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Strategic Warehouse Location Selection in Business Logistics: A Novel Approach Using IMF SWARA–MARCOS—A Case Study of a Serbian Logistics Service Provider

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Abstract: Business logistics encompasses the intricate planning, seamless implementation, and precise control of the efficient and effective movement and storage of goods, services, and associated information from their origin to their final consumption point. The strategic placement of facilities is intricately intertwined with business logistics, exerting a direct influence on the efficiency and cost-effectiveness of supply chain operations. In the realm of business logistics, decisions regarding the location of facilities, including warehouses, distribution centers, and manufacturing plants, assume a pivotal role in shaping the overarching logistics strategy. Warehouses, serving as pivotal nodes in the supply chain network, establish crucial links at both local and global markets. They serve as the nexus connecting suppliers and customers across the entire supply chain, thus constituting indispensable elements that significantly impact the overall performance of the supply chain. The optimal location of warehouses is paramount for efficient supply chains, ensuring minimized costs and bigger profits. The decision on warehouse location exerts a profound influence on investment costs, operational expenses, and the distribution strategy of a company, thereby playing a substantial role in elevating customer service levels. Hence, the primary objective of this paper is to propose a novel methodology grounded in the application of the Improved Fuzzy Stepwise Weight Assessment Ratio Analysis (SWARA)-Measurement of Alternatives and Ranking according to Compromise Solution (MARCOS) methods for determining warehouse locations tailored to a logistics service provider (LSP) operating in the Serbian market. Through the definition of seven evaluation criteria based on a comprehensive literature review and expert insights, this study aims to assess five potential locations. The findings suggest that the proposed model offers great decision support for effectively addressing challenges akin to the one presented in this study.

Keywords: warehouse; location selection; supply chain; logistics; decision-making; IMF SWARA; MARCOS; logistics service provider

MSC: 90B06

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1. Introduction

The issue of location selection is a widely debated phenomenon globally within the realms of transportation and logistics. This problem is inherently universal and can encompass the choice of various types of locations for facilities such as warehouses, distribution centers, transportation hubs, passenger and freight terminals, parking areas, and numerous others, taking into consideration the preferences of decision-makers and existing constraints [1,2]. In the context of transportation and logistics, this matter can be analyzed from various perspectives. For instance, when considering efficiency and costs, the selection of a location can profoundly impact the efficiency and costs of logistical operations—if a warehouse is strategically located near transportation networks or major roads, transportation time and costs will thus be diminished. Regarding proximity to clients and markets, opting for a location close to target clients or markets can expedite deliveries and reduce transportation costs. It is crucial to pay special attention to the availability of appropriate infrastructure supporting logistical operations to ensure swift and efficient distribution. The selection of a location is also heavily influenced by legal and regulatory obligations in the observed area, affecting logistical operations. Another noteworthy aspect is the potential for enhancing competitive advantage—a well-chosen location can give a company a competitive edge if the facility is strategically positioned in relation to competitors, leading to improved service, lower costs, and the attraction of more clients. In essence, effectively addressing the location selection problem in logistics contributes to more efficient supply chain management, heightened customer satisfaction, and reduced overall costs, rendering logistical operations more competitive and sustainable.

The primary objective of this paper is to propose a model for selecting an appropriate location for the establishment of a warehouse facility to meet the logistics service provider's (LSP) needs, employing relevant multi-criteria decision-making (MCDM) methods in accordance with specific criteria. Also, the aim is to fill the gap in the literature regarding the LSP warehouse location selection problem. This paper explores the feasibility of utilizing various multi-criteria decision-making methods in the warehouse location selection problem. To address the posed problem, a hybrid model has been employed, combining IMF SWARA and MARCOS methods. The SWARA method was implemented in a fuzzy form, considering the fact that experts found it more convenient to assess the significance of criteria using a linguistic scale. The advantages of employing the IMF SWARA method are evident in its ability to facilitate precise and high-quality determinations of criteria significance, requiring a reduced number of pairwise comparisons, and in it being user-friendly, especially for individuals unfamiliar with MCDM methods [3]. On the other hand, the MARCOS method was employed for alternative ranking due to its simplicity, capacity to deliver stable solutions, and precision [4]. The primary contribution of this paper lies in the development of an entirely new model for warehouse location selection, providing support to the decision-making process in choosing a suitable location. Additionally, the contribution extends to the fact that the developed model can be easily applied to other related problems in different industries and markets with minor adjustments to input parameters (criteria and alternatives). The application of the developed model enables the making of more informed decisions based on previously gathered data.

The paper is organized as follows. Following the introduction, Section 2 presents a problem description (highlighting the warehouse's pivotal role in supply chains, elucidating the essence and significance of the location selection problem in logistics, and discussing warehouse location within the supply chain) along with a literature review. Section 3 provides a more in-depth description of the proposed methodology model. In Section 4, a case study examined in this paper is outlined, along with the results obtained from applying the proposed methodology. In Section 5, a sensitivity analysis is conducted, and theoretical and managerial implications are discussed. Finally, Section 6 presents concluding remarks and limitations and proposes future research directions.

2. Problem Description and Literature Review

The concepts of supply chain (SC) and supply chain management (SCM) are increasingly attracting attention as essential tools for achieving or maintaining competitiveness in the globally challenging business environment. The network formed among various enterprises involved in producing, handling, and/or distributing a specific product is termed the supply chain. The SC can be described as a network of entities (suppliers, factories, distribution centers, warehouses, etc.) engaged in activities to acquire raw materials, transform them to add value, distribute these materials, and ultimately deliver them to the end-user. In simple terms, the SC is the link between a company and its suppliers and customers. It encompasses these three key components [5]:

- Sourcing: focusing on the raw materials supplied to production, including the delivery method, time, and location;

- Manufacturing: focusing on transforming these raw materials into finished products;
- Distribution: focusing on ensuring that products reach consumers through an organized network of distributors, warehouses, and retail outlets.

On the other side, SCM pertains to the coordination of activities essential for delivering the final product or service. These activities are initiated with raw material procurement and culminate in the delivery of the final product or service to the end-user. At the end of a product's lifecycle, supply chains are also accountable for coordinating recycling, reproduction (renewing the product to its original specifications using used parts), or the disposal of the final product. SCM can be described as the oversight of materials, information, and finances distributed from suppliers to consumers. It constitutes a set of approaches used to seamlessly integrate suppliers, manufacturers, warehouses, and sales outlets, ensuring that goods are produced and distributed in the correct quantities, at the right locations, and at the right time, thereby minimizing costs while maximizing satisfaction with service level requirements. SCM can be categorized into these three primary flows [5]:

- Product flow: encompassing the movement of products from suppliers to consumers;
- Information flow: involving information about orders and delivery status;
- Financial flow: covering payment schedules, credit terms, and additional arrangements.

Given that SC costs can represent up to 13% of the sales value, effective SCM has the potential to boost profitability through cost reduction. Studies have demonstrated that top-performing companies can decrease these costs to as little as 8% [6]. A substantial share of SC costs is attributed to product storage. Therefore, strategically configuring warehouses and distribution centers (DCs) can result in lower transportation costs. Proper warehouse placement can also facilitate more streamlined inventory management, consequently improving the service level. The establishment of DCs and warehouses is a pivotal factor in the redesign of the logistics system.

2.1. The Role of Warehouses in the Supply Chain

Warehouses play a vital role in the supply chain network, whether operating in local or global markets [7]. They serve as the crucial link connecting suppliers and customers throughout the entire SC and can be deemed as key elements influencing the overall performance of the SC [8]. Within the broader SC framework, storage stands out as a critical component in the distribution of goods—from raw materials and semi-finished products to finished goods. It operates as an integral part of the SC network, and its roles and objectives should align with the broader goals of the SC. Warehousing is not an isolated activity; rather, it must be a robust element within the overall SC network, avoiding weaknesses [9]. Warehousing directly contributes to ensuring the continuity of production and the distribution of products. Effective warehouse management enables companies to store and handle a wide range of products across the entire system [10]. Furthermore, it aids in reducing production, transportation, and distribution costs. Consequently, warehouses actively contribute to creating cost-effective shipments during production and distribution, resulting in a reduced average cost per unit and substantial savings in cargo loss management, along with the economical and efficient utilization of storage capacity. Warehousing supports the customer service process by ensuring the delivery of quality products in terms of quantity, quality, and delivery status, and it contributes to timely and specified deliveries [11]. The presence of warehouses in the SC yields various benefits [12], indicated as follows:

- Sustainable inventory management;
- Ensuring packaging that protects the product from unauthorized use;
- On-time delivery;
- Price stabilization;
- Operation optimization;
- Positive customer experience.

