investment in research and development, emission reduction measures, and automotive production, impacting the sector's ranking.
6	Textile	The textile industry consistently ranks sixth among the primary sectors. While the sector may have limited technological innovation compared to other industries, infrastructure development and investment in textile manufacturing facilities support production activities. Textile manufacturing contributes to GDP through domestic production and export opportunities, while employment generation and market demand drive industry dynamics. Environmental sustainability is a growing concern, with initiatives aimed at reducing water consumption and promoting sustainable textile production. Government policies and subsidies support industry competitiveness and sustainability, influencing its ranking.
7	Manufacturing and Construction	The manufacturing and construction sectors consistently rank seventh across all MCDM methods. While these sectors may exhibit some technological adaptation and innovation, infrastructure development and investment in manufacturing facilities and construction projects support economic activities. Manufacturing and construction contribute significantly to GDP through industrial production and infrastructure development, while employment generation and market demand drive sector dynamics. Environmental sustainability considerations are important, with regulations and green building initiatives aimed at reducing environmental impact. Government policies and subsidies support industry growth and sustainability, impacting the sector's ranking.
8	Information Technology	Information technology consistently ranks lowest among the primary sectors. While the sector excels in technological adaptation and innovation, infrastructure development and investment in IT infrastructure and digital connectivity support industry growth. Information technology contributes to GDP through software development, IT services, and digital innovation, while employment generation and market demand drive sector dynamics. Environmental sustainability considerations are relevant, with initiatives aimed at reducing e-waste and promoting energy-efficient technologies. Government policies and subsidies support digital transformation and innovation, influencing the sector's ranking.

Source: Author's own elaboration.

The rankings of Romanian primary sectors prescribed by the IVF-SAW, IVF-WPM, and IVF-WASPAS MCDM tools shown in Figure 2 align with real-world considerations across various factors. These rankings provide valuable insights for policymakers, investors, and stakeholders in strategic decision-making and resource allocation to promote sustainable economic development in Romania.

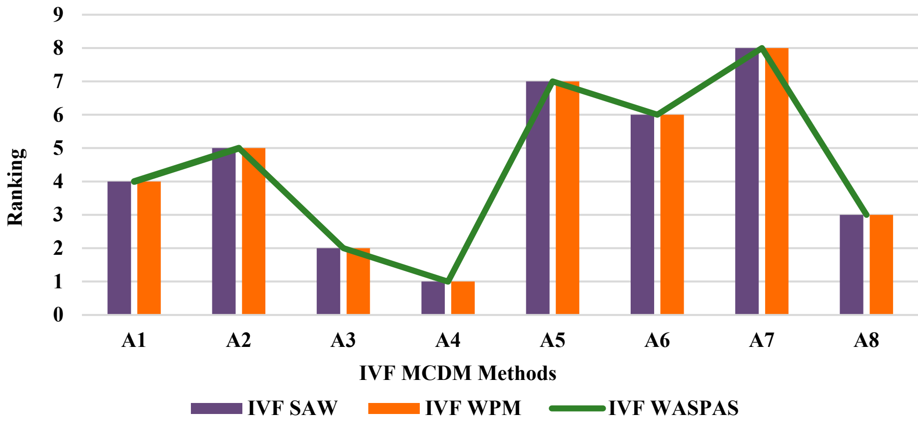

Figure 2. Ranking comparison of IVF-SAW, IVF-WPM, IVF-WASPAS. (Source: Author's own elaboration).

5.1. Sensitivity Analysis

Incorporating the diffusion coefficient (λ) into choice frameworks reflects the economic experts' views on uncertainty. Ensuring model stability requires a sensitivity analysis, varying λ from 0 to 1 and fine-tuning values. Probing the parameter's impact assesses the framework's responsiveness to changes in expert's perspective. This iterative process aligns the model with the intended pedagogical approach and enhances reliability in accommodating uncertainty. Sensitivity analysis validates stability and exhibits adaptability to the experts' evolving viewpoint on uncertainty in education.

