sustainability

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Ranking Agility Factors to Reliably Sustain a Green Industrial Supply Chain Using the Fuzzy Analytic Network Process and Ordinal Priority Approach

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Abstract: Suppliers can achieve high levels of supply chain sustainability by improving the related factors. An agile supply chain can support sustainability. Identifying and ranking agility factors in the SAIPA company in Iran to reach a sustainable and green supply chain is the primary purpose of this study. SAIPA is an automotive company with an extensive supply chain. The data were quantitative, and the collection was completed by reviewing the literature and questioning experts. The FANP and the OPA methods were the tools used to analyze the data. These methods are proper for facing multiple-criteria decision-making problems, as in the case of this paper. We first identified the factors (capabilities, enablers, and attributes) using a literature review. After that, we gathered the data for ranking analysis by collecting the opinions of SAIPA's organizational experts using a pairwise comparison questionnaire for the FANP and a prioritizing list for the OPA. Both methods showed that "Quickness" is the capability with the highest priority. "Customer Sensitivity" was the most critical enabler, and "Accurate customer-based measures" was the most significant attribute of the FANP analysis. The OPA results showed that "Information Management" was the first enabler, and "Efficient funds transfer" took first place among all the attributes. Managers should pay more attention to these factors to develop agile supply chains in the SAIPA company. The results also showed that the methods proposed for multi-attribute decision-making problems like the FANP have shortcomings, such as difficulties completing the pairwise comparison matrix due to burdensome data collection in cases similar to the one in this study with many factors.

Keywords: green supply chain; sustainability; agility attributes; FANP; OPA

Citation: Shafaghizadeh, S.; Sajadi, S.M. Ranking Agility Factors to Reliably Sustain a Green Industrial Supply Chain Using the Fuzzy Analytic Network Process and Ordinal Priority Approach. *Sustainability* **2023**, *15*, 16005. https://doi.org/10.3390/su152216005

Received: 3 August 2023
Revised: 24 October 2023
Accepted: 28 October 2023
Published: 16 November 2023

1. Introduction

The management of economic, social, and environmental effects and the practices to achieve good governance directly affect the sustainability of a supply chain. A sustainable supply chain creates, evolves, and protects the service and product providers' environmental, economic, and social values, especially in the long term. Every stage of a supply chain needs different resources. Careful application of every element (from water to energy and fuel to packaging) supports a chain's sustainability, considering sustainability's dimensions [1]. There are many reasons for companies to pay attention to sustainability. Some can be adherence to the business international principles and laws and the many benefits they can gain from this compliance. Today, supply chain sustainability is essential for companies [2,3]. This area of research is receiving increasing attention regarding social concerns [4,5]. Paying attention to the environmental aspects of a supply chain makes for a green supply chain (GSC). A GSC is highly demanded by business-oriented firms and industries today, and top managers make crucial decisions about GSCs for their organizations' success [6,7]. GSC management dimensions are the managerial activities used to improve sustainability and minimize energy consumption and pollution for an extended period. Consequently, these practices produce competitive advantages [8]. However, they are crucial but cannot guarantee the success of GSC management strategies alone, facing rapid changes in today's world.

Companies and organizations need to consider the rapid changes in the market as well as the consumers' wants, likes, and needs. They have started to improve their products, technologies, business models, and processes to achieve a higher level of sustainability [9]. In dynamic environments full of uncertainties about supply, demand, and channel relationships, it is crucial to implement quick reactive or proactive changes. In such environments, the supply chain will be more agile if there is reliable relationship management among the supply chain users [10]. Using very flexible solutions, an agile supply chain (ASC) makes the data flow quicker and more accessible [11]. Appropriate data management is needed to be able to achieve these solutions. The information delivery to the user must be at the right time, in the right place, and with the proper format and quality [12]. There should be many studies to improve the activities' effectiveness regarding agility in supply chains and simultaneously move toward a sustainable green supply chain [13].