2.2. Facility Location Problem

Business logistics, often synonymous with SCM, involves the planning, implementation, and control of the efficient and effective movement and storage of goods, services, and related information from the point of origin to the point of consumption. It plays a pivotal role in ensuring that products and services are readily available to customers in the correct quantities, at the right time, and in optimal condition. Effective business logistics is an integral component of the overall company strategy, directly impacting its competitiveness, customer satisfaction, and overall business performance. The facility location problem is intricately connected to business logistics, as it directly influences the efficiency and cost-effectiveness of supply chain operations. In business logistics, decisions regarding the placement of facilities such as warehouses, distribution centers, and production plants are instrumental in shaping the overarching logistics strategy [13–16].

The term "facility location problem" (FLP) pertains to the modeling, formulation, and resolution of a class of problems best characterized as the positioning of facilities in specific spaces. The terms deployment, positioning, and location are often used interchangeably. The FLP represents a type of optimization problem where the primary objective is to determine the best or optimal location for placing a particular facility. The formal study of location theory commenced in 1909 when Alfred Weber considered how to locate a warehouse to minimize the overall distance between the warehouse and several customers [17]. FLP is a prevalent topic in the literature and often emerges in the context of logistics, manufacturing, or service delivery, where efficiently arranging facilities is crucial for minimizing costs or maximizing efficiency. Essentially, this type of problem involves selecting locations for placing facilities to meet specified criteria. Different variants of FLP include various conditions and constraints, making this research area challenging and significant, especially in the domains of business logistics. Researchers and experts employ various optimization methods and data analysis to solve these problems and find the most efficient solutions for facility placement in a given environment [1,2,18].

The choice of location is a longstanding and extensively debated decision-making domain related to determining specific sites for facilities such as factories, cargo and passenger terminals, distribution centers, warehouses, and similar entities. The number and placement of these facilities constitute fundamental decisions that form the foundation of designing a logistics system [19]. As selecting the most suitable location for a new organization is a critical strategic consideration in optimizing logistics systems, the ongoing development of global economies and market globalization demand continuous improvement in methods and research in this field [20]. Facility location decisions are pivotal elements in the strategic planning of a diverse range of private and public enterprises. The branches of facility location are extensive and enduring, influencing numerous operational and logistical decisions. The substantial costs associated with acquiring property and constructing a facility transform location projects into long-term investments. Decision-makers must choose locations that not only function well in the current state of the system but will also remain profitable throughout the lifecycle of the facility, even as surrounding factors change, populations shift, and market trends evolve [17].

The location of a facility represents a long-term decision and impacts numerous quantitative and qualitative factors, particularly costs and revenues [20]. It determines transport time, influences SC operational costs, and dictates the possible or minimum inventory quantity. These are crucial considerations in designing an efficient logistics system [21]. When addressing the problem itself, it is necessary to compare performance characteristics decisively when choosing among several alternative potential locations for a facility. Thus, due to the presence of multiple conflicting criteria, the decision on the optimal location becomes more complex, clearly indicating that it is a multifaceted MCDM problem, requiring the application of appropriate methods for effective resolution [22]. MCDM can be defined as the evaluation of alternatives for the purpose of selection or ranking, using a set of quantitative and/or qualitative criteria with different units of measurement [19]. Essentially, solving the facility location problem in the context of business logistics involves finding the optimal balance between costs, efficiency, and responsiveness. This is a strategic decision that shapes the entire supply chain network and impacts the overall competitiveness and success of the enterprise.

2.3. Literature Review Regarding Warehouse Location Selection in the SC

The efficiency and speed of a SC is largely determined by the location of warehouses. In today's competitive landscape, SCs vie for superiority, primarily focusing on delivery times and overall product costs. Storage processes contribute to accelerating material flow in SCs, with warehouses serving as significant facilities where raw materials or manufactured products are stored for a designated period before distribution for sales. Products are dispatched from production facilities to warehouses, from where they are distributed to various sellers based on market demand. To thrive in specific demand areas, companies must establish a presence in warehouse facilities. SCM, beyond managing the flow of goods, production decisions, and information sharing at various levels, also involves determining optimal storage levels at each stage of the process and, crucially, selecting warehouse locations—whether locally or globally [7]. Regardless of the success of other warehouse activities, if products dispatched from warehouses fail to meet customer needs promptly, companies risk losing customers [8].

Storage has become one of the pivotal facilitators in ensuring the efficiency of today's global SCNs. Each company endeavors to optimize its supply chain for specific objectives like market expansion, market penetration, and customer support, with warehouse-related factors playing a crucial role. Therefore, making various decisions regarding warehouse scheduling and location becomes paramount [7]. In the contemporary business landscape, the location of a warehouse can confer a substantial competitive advantage to companies. Indeed, the warehouse location stands as a key issue in SCM and a vital component of the overall logistics system. When determining where to situate a warehouse, companies aim to be in proximity to markets and facilities to minimize inventory and transportation costs. The challenge lies in deciding how many warehouses to establish, where to locate them, and how to efficiently serve retail outlets using these warehouse facilities [20]. For companies, it becomes imperative to focus on making decisions about the appropriate location from various alternatives for warehouse placement. Factors such as sufficient space, customer service, convenient transportation links with suppliers and key markets, access to highways, and proximity to railways, ports, and airports must be taken into account when selecting a location [7].

Optimal warehouse location ensures the success of the SC by minimizing costs and maximizing profits [7]. The decision on warehouse location significantly influences investment costs, operational expenses, and the company's distribution strategy, playing a critical role in enhancing customer service levels. The importance of choosing a suitable warehouse location is underscored by the fact that an incorrect location can disrupt SC activities. The primary goal of the SC is to enhance on-time delivery with minimal costs and increased efficiency [19]. The warehouse should be situated in an appropriate location to enhance the overall efficiency of the company's SC and avoid causing delays in the delivery process or increasing production costs. Choosing a warehouse location is a challenging task because once the decision is implemented, it cannot be changed, and any wrong decision can result in significant losses for the company [7].

The significance of the warehouse location selection problem is recognized in the literature as well. Thus, ref. [7] proposed a model based on a fuzzy AHP (analytical hierarchy process) for selecting the optimal warehouse location in a free-trade zone. The same method was applied by [23] for selecting the location for a sustainable warehouse. The authors assessed four potential locations using 11 evaluation criteria. Demonstrated in a case study by [24], the UTASTAR method facilitated the evaluation and ranking of alternative warehouse locations based on decision-makers' preferences and provided a valuable perspective for justifying the selection of the optimal warehouse location. The research by [8] introduced an integrated grey MCDM model, incorporating the grey preference selection index (GPSI) and grey proximity indexed value (GPIV), for evaluating the optimal location of a supermarket warehouse. This study contributes by introducing PSI and PIV methods with grey theory and combining GPSI and GPIV methods to determine the best warehouse location, evaluating the performance of five alternatives against twelve criteria. The study by [25] introduced three novel fuzzy MCDM methodologies designed to address both subjective and objective factors in the evaluation and selection of warehouse locations. Integrating fuzzy set theory with TOPSIS (technique for order of preference by similarity to ideal solution), SAW (simple additive weight), and MOORA (multi-objective optimization on the basis of ratio analysis) methods, these approaches considered subjective criteria through subjective factor measures, while objective criteria were assessed using a classical normalization technique. The Brown and Gibson model integrated subjective and objective factor measures to calculate the warehouse location selection index, demonstrating the applicability and effectiveness of the proposed methodologies in two examples of warehouse location selection within a supply chain context. A novel group decision-making model, based on the AHP method for warehouse location selection in a SC, was proposed by [26]. On the other hand, ref. [27] introduced a novel method employing fuzzy multi-criteria analysis (FMCA) for evaluating warehouse locations within a leagile SC. The algorithm, based on decision theory, calculates the benefit cost ratio (BCR) as the warehouse selection index, using the aggregate modified weighted value (MWV) of normalized scores for alternatives. A study by [28] aimed to employ several MCDM methods (SAW, AHP, TOPSIS) to select an appropriate warehouse location for businesses dealing with agricultural products, specifically grass flowers. The research explored seven key factors influencing warehouse selection, used to evaluate five alternatives. Cetinkaya and Akdas [19] used the best–worst method (BWM) for determining criteria weights for warehouse location selection. It was concluded, based on the results, that the criteria related to the market dominantly affect the selection process. Warehouse location selection was also addressed by [20]. The authors implemented a genetic algorithm (GA) in order to select an optimal location in Turkey. An examination of the sensitivity of the warehouse location problem was conducted by [21]. Namely, the authors used FLEXSIM software (FlexSim Software Products, Inc., Orem, UT, USA, https://www.flexsim.com/) to simulate several scenarios with different inputs and parameters of the model.