5.1.1. Sensitivity Analysis on IVF-SAW Method

To determine the weighted sum score, convert overall performance ratings into exact IVF values. The choice of defuzzification techniques may impact outcomes, making it crucial to decide which technique to use and when to use it. Adjusting 'λ' in Equation (21) provides more options than Equation (17), allowing for a flexible weighting of lower (l, l′) and upper (u, u′) bounds. Table 12 presents results from Equation (21) for various coefficient values.

$$DF_\lambda = \frac{(1-\lambda)l + \lambda l' + m + \lambda u' + (1-\lambda)u}{3} \tag{21}$$

Table 12. Ranking for various parameters λ on IVF-SAW and IVF-WPM method.

PS	λ = 0				λ = 0.5				λ = 1			
	W_i^s	Rank	W_i^p	Rank	W_i^s	Rank	W_i^p	Rank	W_i^s	Rank	W_i^p	Rank
A1	1.2162	4	0.0356	4	0.5993	4	0.0346	4	1.2162	4	3.8220	4
A2	0.8534	5	0.0241	5	0.4262	5	0.0236	5	0.8534	5	2.5410	5
A3	1.6117	2	0.0822	2	0.7178	2	0.0785	2	1.6117	2	11.8604	2
A4	1.6728	1	0.0826	3	0.7395	1	0.0803	1	1.6728	1	12.3922	1
A5	0.3008	7	0.0004	7	0.2157	7	0.0004	7	0.3008	7	0.0014	7
A6	0.5850	6	0.0040	6	0.3287	6	0.0036	6	0.5850	6	0.0802	6
A7	0.1348	8	0.0001	8	0.1662	8	0.0001	8	0.1348	8	0.0001	8
A8	1.4834	3	0.0820	1	0.6828	3	0.0775	3	1.4834	3	11.4447	3

Source: Author's own elaboration.

The rankings in Table 12 and Figure 3 demonstrate that the proposed IVF integrated with SAW approach is a valuable tool for assessing decision-making scenarios and selecting the best alternative.

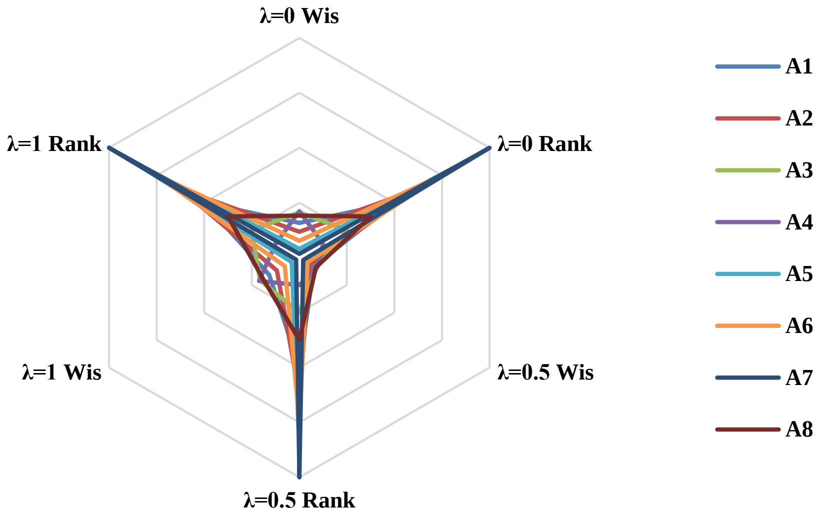

Figure 3. Ranking with change of λ for IVF-SAW. Source: Author's own elaboration.

5.1.2. Sensitivity Analysis on IVF-WPM Method

The same process is followed here as in IVF-SAW. By using Equation (21) and adjusting 'λ', it is possible to give more weight to the lower (l, l′) or upper (u, u′) bounds, allowing for sensitivity analysis. The weighted product of each alternative considering varying the 'λ' values is presented in Table 12. The rankings in Table 12 and Figure 4 demonstrate that the proposed IVF integrated with WPM approach is a valuable tool for assessing decision-making scenarios and selecting the best alternative.