This paper is a study that investigates the different elements of an agile, sustainable supply chain and focuses on the industrial organization of the SAIPA company. "What are the agility factors supporting a sustainable supply chain?" and "How to rank them to find the most significant ones categorically in the SAIPA company to reach a sustainable and green supply chain?" are the two main questions. SAIPA is an Iranian automobile company established in 1965. The government of Iran took ownership of this company in 1979. During the intensification of inflation, some Iranian automotive parts manufacturers refused to supply the parts that were their exclusive production or import. Thus, the company increased the number of incomplete cars in the warehouses, causing a decrease in the supply of cars to the market and an increase in market car prices. The decrease in the supply of cars to the market has created many differences between the factory and the market price. Hostage-taking of the production line is the other name of this issue caused by the lack of transparency in the industry. Incompletely produced cars with minor defects are usually not repaired and are only given the title of defective cars. They are sold at prices close to the market and in the form of auctions by SAIPA.

The mentioned challenges in the SAIPA supply chain and many others motivated us to rank the agility factors reliably for sustaining a green industrial supply chain. First, we need to know the meaning of agility and find its elements. An organization can find many benefits in measuring agility, mainly if completion is in a dynamically changing environment. As a result, learning about essential agility factors of a sustainable supply chain is one of this study's objectives, and the second one is ranking these factors using analytical means. Another goal is to compare the means or methods from computational and result views. This study uses two different multiple attribute decision-making (MADM) methods: the fuzzy analytic network process (FANP) and the ordinal priority approach (OPA).

FANP and analytic network process (ANP) are tools used to rank attributes and widely used multi-criteria methods. The FANP algorithm handles interactions among linguistic variables and criteria [14]. OPA is helpful in individual or group decision-making (GDM). Determining experts and their priorities is the first step of this method in the case of GDM. Experts' experience or knowledge clarifies their importance. After prioritizing the experts, they prioritize the attributes (criteria). Meanwhile, each expert grades the alternatives considering each criterion and the sub-criterion. Solving this method's presented linear programming model leads to obtaining all weights for the experts, options, attributes, and sub-attributes together [15]. There are many MADM methods, but in brief, due to the complicated and uncertain situations in supply chains like SAIPA, FANP leads us to a comprehensible model using fuzzy calculations, and OPA can overcome difficulties forming pairwise comparison matrices in cases with many factors like agile GSC management.

In the next section, we first investigate and review the research literature comprehensively. The section is about studies concerning sustainability and agility simultaneously, including the agile practices' effects on sustainability, evaluating sustainable agility in supply chains, designing sustainable and agile supply chains, supply chain agility indicators supporting sustainability, and more. Then, we will introduce the methodology based on the FANP and OPA. After that, the method is implemented to produce the results. For this purpose, identifying the criteria and sub-criteria is the first step. Finally, the conclusions indicate the most critical indicators, including the most significant capability, enabler, and attribute.

2. Literature Review

Investigating the components of supply chain performance has recently been an influential topic for researchers. The field of research focuses on different aspects, such as identifying and ranking the factors affecting a sustainable supply chain. Dehghani et al. [16] stated environmental, economic, and structural characteristics to manage a sustainable supply chain in development projects.

Geyi et al. [17] explained that analyzing the agility and increasing acceptance of sustainability is required to show the agility effects on sustainability performance measures. They examined the interactions between sustainability practices, operational performance objectives, agility practices, and organizations' overall performances. They showed a significant correlation between agility and sustainable practices in supply chains. The results also indicated that these agility practices positively influence organizations' sustainability and operational performances. The connection between sustainability performance and agility practices is a novel issue. Also, implementing different sustainability methods within various supply chains has been criticized when there is little to no agility. Business owners can maximize their sustainability campaigns' outcomes considering implementing these agility and sustainability practices.