3. Methodology

The presence of conflicting criteria in solving the problem of selecting the optimal warehouse location eliminates the possibility of finding a singular solution that could satisfy all criteria simultaneously. Consequently, MCDM methods are employed to differentiate potential solutions based on the expressed preferences of decision-makers. The core of all MCDM methods is grounded in three essential steps: defining sets of alternatives and criteria for their evaluation, assigning weights to criteria through numerical values indicating their importance, and assigning numerical values to alternatives in relation to the considered criteria, aiming for the final ranking of alternatives and the selection of the best option from the pool of potentials. The concept of a proposed hybrid model in this paper is illustrated in Figure 1, where the IMF SWARA method is initially applied to determine criteria weights, followed by the MARCOS method to obtain evaluations of alternatives, the final ranking, and the selection of the most favorable alternative based on the considered criteria. The advantage of the proposed model over existing models in the literature lies in the application of the SWARA method in a fuzzy environment, enabling easier evaluation by experts through the use of linguistic scales. Additionally, the model employs the improved fuzzy SWARA method, which has been proven to yield superior results compared to the fuzzy SWARA method due to the application of a different linguistic scale [3]. On the other hand, the simplicity of application distinguishes the MARCOS method, which is particularly significant for practitioners who would implement the proposed model. Moreover, the MARCOS method is characterized by providing stable and precise solutions, adding further robustness to the model. The implementation steps of the proposed methodology are as follows:

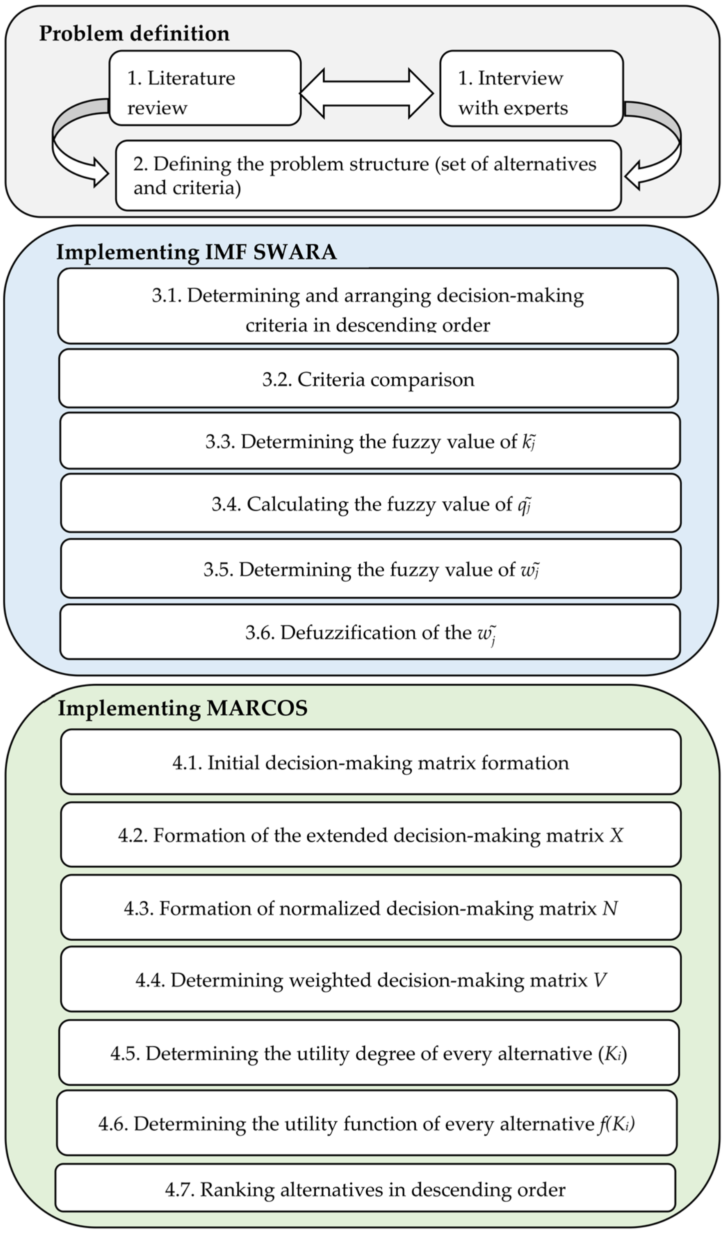

Figure 1. Methodology for warehouse location selection.

Step 1: Defining the problem is conducted in the first phase and also involves forming sets of alternatives and criteria for evaluating alternatives.

Step 2: Establishing a fuzzy scale for evaluating criteria and alternatives by decision-makers is undertaken. Linguistic expressions and corresponding triangular fuzzy values are provided in Table 1.

Step 3: Determining criteria weights are performed using the IMF SWARA method. The implementation steps of the method (3.1–3.6) are elaborated in more detail below.

Step 4: Assessing and ranking alternatives occurs by using the MARCOS method. The implementation steps of the method (4.1–4.7) are elaborated in more detail below.

Table 1. Linguistic and triangular fuzzy numbers (TFN) scale [3].

Linguistic Scale	Abbreviation	TFN Scale
Absolutely less significant	ALS	(1,1,1)
Dominantly less significant	DLS	(1/2,2/3,1)
Much less significant	MLS	(2/5,1/2,2/3)
Really less significant	RLS	(1/3,2/5,1/2)
Less significant	LS	(2/7,1/3,2/5)
Moderately less significant	MDLS	(1/4,2/7,1/3)
Weakly less significant	WLS	(2/9,1/4,2/7)
Equally significant	ES	(0,0,0)

3.1. Improved Fuzzy SWARA (IMF SWARA) Method

The fuzzy SWARA method used for assessing criteria weights efficiently addresses uncertainties in decision-makers' reasoning and the expression of preferences. This approach is utilized to determine criteria weights for the selection of warehouse locations based on the descending order of criterion importance (from most to least significant). What sets this method apart from other multi-criteria decision-making techniques is its numerous advantages. It boasts a simple application, with a straightforward problem-solving algorithm that is easily comprehensible even for less experienced users. It requires a minimal time investment for implementation and is equally effective for both group and individual decision-making. Moreover, the method stands out for its low demand for evaluations, exemption from consistency checks due to the predetermined descending order of criteria, high flexibility, and the absence of a need for a predefined scale to compare criteria. The application steps for this method are outlined in [3].

Step 1—Determining and arranging decision-making criteria $\{c_1, c_2, \ldots, c_n\}$ in descending order is undertaken with respect to their significance (from the most to the least significant).

Step 2—Criteria comparison. The significance of the criterion C_j is determined in relation to the previous one (C_{j-1}). The procedure is repeated for each subsequent criterion. A comparative significance of the average value ($\overline{s_j}$) is calculated based on this.

Step 3—Determining the fuzzy value of the coefficient $\overline{k_j}$ by applying Equation (1):

$$\overline{k_j} = \begin{cases} \overline{1} & j = 1 \\ \overline{s_j} & j > 1 \end{cases} \tag{1}$$

Step 4—Calculating the fuzzy value of the coefficient $\overline{q_j}$ by applying Equation (2):

$$\overline{q_j} = \begin{cases} \overline{1} & j = 1 \\ \frac{\overline{q_{j-1}}}{\overline{k_j}} & j > 1 \end{cases} \tag{2}$$

Step 5—Determining the fuzzy value of the criteria weights by applying Equation (3):

$$\overline{w_j} = \frac{\overline{q_j}}{\sum_{j=1}^{m} \overline{q_j}} \tag{3}$$

Step 6—Defuzzification of the $\overline{w_j}$ to obtain crisp values by applying Equation (4):

$$w_j = \frac{w_j^l + 4w_j^m + w_j^u}{6},\ j = 1,\ 2,\ \ldots,\ n \tag{4}$$

3.2. MARCOS Method

The MARCOS method relies on establishing relationships between alternatives and reference values (ideal and anti-ideal alternatives). Utility functions for alternatives are determined based on these relationships, and a compromise ranking is established in relation to both ideal and anti-ideal solutions. Decision preferences are defined by utility functions that indicate the position of each alternative relative to the ideal and anti-ideal solutions. The best alternative is identified as the one closest to the ideal solution while simultaneously being farthest from the anti-ideal reference point. This method is characterized by considering ideal and anti-ideal solutions right from the initial formation of the initial decision-making matrix, providing a more precise determination of the degree of utility in relation to both solutions. It introduces a novel approach to determining utility functions and their aggregation, enabling the consideration of a large set of alternatives and criteria while maintaining the stability of the method. The MARCOS method is implemented through the following series of steps [4,29]:

Step 1—Defining the initial decision-making matrix consisting of n criteria and m alternatives.