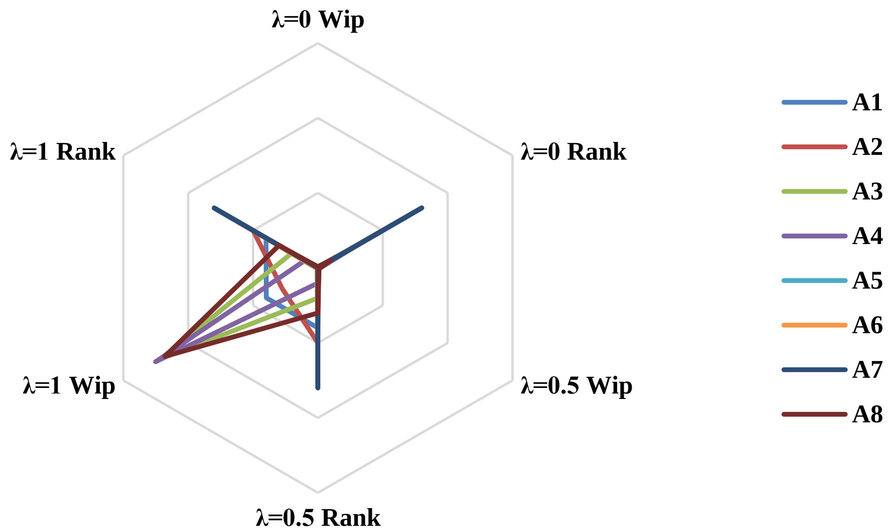

Figure 4. Ranking with change of λ for IVF-WPM. (Source: Author's own elaboration).

5.1.3. Sensitivity Analysis on IVF-WASPAS Method

A more generalized equation represented by Equation (22) is used to improve the efficacy and ranking accuracy. The corresponding values are shown in Table 13 and the alternative's ranking deviations are illustrated using Figure 5. Where, λ = 0, 0.1, 0.2, 0.3. . ., 1.

$$Q_i = \lambda W_i^s + (1-\lambda) W_i^p = \lambda \sum_{j=1}^{n} N_{ij} W_j + (1-\lambda) \sum_{j=1}^{n} {N_{ij}}^{W_j} \tag{22}$$

Table 13. Ranking of IVF-WASPAS method for varying 'λ'.

PS	λ = 0	λ = 0.1	λ = 0.2	λ = 0.3	λ = 0.4	λ = 0.5	λ = 0.6	λ = 0.7	λ = 0.8	λ = 0.9	λ = 1
A1	4	4	4	4	4	4	4	4	4	4	4
A2	5	5	5	5	5	5	5	5	5	5	5
A3	2	2	2	2	2	2	2	2	2	2	2
A4	1	1	1	1	1	1	1	1	1	1	1
A5	7	7	7	7	7	7	7	7	7	7	7
A6	6	6	6	6	6	6	6	6	6	6	6
A7	8	8	8	8	8	8	8	8	8	8	8
A8	3	3	3	3	3	3	3	3	3	3	3

Source: Author's own elaboration.