The main focus of [18] was to present an organized literature study to incorporate lean, agile, resilient, green, and sustainable (LARGS) paradigms in the field. The authors raised various research questions to reach their goal. The analysis utilized 160 relevant articles published from 1999 to 2019. The first contribution of [19] was checking and evaluating the sustainable agility of Saudi Arabian dairy manufacturing organizations' supply chains. Another was updating the information about the various factors related to achieving an ASC. They proposed an assessment approach and a conceptual framework that regulate the connections between capabilities, attributes, and enablers and diminish barriers to the agility of the sustainable supply chain. They tried to facilitate the manufacturing performance of organizations, so they identified the agility of supply chain capabilities and drivers. There was also a framework defining the agility levels, supply chain barriers, and a conceptual model. There were many challenges, such as vagueness and impreciseness, so a fuzzy logic approach was preferable. The barriers of the supply chain impacted the agility level. An important priority in developing an ASC was enhancing maintainability and serviceability. Decision-makers can develop a strategic solution using the study results for different organizational barriers.

Digalwar et al. [20] evaluated crucial criteria for implementing sustainable supply chain practices successfully. The interpretive structural modeling (ISM) methodology identified various measures from field professionals' opinions and the systematic literature review. Using the ISM methodology, they exposed the relationship among all criteria hierarchically. The output of ISM was the input to the ANP matrices. The societal issues (SIS), information technology-enabled system support (ITS), the SC members' awareness and literacy (SAL), and the scarcity of natural resources (SNR) were stated as the most critical blocks for organizations to implement sustainable supply chain practices successfully.

Aghamohamadi-Bosjin et al. [21] proposed a multi-objective model to deal with the closed-loop supply chain problem considering the agility, sustainability, and lean factors simultaneously. A robust possibilistic programming method handled the model's uncertainty. Based on the customers' adjacency, the selection of potential locations was completed using fuzzy c-means clustering to boost the system's responsiveness. A new hybrid metaheuristic algorithm efficiently solved large-sized problems before assessing a single initial solution's impact—the solution was the input of the algorithm's second phase. The hybrid metaheuristic algorithm's efficiency was verified by finding better solutions among different test problems.

Multi-objective algorithms were used to optimize a sustainable and agile retail supply chain in [22]. The mathematical modeling of a sustainable supply chain had five objectives, including "maximizing the quality of goods purchased from suppliers", "minimizing the unanswered demand", "maximizing the social responsibility or social benefits", "minimizing the environmental impacts", and "minimizing the costs". The PESA, NSGA-II, and SPEA-II algorithms were used to solve the proposed model after data collection from the supply chain of the SAIPA company. The SPEA-II algorithm resulted in responses of higher quality.

An improvement in sustainability and performance by establishing a supply chain model in the shipbuilding industry was the purpose of [23]. By identifying the critical factors in the conceptual model, the authors stated that the supply chain should be lean, agile, resilient, and green in this industry. The study [24] investigated big data analytics (BDA) as a mediator between the business performance of a sustainable supply chain and critical factors such as social, lean, organizational, environmental, financial, supply chain practices, and the entire quality management. Practitioners and managers can take advantage of the paper's acquaintance, analytics, and the challenges in the LARG practices' direction.

The existing strategies in supply chains need a redesign, and we need to develop new procedures for effectively facing both manufactured and natural challenges. This goal requires evident, flexible, cost-effective, and reliable supply chains. The strategic vision, dynamic leadership, effective utilization of information technology, and cooperation of members can guide companies to achieve ASCs in today's competitive market. Despite many initiatives to achieve ASCs for improving organizational performance in the industry, some large, medium, and small companies adopt and design ASCs. This might be the result of the various challenges in achieving agility. Alzoubi and Yanamandra [25] defined the mediating role of the information-sharing strategy (ISS) in ASC practices to improve supply chain performance in Emiratian medium-sized manufacturing enterprises. A practical survey from supply chain managers was the tool used to achieve the study's goal. The authors discovered the significant mediating role of information sharing in ASCs for achieving superior supply chain performance.

The critical factors driving agility in supply chain management in the oil and gas industries were identified in [26]. An extensive questionnaire survey and literature review identified the critical factors. Several brainstorming sessions with the collaboration of oil and gas industry experts led to the contextual relationship among the specified factors. Also, analyzing relationships between the factors was performed by applying a digraph developed using an interpretive structural modeling tool. Competency of management, high management commitment, strategic alignment, and information technology integration were the pinpointed main drivers of an ASC.