Step 2—Determining ideal (AI) and anti-ideal (AAI) solutions to extend the initial decision-making matrix, via Equation (5):

$$\begin{array}{c} \\ AAI \\ A_1 \\ A_2 \\ \dots \\ A_m \\ AI \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \dots & C_n \end{array} \\ \begin{bmatrix} x_{aa1} & x_{aa2} & \dots & x_{aan} \\ x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \\ x_{ai1} & x_{ai2} & \dots & x_{ain} \end{bmatrix} \end{array} \quad (5)$$

The anti-ideal solution (AAI) represents the alternative that is the worst, while the ideal solution (AI) represents the best alternative. AAI and AI are obtained by applying Equations (6) and (7):

$$AAI = \min_i x_{ij} \text{ if } j \in B \text{ and } \max_i x_{ij} \text{ if } j \in C \quad (6)$$

$$AI = \max_i x_{ij} \text{ if } j \in B \text{ and } \min_i x_{ij} \text{ if } j \in C \quad (7)$$

where B stands for beneficial criteria, while C stands for cost criteria.

Step 3—Conducting the normalization of the extended initial decision-making matrix using Equations (8) and (9):

$$n_{ij} = \frac{x_{ai}}{x_{ij}} \text{ if } j \in C \quad (8)$$

$$n_{ij} = \frac{x_{ij}}{x_{ai}} \text{ if } j \in B \quad (9)$$

Step 4—Determining the weighted decision-making matrix $V = [v_{ij}]_{mxn}$ by applying Equation (10):

$$v_{ij} = n_{ij} \times w_j \quad (10)$$

Step 5—Determining the utility degree of every alternative (K_i) using Equations (11) and (12) with respect to AAI and AI:

$$K_i^- = \frac{S_i}{S_{aai}} \quad (11)$$

$$K_i^+ = \frac{S_i}{S_{ai}} \quad (12)$$

where S_i (i = 1, 2, . . ., n) is the sum of the elements of the weighted matrix V and is obtained using Equation (13).

$$S_i = \sum_{i=1}^{n} V_{ij} \tag{13}$$

Step 6—Calculating the utility function of every alternative $f(K_i)$. This value represents the compromise of the observed alternative in relation to the *AI* and *AAI* solutions, obtained by using Equation (14):

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \frac{1 - f\left(K_i^+\right)}{f\left(K_i^+\right)} + \frac{1 - f\left(K_i^-\right)}{f\left(K_i^-\right)}} \tag{14}$$

where $f\left(K_i^-\right)$ is the utility function in relation to the *AAI*, while $f\left(K_i^+\right)$ is the utility function in relation to the *AI* solution and are obtained using Equations (15) and (16):

$$f\left(K_i^-\right) = \frac{K_i^+}{K_i^+ + K_i^-} \tag{15}$$

$$f\left(K_i^+\right) = \frac{K_i^-}{K_i^+ + K_i^-} \tag{16}$$

Step 7—In the final step, the alternatives are ranked in descending order based on the value of the utility functions $f(K_i)$.

4. Warehouse Location Selection—Case Study

4.1. Case Study Description

In this section of the paper, the focus is on establishing the groundwork for addressing the warehouse location selection problem. The initial foundation of the problem involves identifying and forming a list of alternatives for consideration, as well as a list of criteria by which the alternatives are assessed using appropriate methods. The primary challenge in implementing the proposed methodology lies in gathering information during interviews, as well as in defining criteria, alternatives, and their evaluations. Consequently, it would be most beneficial to conduct interviews with all experts simultaneously, facilitating the exchange of thoughts and perspectives, contributing to more robust information. For practitioners, a challenge may arise in the application of the model, particularly for those unfamiliar with MCDM methods. This challenge can be easily addressed by using the proposed model through Excel or by developing an application with a user-friendly interface. The model's limitation is evident in its challenging application to problems with extremely large dimensions (given the large number of alternatives that need evaluation in accordance with criteria), although such situations are rare, especially in solving FLP where the number of potential alternatives is not typically substantial. The list of alternatives essentially comprises potential solutions, among which the optimal one must be chosen—the one that will most effectively satisfy the specified criteria. Potential locations were determined based on interviews with experts from the observed company who considered them for the establishment of a new warehouse. The preliminary foundation for selecting the warehouse location included the general urban plan of the city of Belgrade, illustrated in Figure 2. Areas designated for facility locations such as warehouses are highlighted in purple (industrial zones) and red (commercial facilities). Accordingly, locations with such designated areas were taken into consideration.

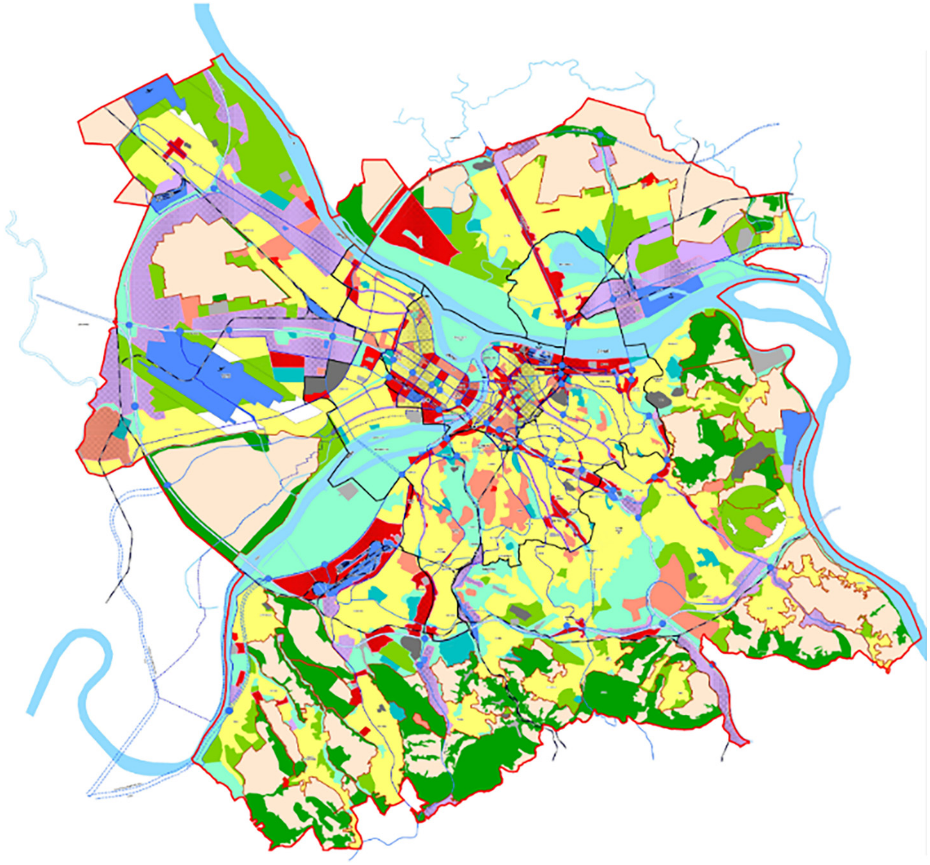

Figure 2. General urban plan of Belgrade [30].

The following locations were selected as potential alternatives for establishing the warehouse:

A1—Borča—The land price per square meter at this location is estimated at EUR 24.19 [31]. In terms of infrastructure access, Borča is intersected by Zrenjaninski Put, providing a connection to the E70 highway and the Pančevački Most. A crucial road link is facilitated by Pupinov Most, spanning the Danube River and linking Borča to central areas of Belgrade (Figure 3). This location is situated 26.7 km away from Belgrade, with a required driving time of 35 min [32]. Borča offers substantial site capacities, although they are smaller compared to Surčin and Dobanovci. This location does not have significant competitors, indicating that there is not a high demand for skilled labor, and a considerable number of qualified workers are available.