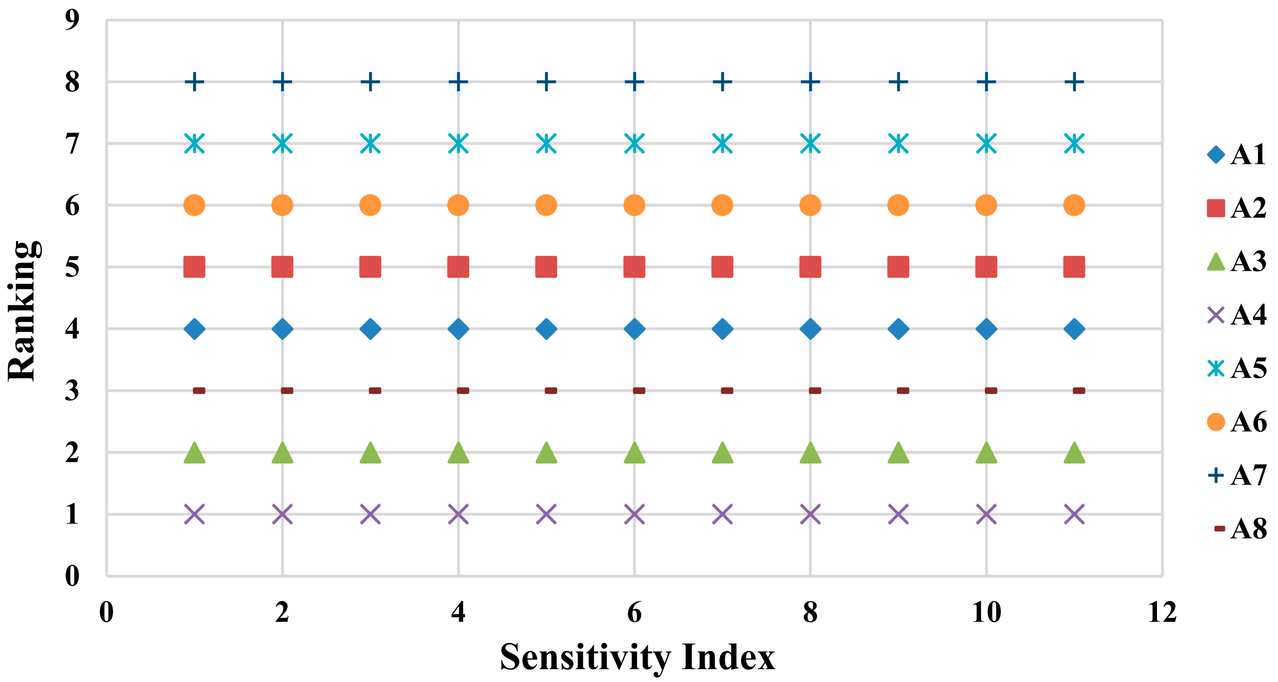

Figure 5. Ranking with change of λ for IVF-WASPAS. (Source: Author's own elaboration).

In conclusion, varying the variables from 0 to 1 in intervals of 0.1 does not impact the ranking order of alternatives. This suggests that, without changes, A-4 remains the top choice. This study highlights the reliability and robustness of the evaluation model, recommending the optimal method from a range of options. Overall, it is evident from Tables 12 and 13 that for every value of 'λ' variation, the exact same rankings have been obtained for every case, thus indicating the robustness and stability in the final output rankings.

The findings from the rankings of Romanian primary sectors can provide valuable guidance to decision-makers in selecting and prioritizing sectors for investment, policy intervention, and development initiatives. By leveraging sectoral strengths, addressing challenges, and promoting sustainability and resilience, decision-makers can foster inclusive and sustainable economic growth in Romania. Table 14 provides more concrete insights into how the findings from the rankings of Romanian primary sectors prescribed by the IVF-SAW, IVF-WPM, and IVF-WASPAS MCDM tools could influence primary sector selection and guide decision-making.

Table 14. Implications and recommendation of the experts.

Area of Implications	Implications and Recommendation	
Strategic investment prioritization	Implications	The consistent top rankings of the energy, agriculture, and forestry sectors indicate their significant contributions to economic development and sustainability.
	Recommendations	Decision-makers should prioritize strategic investments in these sectors to capitalize on their strengths and potential for growth. This could involve allocating resources for infrastructure development, research and development, and capacity-building initiatives to enhance productivity and competitiveness.
Diversification and innovation	Implications	While certain sectors like energy and agriculture perform well across all MCDM methods, others like information technology and manufacturing show variability in their rankings.
	Recommendations	Decision-makers should focus on diversifying the economy and fostering innovation in sectors with lower rankings. This could involve implementing policies to support technology adoption, research and development, and entrepreneurship to stimulate growth and competitiveness in these sectors.
Environmental sustainability	Implications	The rankings provide insights into the environmental impact and sustainability practices of different sectors, with sectors like mining and manufacturing potentially facing challenges.
	Recommendations	Decision-makers should prioritize environmental sustainability in sector selection by promoting sustainable practices, implementing stricter regulations, and investing in clean technologies and renewable energy sources. This would not only mitigate environmental risks but also enhance long-term resilience and competitiveness.
Market demand and export opportunities	Implications	Sectors with high rankings in market demand and export opportunities, such as energy and agriculture, indicate their potential for driving economic growth through international trade.
	Recommendations	Decision-makers should leverage these sectors' strengths by promoting exports, facilitating market access, and fostering international partnerships. This could involve implementing trade policies, providing export incentives, and supporting market intelligence and export promotion initiatives.
Employment generation and rural development	Implications	Sectors like agriculture and forestry play a crucial role in employment generation and rural development, as indicated by their high rankings.
	Recommendations	Decision-makers should prioritize sectors with strong potential for job creation and rural development through targeted investments, skills training programs, and entrepreneurship support. This could help address unemployment, reduce rural-urban disparities, and stimulate inclusive economic growth.
Policy alignment and coordination	Implications	Government policies and subsidies can significantly influence sector performance and competitiveness.
	Recommendations	Decision-makers should ensure alignment and coordination of policies across sectors to create a conducive business environment and address sector-specific challenges. This could involve developing sectoral strategies, establishing policy coherence mechanisms, and enhancing stakeholder engagement to maximize policy effectiveness and impact.
Resilience and risk management	Implications	Sectors with lower rankings may face challenges related to resilience and risk management, such as technological disruptions, market volatility, and environmental risks.
	Recommendations	Decision-makers should assess and address sector-specific risks by implementing proactive measures, diversifying revenue streams, and enhancing adaptive capacity. This could involve establishing risk management frameworks, promoting innovation and flexibility, and providing targeted support to vulnerable sectors.