A significant issue in the management of supply chains is the supplier selection problem (SSP). The literature showed that researchers had ignored this field's combination of green and agile indicators. Hence, Alamroshan et al. [27] attempted to study the SSP by simultaneously taking agile and green aspects. Researchers developed a hybrid approach utilizing the fuzzy best–worst method (FBWM), fuzzy decision-making trial and evaluation laboratory (FDEMATEL), fuzzy vlse kriterijumsk optimizacija kompromisno resenje (FVIKOR), and FANP methods. Then, to show the proposed approach's efficiency and application, they investigated a case study in the medical devices industry. The FDEMATEL method identified the interrelationships between the determined indicators alternatives. Then, integrated FBWM-FANP was used to calculate the weights of indicators. Finally, applying FVIKOR ranked the potential suppliers. Price and greenness were the most critical aspects. Environmental performance evaluation, material costs, service level, manufacture flexibility, and system reliability were the most critical criteria in the green–agile supplier selection problem in the medical devices industry.

International supply chains are becoming increasingly complex, including multiple suppliers worldwide. Managing complexities requires determining the optimum number of suppliers by organizations. The literature contains various approaches to this problem, but it requires more attention due to its importance. Darvazeh et al. [28] proposed a hybrid procedure to disclose the problem's process, assisting managers in learning to determine the appropriate number of suppliers. They solved this problem by devising an integrated method based on MADM incorporating the simple additive weighting (SAW), best–worst method, and technique for order preference by similarity to the ideal solution (TOPSIS). An Iranian oil company practical case study was used to examine the efficiency of the proposed approach. The final results identified that one supplier for each type of equipment was the best possible scenario to determine the optimal number of agile–sustainable suppliers.

Supply chain management practitioners and scholars can boost our knowledge by theorizing and moderating mediation analysis. They can examine how, when, and why agile, resilient, green, and lean associations regarding capabilities, performance, and sustainability occur. Few studies address this issue due to the execution sophistication. Alqudah et al. [29] provided primary data to show detailed contexts about a supply chain's sustainability, performance, and capabilities. There is an extensive literature review on the underlying measures of supply chain capability, sustainability management paradigms, performance, and so on. The authors used the criteria to create a study model. They claimed that the review and subsequent model will support the future practical and theoretical analyses of supply chain management paradigms among comprehensive and complex connections.

Dağdeviren and Yüksel [30] measured an organization's sectoral competition level (SCL) within the framework of Porter's five forces analysis using the FANP technique. There were two main thoughts as the framework of this study. The first was to use fuzzy logic due to the complex and vague nature of the competition concept. The second was considering the mutual interactions between the factors in Porter's five forces analysis to determine the SCL. The first step was the selection of factors and subfactors affecting the competition level. The next was to examine the internal dependencies between the models and elements.

As we can see in Table 1, some studies evaluate the agility of supply chains to support sustainability. The main factors of supply chain agility are extracted in different organizations using various studies. There is a need to understand the significance of each criterion by manufacturing companies, which is the notable contribution of this study. The goal is to rank agility factors using the FANP in the SAIPA company.

As we have stated, implementing agility and sustainability practices together will lead to more optimized supply chains. There has been much research about agility in the literature and some about applying MADM methods in sustainability [32,33]. According to our information, there is still no study about ranking agility factors fostering sustainability in GSCs. This is due to the diversity and the high number of elements in the field, making data gathering and analysis very difficult, which is the contribution of this research.

Table 1. Review of published studies in the field of sustainable ASCs.