A2—Surčin—The estimated land price per square meter at this location is EUR 22.76 [31]. In terms of infrastructure, this location boasts access to the state road, linking Leštane–Grocka–Petrijevo–Ralja, serving as a connection to the A1 state road. Surčin is well connected to the E70 and E75 highways. The E70, running east–west, connects Surčin to Belgrade and further west to the Serbian border. The E75, spanning north–south, links Surčin to Belgrade and extends south through Serbia. These highway connections position Surčin as a significant transportation hub, facilitating the movement of goods between Belgrade and other parts of Serbia, as well as neighboring countries. Surčin is renowned for the “Nikola Tesla” airport, a crucial air traffic hub in Serbia that plays a vital role in connecting Belgrade with other cities and countries. Located on the southern edge of the Pannonian Plain along the Sava River, it provides a navigable route connecting with the Danube River as European Corridor 7 [33]. Surčin is 31.5 km away from Belgrade, with a delivery time of 34 min [32]. Surčin is situated within an industrial zone, and its capacities are smaller compared to those present in Dobanovci. As it is an industrial zone with numerous competitors, there is a high demand for skilled labor (Figure 4).

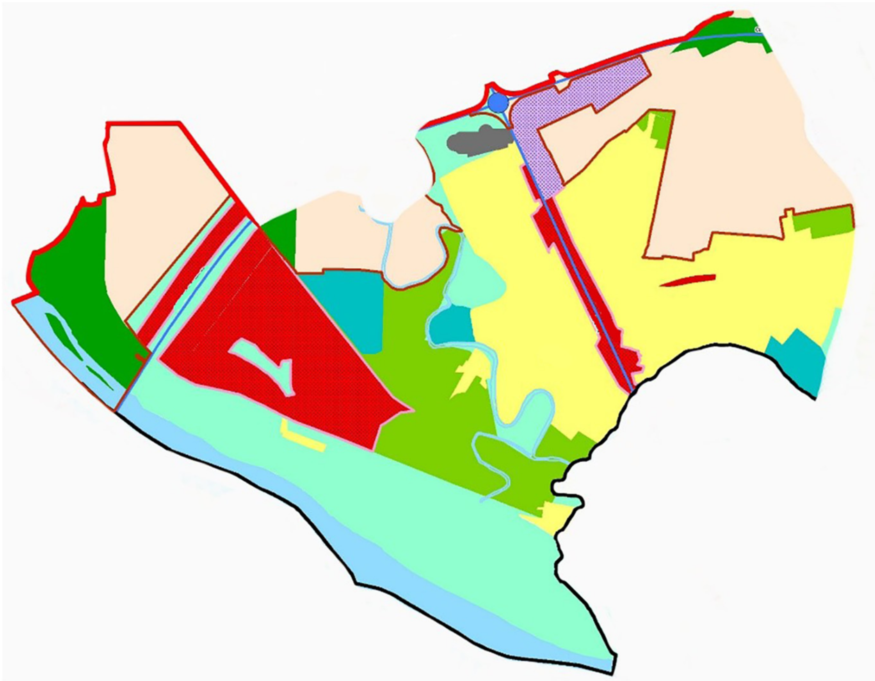

Figure 3. Urban plan of A1—Borča [30].

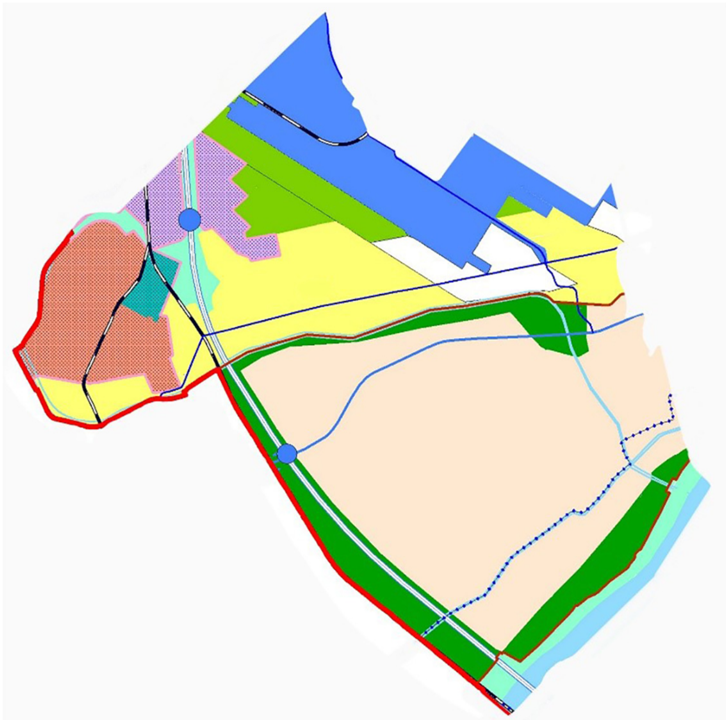

Figure 4. Urban plan of A2—Surčin [30].

A3—Batajnica—The estimated land price per square meter at this location is EUR 25.07 [31]. In terms of infrastructure access, Batajnica is connected to the state road, linking it to the A1 state road Batajnica–Ugrinovci–Surčin, and state road Horgoš–Subotica–Bačka Topola–Mali Iđoš–Srbobran–Novi Sad–Sremski Karlovci–Inđija–Stara Pazova–Belgrade. It is essential to mention the Batajnica loop, approximately 3.5 km in length, enhancing transportation connectivity and facilitating the flow of goods and services, connecting Batajnički Boulevard and the intermodal transport logistics center to the E-75 highway.

There is also good connectivity to the railway network via the mainline of railway 111 Belgrade "A"–Ostružnica–Batajnica [34]. The Batajnica intermodal terminal promotes the development of modern combined cargo transport by increasing the railway's share and creating a partnership with road transport. Batajnica is located 22.1 km from Belgrade, requiring a 32 min drive [32]. Batajnica has relatively smaller location capacities compared to other alternatives. Strong competitors are not present at this location, indicating a higher availability of skilled labor (Figure 5).

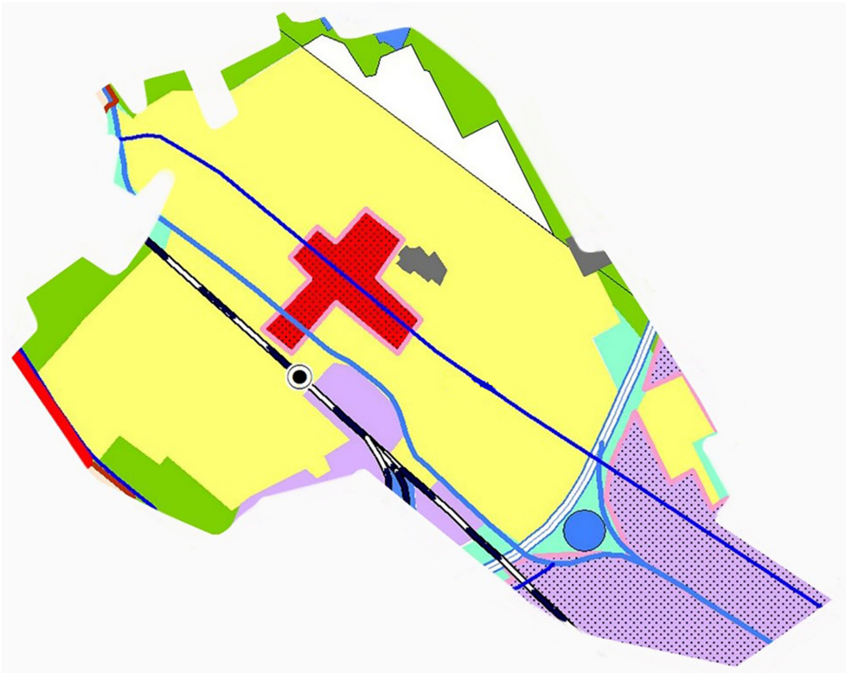

Figure 5. Urban plan of A3—Batajnica [30].