Source: Author's own elaboration.

5.2. Ranking Comparisons

The following section highlights the comparisons of the present rankings with other methods to observe any differences in the outcome results. To prove the robustness of the present hybrid model, traditional SAW, WPM and WASPAS without considering fuzzy were further applied and the alterations in the output rankings were observed. It is to be noted from Table 15 that the alternative rankings vary across the three traditional MCDM tools. Although conventional SAW and WASPAS prescribe the same ranking order, the ranking proposed by traditional WPM is completely different, thus indicating the instability and lack of cooperation among these three traditional methods. On the other hand, when IVF is integrated with SAW, WPM and WASPAS, the ranking order is modified and the stability is further enhanced, thus producing the same ranking across the three methods as evident from Table 15. The variations in the ranking order among the applied MCDM methods are also illustrated graphically in Figure 6.

Table 15. Ranking comparisons among different MCDM models.

PS	IVF-Fuzzy			Non-Fuzzy		
	WSM	**WPM**	**WASPAS**	**WSM**	**WPM**	**WASPAS**
A1	4	4	4	4	1	4
A2	5	5	5	5	5	5
A3	2	2	2	2	4	2
A4	1	1	1	1	2	1
A5	7	7	7	8	8	8
A6	6	6	6	6	6	6
A7	8	8	8	7	7	7
A8	3	3	3	3	3	3

Source: Author's own elaboration.

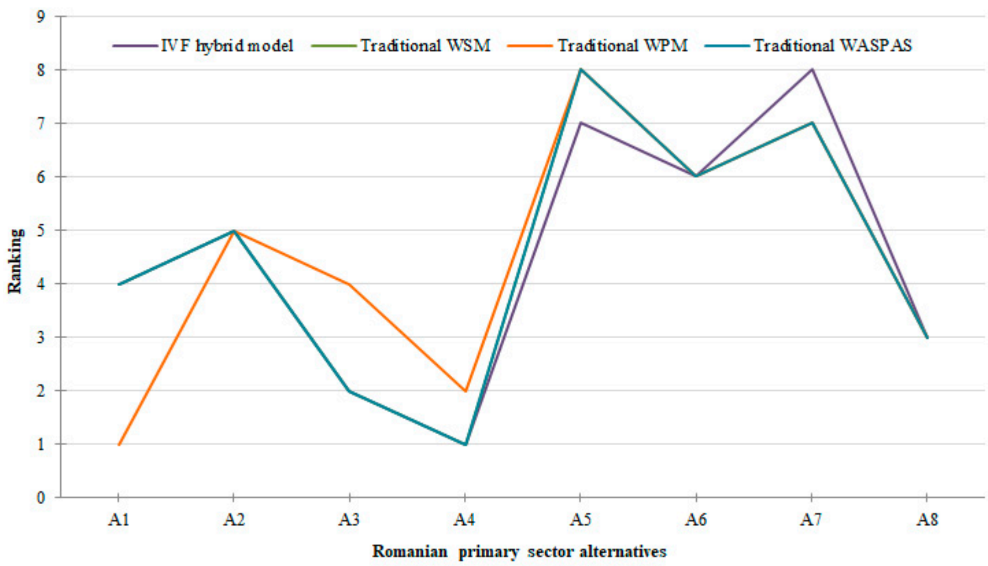

Figure 6. Graphical representation of the ranking comparisons. (Source: Author's own elaboration.)

Some other insights can be derived from this comparative analysis. Across both analyses, alternatives A2, A6 and A8 maintain the same ranks. This suggests that these alternatives possess a consistent performance across both IVF and traditional methods. Notably, there are differences in the rankings of alternatives A1, A3, A4, A5 and A7 between the two analyses. In the IVF analysis, all the alternatives are consistently ranked at the same positions for all three methods, respectively. In the second analysis of traditional methods, alternatives A2, A5, A6, A7 and A8 remain at positions 5, 8, 6, 7, and 3, but A1, A3 and A4 swap positions with ranks 1, 2 and 4, respectively. Hence, from the traditional methods, it would be contradictory to accomplish the first and second-rank alternatives since different methods suggest different ranking orders to the alternatives A1, A3 and A4. The discrepancies in rankings could be attributed to the handling of uncertainty and fuzziness in the IVF methods. IVF techniques allow for a more nuanced representation of uncertainty, which may lead to different rankings compared to traditional methods that do not account for fuzziness. Fuzzy methods tend to capture the imprecision and ambiguity present in decision-making processes more effectively, potentially resulting in better prioritization of alternatives.

In conclusion, the ranking comparisons between the two MCDM analyses reveal both consistencies and differences, primarily driven by the inclusion of fuzziness in IVF methods. The performance and the robustness of the results of any MCDM tools can be enhanced by integrating the fuzzy concept. However, it can be observed that fuzzy-embedded hybrid MCDM tools perform better compared to the traditional MCDM methodologies. Fuzzy models can produce consistent rankings and their stability is also better compared to other alternative models. Therefore, if decision-makers want to prioritize a more nuanced handling of uncertainty and are willing to accept potentially different rankings due to fuzziness, IVF methods might be preferred. Conversely, if decision-makers prefer straightforward, deterministic rankings without considering fuzziness, traditional methods could be more suitable.

6. Conclusions

This research delves into a comprehensive analysis of the primary sector's role in shaping the economic activity in Romania. Using advanced decision-making methodologies like IVF-SAW, IVF-WPM, and IVF-WASPAS within the MCDM framework, this study emphasizes the pivotal role of the energy sector compared to other alternatives. The findings underscore the critical significance of the energy sector in driving economic growth and development. Rigorous evaluation demonstrates its superior performance, indicating its capacity to generate economic value, create employment opportunities, and contribute significantly to overall prosperity in Romania. This research highlights the importance of prioritizing investments and initiatives in the energy sector for sustainable economic progress and increased resilience to economic fluctuations.

While the success of the energy sector is crucial, it does not diminish the importance of other primary sectors in Romania's economic landscape. These sectors play vital roles and must be nurtured alongside the energy sector for a balanced and diversified economy. This research provides a solid foundation for future studies and policy decisions related to the primary sector's selection in Romania. Acknowledging the central role of the energy sector and adopting a holistic approach to economic development can guide Romania towards greater prosperity and resilience in the evolving global economic landscape.

6.1. Managerial Implications

The present research on the selection of Romanian primary sectors using an integrated SAW, WPM, and WASPAS approach provides valuable insights for managers involved in sectoral development and investment decisions. By leveraging the findings and implications of this research, managers can make informed decisions that support the growth, competitiveness, and sustainability of primary sectors in Romania. The following research has several managerial implications that may be discussed as follows.

- Managers can use the integrated approach to allocate resources effectively across different primary sectors in Romania. By considering the strengths and weaknesses of each sector identified through the integrated SAW, WPM, and WASPAS approach, managers can allocate resources such as funding, manpower, and technology to maximize sectoral performance.
- The integrated approach provides a systematic framework for evaluating the performance of primary sectors. Managers can use the findings to identify areas for improvement within each sector and develop strategies to enhance performance. This

may involve implementing process improvements, adopting new technologies, or investing in workforce training and development.