A4—Krnjača—The estimated land price per square meter at this location is EUR 25.5 [31]. Krnjača is connected to the state road Horgoš–Kanjiža–Novi Kneževac–Čoka–Kikinda–Zrenjanin–Čenta–Belgrade. Additionally, it is crucial to note that Krnjača is situated near the E70 highway, alongside which Zrenjaninski put stretches, and has a direct connection to Belgrade via the Pančevački Most. There is also connectivity to railway traffic through the Krnjača railway station located on the left bank of the Danube River. The railway continues towards Krnjača in one direction and Pančevački Most in the other. The distance on the Krnjača–Belgrade route is 10.7 km, requiring approximately 19 min of travel time [32]. The capacity of the Krnjača location is larger than Batajnica but smaller than other locations. There are competitors present, but not to a significant extent. As mentioned for Batajnica, the same applies to Krnjača; namely, due to a lack of competitors, there is a higher availability of qualified labor (Figure 6).

A5—Dobanovci—The estimated land price per square meter at this location is EUR 20.18 [31]. Dobanovci is characterized by excellent traffic connectivity with major road networks, including the E70 and E75 highways, as well as the M2 Miloš Veliki highway. Notably, there is an intermodal terminal situated within the central distribution-logistics center in Dobanovci, connected by rail to all major European ports and land terminals. The Dobanovci railway station serves as a crucial hub in the railway system, offering transportation services for both passengers and goods and facilitating substantial connectivity to the railway network. The distance from Belgrade is 22.8 km, covering a journey time of approximately 23 min [32]. A distinctive feature of Dobanovci is that it boasts the largest capacities for expansion and future warehouse development. Concerning the presence of a large number of competitors in this area, challenges may arise in attracting and retaining qualified labor due to increased demand, indicating a shortage of available skilled workforce (Figure 7).

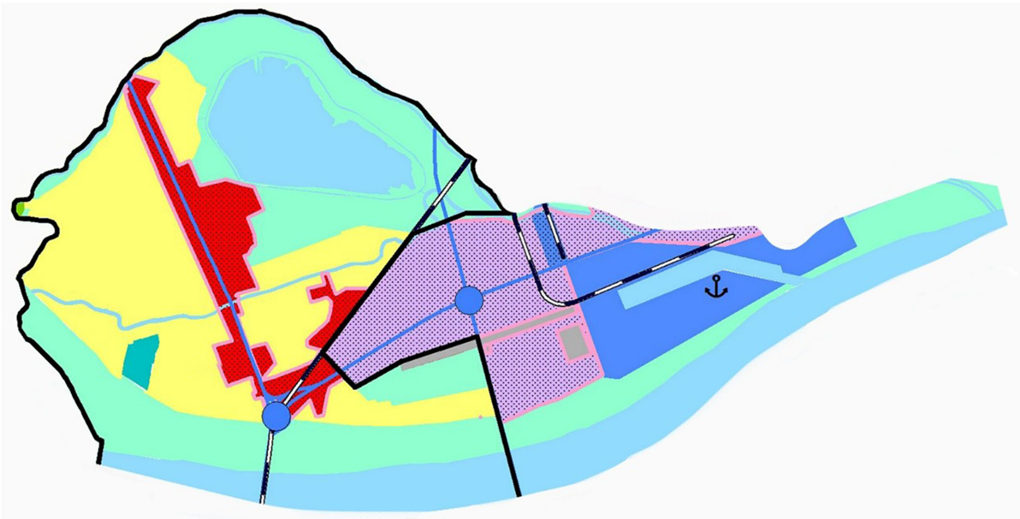

Figure 6. Urban plan of A4—Krnjača [30].

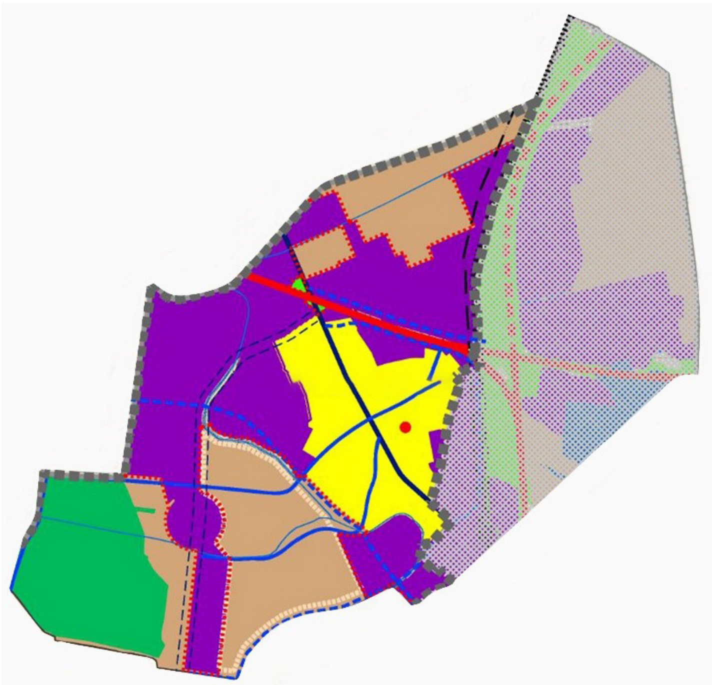

Figure 7. Urban plan of A5—Dobanovci [30].

Once the list of potential alternatives was formulated, the next step involved identifying criteria to facilitate the final decision-making process, specifically the selection of the optimal location from the available options. The identification and definition of criteria, which would vary among alternatives, needed to align with desired objectives, as they represent the preferred characteristics of potential solutions. Following the establishment of the final list of criteria with distinct variations, acknowledging that not every criterion holds equal importance, the subsequent task was to determine their respective weights. The quantitative expression of these weights signifies their significance and influence on the ranking of alternatives, culminating in the ultimate decision. Through these weights, the priorities and preferences of the decision-maker are reflected. For the evaluation of the specified alternatives or potential locations, the following criteria were applied (Table 2) [26,27,35,36]:

Table 2. Criteria used for evaluation.

Criteria	Reference
C1—Land Cost	[24–27,35,36]
C2—Infrastructure Access	[22,26,35]
C3—Workforce Availability	[22,27]
C4—Delivery Time	[22,24,25,27,35,36]
C5—Area Competitiveness	[35]
C6—Location Capacity	[24–27]
C7—Presence of Various Transportation Modes	[24]

C1—Land Cost. This criterion serves as a crucial factor in warehouse construction and directly impacts the escalation of investment costs. Beyond the required land area for the warehouse, there must also be sufficient additional surrounding space available for future development and expansion.

C2—Infrastructure Access. Transportation facilitates the movement of goods from producers to warehouses, between various warehouses, and from warehouses to retail or end customers. A warehouse must have excellent connectivity with transportation networks, including highways, railways, river ports, and airports to facilitate this transportation.

C3—Workforce Availability. Warehouse facilities require a qualified workforce to perform various tasks, ranging from handling inventory and order picking to managing warehouse operations. A qualified workforce in the warehouse includes employees who are trained and experienced in executing diverse warehouse tasks. This criterion is closely tied to C5, as increased competitiveness in the environment implies a higher demand for a skilled workforce.

C4—Delivery Time. This is directly linked to criterion C2 but also depends on the destination. For this study, the central location of Belgrade has been selected as the destination. It is of paramount importance since a short delivery time contributes to customer satisfaction, enhances adaptability to market changes, facilitates gaining a competitive advantage, and more.

C5—Area Competitiveness. This refers to the level of competition in the environment. The less competitive the environment, the better the location's result.

C6—Location Capacity. This relates to the location's ability to support the necessary warehouse capacities, including space for storing goods, handling cargo, parking for delivery vehicles, space for installing specific equipment and technology, and other required resources. This criterion also pertains to the location's availability for future expansions and warehouse development.

C7—Presence of Various Transportation Modes. The ability to utilize multiple transportation modes is crucial for adapting to diverse transport requirements and optimizing transportation costs.

4.2. Results

As previously outlined, the initial step involves the application of the IMF SWARA method to derive criteria weights. Determining the weights begins with ranking the criteria based on their significance, from the most significant to the least. Subsequently, experts utilize linguistic scales, which are then converted into fuzzy numbers (Table 3). Five experts from the observed company (LSP) participated in the evaluation. Among the overall pool of experts, two are engaged as logistics managers, another two hold positions as warehouse managers, and one assumes the role of a supply chain manager. All of the experts have more than 10 years of working experience. In the assessment process involving multiple experts, the chosen unified value corresponds to the one that occurs most frequently during the evaluation process.

Table 3. Criteria significance using a linguistic scale.

Criterion	Significance
C1	-
C2	MDLS
C7	WLS
C4	WLS
C6	LS
C5	LS
C3	WLS

Based on Table 3, it can be inferred that the most significant criterion is C1—land cost, given its direct impact on overall investments in establishing a warehouse and its potential decisive significance. Land price constitutes a portion of the total costs associated with facility setup. Companies often face financial constraints, and the cost of land is a pivotal factor in determining whether a specific location is viable within budget constraints. Following this, a slightly less significant criterion is C2—infrastructure access, representing a crucial element for timely and cost-effective deliveries. Well-developed infrastructure helps minimize transportation costs. Efficient connectivity leads to shorter distances, reduced fuel consumption, and lower overall logistics costs. Proximity to major infrastructure nodes like highways, railways, and ports ensures efficient transportation of goods to and from the warehouse. Additionally, good transportation connectivity allows for quick adaptation in case one mode of transport encounters challenges such as road closures, strikes, roadworks, traffic congestion, etc., enabling the swift utilization of alternative routes or transport modes. Criterion C7—the presence of various transport modes—represents the ability to access multiple transport modes, thus providing flexibility in choosing the most efficient and economical transportation method based on specific needs and requirements. A slightly less significant criterion is C4—delivery time, impacting customer satisfaction, logistical chain efficiency, the fulfillment of requirements, and overall costs. Criterion C6—location capacity, relating to capacity for current and future needs, is essential for adapting to business operations and accommodating growing demand. A bit less significant is C5—area competitiveness, which may limit access to resources like qualified labor, infrastructure, or land availability. Moreover, intense competition may exert pressure to reduce service prices to attract clients. The last-ranked criterion is C3—workforce availability, contributing to improved warehouse operations management but is not of paramount importance, as companies can provide various training programs to employees, aiding in enhancing overall operational efficiency and performing various operations (Table 4).

Following the determination of criteria weights, the MARCOS method was employed to rank potential locations. The initial decision-making matrix (Table 5) was formed as the first step in implementing the MARCOS method. For quantitative criteria, precise values were utilized, while values for qualitative criteria were derived from expert assessments, where experts evaluated criteria using a scale of 1–5.

The presented values were then normalized using Equations (8) and (9), depending on the type of criteria. The normalized values are shown in Table 6.

The normalized values were then multiplied by the corresponding criterion weights obtained after applying the IMF SWARA method. This way, the weighted decision-making matrix was formed (Table 7).

Table 4. IMF SWARA application.

		$\overline{s}_j$			$\overline{k}_j$			$\overline{q}_j$			$\overline{w}_j$		w_j (crisp)
C1				1.000	1.000	1.000	1.000	1.000	1.000	0.250	0.265	0.284	0.266
C2	0.25	0.286	0.333	1.250	1.286	1.333	0.750	0.778	0.800	0.188	0.206	0.227	0.206
C3	0.222	0.250	0.286	1.222	1.250	1.286	0.583	0.622	0.655	0.146	0.165	0.186	0.165
C4	0.222	0.250	0.286	1.222	1.250	1.286	0.454	0.498	0.536	0.114	0.132	0.152	0.132
C5	0.286	0.333	0.400	1.286	1.333	1.400	0.324	0.373	0.417	0.081	0.099	0.118	0.099
C6	0.286	0.333	0.400	1.286	1.333	1.400	0.231	0.280	0.324	0.058	0.074	0.092	0.074
C7	0.222	0.250	0.286	1.222	1.250	1.286	0.180	0.224	0.265	0.045	0.059	0.075	0.060
						SUM	3.523	3.775	3.996				

Table 5. Initial decision-making matrix.

Alternative	C1	C2	C3	C4	C5	C6	C7
type	min	max	max	min	min	max	max
AAI	25.5	3	1	35	5	2	1
A1	24.19	3	5	35	1	4	1
A2	22.76	5	2	34	4	2	5
A3	25.07	4	5	32	1	2	4
A4	25.5	3	4	19	2	3	3
A5	20.18	5	1	23	5	5	3
AI	20.18	5	5	19	1	5	5

Table 6. Normalized decision-making matrix.

Alternative	C1	C2	C3	C4	C5	C6	C7
AAI	0.79	0.60	0.20	0.54	0.20	0.40	0.20
A1	0.83	0.60	1.00	0.54	1.00	0.80	0.20
A2	0.89	1.00	0.40	0.56	0.25	0.40	1.00
A3	0.80	0.80	1.00	0.59	1.00	0.40	0.80
A4	0.79	0.60	0.80	1.00	0.50	0.60	0.60
A5	1.00	1.00	0.20	0.83	0.20	1.00	0.60
AI	1.00	1.00	1.00	1.00	1.00	1.00	1.00
w_j	0.266	0.206	0.059	0.132	0.073	0.099	0.165

Table 7. Weighted decision-making matrix.

Alternative	C1	C2	C3	C4	C5	C6	C7
AAI	0.21	0.12	0.01	0.07	0.01	0.04	0.03
A1	0.22	0.12	0.06	0.07	0.07	0.08	0.03
A2	0.24	0.21	0.02	0.07	0.02	0.04	0.17
A3	0.21	0.17	0.06	0.08	0.07	0.04	0.13
A4	0.21	0.12	0.05	0.13	0.04	0.06	0.10
A5	0.27	0.21	0.01	0.11	0.01	0.10	0.10
AI	0.27	0.21	0.06	0.13	0.07	0.10	0.17

To perform the final ranking, Equations (11)–(16) were applied. After applying the described equations, a utility function value for every alternative was obtained, based on which the alternatives were ranked (Table 8).

Table 8. Final ranking of the alternatives.

Alternatives	S_i	K_i^-	K_i^+	$f(Ki^-)$	$f(Ki^+)$	$f(K_i)$	*Rank*
	0.50						
A1	0.66	1.31	0.66	0.34	0.66	0.57	4
A2	0.76	1.51	0.76	0.34	0.66	0.65	2
A3	0.76	1.51	0.76	0.34	0.66	0.65	2
A4	0.71	1.40	0.71	0.34	0.66	0.61	3
A5	0.81	1.60	0.81	0.34	0.66	0.69	1
	1.000						

Based on the results in Table 8, it can be concluded that the best-ranked alternative (potential location) is A5—Dobanovci, followed by A2 and A3 sharing the same position, and then A4 and A1. The alternative ranking can also be represented as A5 > A2 = A3 > A4 > A1. Based on the results, it can be inferred that criteria with higher weights (for example C1 and C2) exert a greater influence on the final ranking of alternatives, whereas, on the other hand, criteria with lower weights (for example C6 and C7) have a smaller impact. For this reason, sensitivity analysis was conducted in this study to assess whether there would be any changes in the ranking of alternatives.

5. Discussion

5.1. Sensitivity Analysis and Model Validation

After applying the proposed methodology, a sensitivity analysis was conducted to test the proposed model against changes in input values. For this reason, five scenarios were defined, each involving different weights assigned to the criteria. In the first scenario, labeled "performance-related", higher weights (and therefore significance) were assigned to criteria that could significantly impact performance, leading to an increased weight for criteria C2, C4, and C7 (Table 9). In the second scenario, named "cost-related", weights were increased for criteria related to costs, specifically C1, C5, and C6. In the third scenario, all criteria were considered equally important, thus receiving equal weights. In the fourth scenario, weights for the first three criteria were decreased by 5% (while the weights for the remaining criteria were proportionally increased). In the last (fifth) scenario, weights for criteria C4, C5, C6, and C7 were decreased by 5% (with the weights for the remaining criteria proportionally increased to maintain a sum equal to 1).

Table 9. Criteria weights in different scenarios.

Criterion	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
C1	0.107	0.29	0.143	0.2527	0.272
C2	0.266	0.13	0.143	0.1957	0.215
C3	0.059	0.059	0.143	0.05605	0.067
C4	0.206	0.09	0.143	0.142	0.1254
C5	0.073	0.15	0.143	0.088	0.06935
C6	0.099	0.18	0.143	0.101	0.09405
C7	0.19	0.101	0.143	0.165	0.15675

The weights obtained in this way were subsequently used to create weighted decision-making matrices in the MARCOS method, with the goal of calculating the utility function for each alternative to determine their rankings (Table 10).

Table 10. Alternative ranking in different scenarios.