- Managers can use the integrated approach to assess and mitigate risks associated with sectoral selection and investment decisions. By considering the uncertainties inherent in the decision-making process, managers can identify potential risks and develop contingency plans to manage them effectively.
- The integrated approach can facilitate collaboration and partnerships between different stakeholders within the primary sectors. Managers can leverage the findings to identify complementary strengths and opportunities for collaboration, such as joint research initiatives, supply chain partnerships, or market development efforts.
- This research's findings can inform policy formulation and advocacy efforts aimed at supporting the growth and development of primary sectors in Romania. Managers can use the insights gained from the integrated approach to advocate for policies that address sector-specific challenges, promote innovation, and create a conducive business environment.
- Managers can use the integrated approach to inform long-term planning and investment decisions within the primary sectors. By considering the sectoral priorities and opportunities identified through the approach, managers can develop strategic plans and investment strategies that support sustainable growth and development over the long term.
- Effective stakeholder engagement and communication are essential for the successful implementation of sectoral development initiatives. Managers can use the integrated approach to engage stakeholders such as government agencies, industry associations, and local communities in the decision-making process and communicate the rationale behind sectoral selection and investment decisions.

6.2. Limitations of the Present Research

Despite numerous positive interpretations, every decision-making analysis involving different factors involves certain limitations that need to be addressed properly to enhance the robustness and applicability of the MCDM models. Below are some of the identified limitations that may be associated with this research.

- The accuracy and reliability of the decision-making process heavily rely on the availability and quality of the data used in the analysis. Limitations in data availability or inaccuracies in data collection may introduce biases or uncertainties into the results.
- The integration of expert judgments in assigning criteria weights or assessing performance scores may introduce subjectivity and bias into the decision-making process. Differences in expertise, perspectives, or preferences among experts may influence the outcomes of the analysis.
- This research may involve simplifying assumptions or constraints to facilitate the decision-making process. These assumptions may not fully capture the complexities and nuances of the primary sector selection problem, potentially leading to oversimplification or unrealistic conclusions.
- The integrated SAW, WPM, and WASPAS decision-making approach may be complex and computationally intensive, particularly when dealing with a large number of criteria and alternatives. This complexity may limit the practical applicability of the approach or require significant computational resources and expertise for implementation.
- While interval-valued fuzzy sets offer a flexible framework for handling uncertainty, their validity and effectiveness depend on the appropriateness of the membership functions and the accuracy of interval assignments. Inaccurate or arbitrary assignments of interval values may undermine the reliability of the analysis.
- The findings and recommendations derived from this research may be specific to the context of the Romanian primary sector and may not be directly applicable to other regions or sectors. Factors such as cultural, economic, or institutional differences may limit the generalizability of the results.

- The primary sector selection problem is inherently dynamic, with evolving trends, preferences, and external factors influencing decision outcomes over time. This research may not adequately capture the dynamic nature of the decision context, leading to static or outdated recommendations.

6.3. Future Directions

Future work stemming from this research could focus on several areas to enhance the understanding and applicability of the decision-making process. By addressing these areas in future research, the understanding and applicability of the decision-making approach for selecting primary sectors in Romania can be further advanced, leading to more informed and effective decision outcomes.

- Further research could refine the methodology for defining and using interval-valued fuzzy sets in the decision-making process. This includes exploring alternative approaches for assigning interval values and membership functions to better capture the uncertainty and variability in criteria weights and performance scores.
- Future work could explore the integration of additional MCDM models beyond SAW, WPM, and WASPAS. Incorporating other models such as PROMETHEE, ELECTRE, or TOPSIS could provide alternative perspectives and enhance the robustness of the decision-making process.
- Developing dynamic decision-making frameworks that account for changes and uncertainties over time could be a promising avenue for future research. This includes exploring methods for updating criteria weights and performance scores in response to evolving conditions and preferences within the primary sectors.
- Extending this research to other sectors and regions beyond the Romanian primary sector could broaden the scope and impact of the decision-making approach. This includes adapting the methodology to address sector-specific challenges and priorities in different contexts and geographical areas.

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