	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
Alternatives	$f(K_i)$	**Rank**	$f(K_i)$	**Rank**	$f(K_i)$	**Rank**	$f(K_i)$	**Rank**	$f(K_i)$	**Rank**
A1	0.53	4	0.64	3	0.63	2	0.57	5	0.57	4
A2	0.65	2	0.58	5	0.57	5	0.64	3	0.65	2
A3	0.65	2	0.65	2	0.69	1	0.65	2	0.65	2
A4	0.62	3	0.59	4	0.62	3	0.61	4	0.61	3
A5	0.68	1	0.67	1	0.61	4	0.68	1	0.69	1

Based on the results of the conducted sensitivity analysis, it can be inferred that the proposed model is quite stable, considering that alternative 5 is not ranked the highest in only one scenario (the third), while it is in all others. In the second, third, and fourth scenarios with changes in the criteria weights, alterations in the ranking of alternatives are observed. Conversely, in the first and fifth scenarios, the ranking remains unchanged. Additionally, it was determined that reducing the weights of the most significant criteria results in a change in the final ranking. On the other hand, reducing the weights of the least significant criteria does not lead to a change in the ranking. Furthermore, it is evident that the rankings of other alternatives vary considerably across scenarios, depending on the decision-maker's preferences (weights assigned to specific criteria).

In addition to the sensitivity analysis, model validation was conducted to assess whether there would be a change in ranking if other MCDM methods were applied instead of the MARCOS method. For this purpose, the presented case study was solved using the ADAM (axial-distance-based aggregated measurement), TOPSIS, MOOSRA (multi-objective optimization on the basis of simple ratio analysis), and MABAC (multi-attributive border approximation area comparison) methods [37–39]. The rankings obtained from these methods are illustrated in Figure 8. Based on the figure, it can be concluded that the ranking of alternatives changed only when the TOPSIS method was applied, where alternative 2 was ranked the highest. In all other cases, alternative 5 consistently held the best rank.

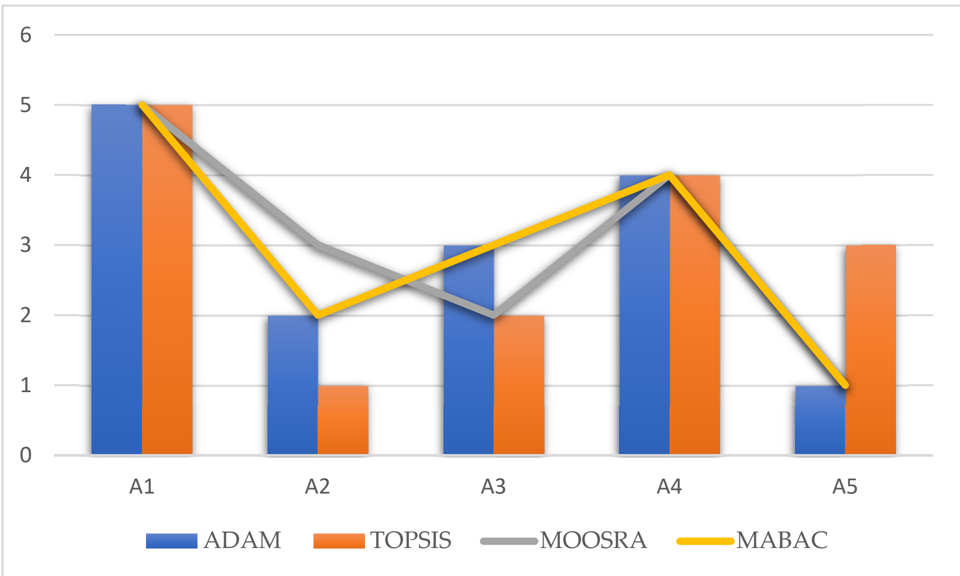

Figure 8. Alternative ranking using different MCDM methods.

5.2. Contributions and Theoretical and Managerial Implications

The literature review has revealed a significant gap in research concerning the warehouse location selection problem. This research contributes to the theoretical landscape by delving into this critical issue and providing a systematic exploration of the relevant methodologies. The proposed model, rooted in innovative methods, introduces a novel approach to solving the warehouse location selection problem. By employing techniques not previously utilized for this purpose, we contribute to the theoretical advancement of location-based decision-making models.

This paper systematizes the most significant criteria for warehouse location, enhancing the theoretical foundation of logistics and supply chain management. The systematic identification and prioritization of these criteria contribute to a more comprehensive understanding of the complexities involved in location-based decision-making.

In practical terms, the proposed model serves as an excellent decision-making tool for industry professionals. Through user-friendly Excel tables, practitioners can efficiently utilize the model to address a variety of location-related challenges, including the placement of distribution centers and terminals. With minimal adjustments, this model can extend its utility to solve location-related issues in diverse logistics systems. Its flexibility makes it applicable to a broad spectrum of challenges, showcasing its practical relevance in addressing real-world logistical complexities.

In the practical realm, this paper fills a significant gap in the literature by offering a tangible tool to support decision-making processes. Practitioners can rely on this model to streamline and enhance their warehouse location selection processes, thereby improving overall operational efficiency. The reliability of the proposed model has been rigorously validated through sensitivity analysis, unequivocally confirming its quality and the dependability of the results obtained. This further solidifies the practical applicability of the proposed model in aiding decision-makers in the field.

In summary, this research not only contributes to bridging the theoretical gap in the literature but also offers a practical and adaptable model that can be readily employed by industry professionals. The systematic approach to warehouse location selection criteria, coupled with the demonstrated reliability of the model, positions this research as a valuable asset for both academics and practitioners in the field of logistics and supply chain management.

6. Conclusions

The process of determining the optimal location for a warehouse involves a complex interplay of various factors, and the location selection significantly impacts the overall efficiency and effectiveness of the entire SCM system. This paper proposed a hybrid MCDM model that integrates the IMF SWARA and the MARCOS methods, demonstrated through the identification of the most suitable warehouse location in Belgrade. While the IMF SWARA method is employed to determine the criteria weights, the MARCOS method was used to assess the performance of alternatives and to rank them. The application of MCDM methodologies, as demonstrated in this paper, provides a structured and systematic approach to solving warehouse location problems. Additionally, this paper emphasizes the importance of including diverse criteria, such as land cost, infrastructure access, workforce availability, delivery time, area competitiveness, location capacity, and presence of various transportation modes. The applied IMF SWARA method represents a type of MCDM method that utilizes subjective determination of criteria weights. Integrating fuzzy logic into SWARA accounts for uncertainty and subjectivity in weight assessments, offering flexibility in modeling the real complexities of decision-making problems. Among the considered criteria, C1—land cost—is identified as the most significant criterion in the decision-making process. Potential locations, considered based on the general urban plan of Belgrade, include the following five: Borča, Surčin, Batajnica, Krnjača, and Dobanovci. Dobanovci, based on the evaluation, received the highest scores. Consequently, this alternative is expected to represent the optimal solution to the problem. Also, sensitivity analysis results as well as model validation confirmed that the A5—Dobanovci—is the best ranked alternative even in different scenarios (using different criteria weights) and even when combining different MCDM methods. The results of implementing the proposed model indicate that the warehouse should be constructed at the location of alternative A5 (Dobanovci), aligning with internal company data (obtained during the site selection research conducted by the company), obtained after interviews with company managers. After solving the FLP problem, it can be concluded that the proposed model serves as a suitable tool for MCDM, providing a simple and rapid solution to the defined problem. From the perspective of LSP, the developed model serves as a tool that facilitates decision-making regarding warehouse location selection. Furthermore, this tool lays the foundation for similar decisions that the company may encounter in the future. Essentially, the warehouse location selection problem is a dynamic and complex challenge, and this paper not only contributes to understanding location choices but also offers a practical framework that integrates qualitative investigation and MCDM evaluation for efficient and strategically positioned warehouses within the broader context of the supply chain.

A limitation of this study lies in the fact that only municipalities near Belgrade were considered as potential locations, excluding other parts of the country. Additionally, a relatively small-scale problem was addressed in this study (with only five alternatives). As far as future research directions are concerned, the following are highlighted: the application of the proposed methodology in combination with other MCDM methods, metaheuristics, and linear programming models for determining the optimal location. Furthermore, the development of a software application to assist decision-makers in such situations is also identified as a future research direction. The application of the proposed methodology to related location problems and larger-scale examples is emphasized as another future research direction. Finally, the implementation of the model in different industries and different geographical areas (markets) represents additional future research directions.

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