#	Contribution	Authors	Reference
1	Presenting the impacts of agile procedures on sustainability performance dimensions	Geyi et al.	[17]
2	Presenting an organized literature study on LARGS paradigms in the supply chain field	Sharma et al.	[18]
3	Exploring and evaluating sustainable agility in supply chains	Al-Zabidi et al.	[19]

Table 1. *Cont.*

#	Contribution	Authors	Reference
4	Evaluating critical criteria impacting the successful execution of sustainable supply chain procedures	Digalwar et al.	[20]
5	A multi-objective model for dealing with the supply chain problem of a closed-loop type, simultaneously considering agility, sustainability, and lean factors	Aghamohamadi-Bosjin et al.	[21]
6	Developing an agile and sustainable retail supply chain by applying multi-objective optimization algorithms	Azizi et al.	[22]
7	Improving the sustainability and performance of the shipbuilding industry by establishing a green, agile, resilience and lean supply chain model	Ramirez-Peña et al.	[23]
8	Investigating the role of big data analytics as a mediator between sustainable supply chain business execution and critical factors	Raut et al.	[24]
9	Determining the mediating role of the information-sharing approach on agile supply chain practices	Alzoubi and Yanamandra	[25]
10	Identifying critical factors driving agile supply chain control related to the oil and gas industries	Piya et al.	[26]
11	Studying the supplier selection problem taking green and agile aspects simultaneously into account	Alamroshan et al.	[27]
12	Managing the complexity of having numerous suppliers worldwide by identifying the optimum number of suppliers using a hybrid methodology	Darvazeh et al.	[28]
13	Providing primary data to find detailed contexts about sustainability, performance, and capabilities of a supply chain	Alqudah et al.	[29]
14	Measuring an organization's sectoral competition rank with Porter's five forces analysis framework using the FANP technique	Dağdeviren and Yüksel	[30]
15	Checking and evaluating the supply chain manners within the context of enterprises in Saudi Arabia	Rehman et al.	[31]

3. Methodology

Here, we explain two different MADM methods used in this paper (FANP and OPA).

3.1. FANP

In recent times, people have had to deal with many MADM evaluations. Making these decisions is based on several qualitative and quantitative criteria. Satty proposed the analytic hierarchy process (AHP), a highly comprehensive process for MADM. This method can also determine the compatibility or incompatibility of decisions [34]. The ANP method is the general structure of the AHP. Pairwise comparisons with a scale of 1–9 in AHP determine the strength or relative importance of the impacts on an element [35]. Although the AHP is a valuable method in many applications, the measurement of the possible dependencies is not allowed among its factors. The factors presented in the hierarchical structure are assumed independent by the AHP, and this assumption can be inappropriate after the effects of certain external and internal environmental elements. Therefore, we should consider some possible dependencies among the factors [36,37]. The problem of the dependence among criteria or alternatives can be solved using the ANP [38]. To explain the FANP, we need to know about the ANP.

ANP method. The ANP approach eliminates the interdependence among the elements by developing a super matrix. The super matrix leads to composite weights. The method represents a node or a cluster by the parts inside. An arc or a straight line indicates the interaction between two elements, and a loop means the internal dependence of the elements within an element [39]. The structure of many real decision problems is not hierarchical. They include interdependent relationships and feedback among the decision levels and components (Figure 1). Therefore, the ANP is a better choice for such problems where there is a network with elements' clusters, not a hierarchy [40].

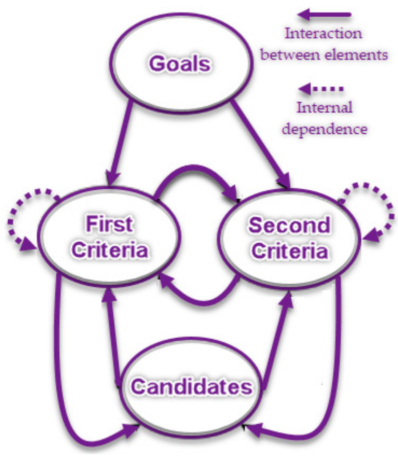

Figure 1. Relationship between components in ANP.

The existence of internal communication is the difference between the ANP and the AHP. The first stage of the ANP method is to define the internal relationships between criteria and sub-criteria. These relationships are obtained from techniques such as FDEMATEL, questioning experts, or related articles. Then, we form pairwise comparisons according to these internal relations to obtain the weights. The first step in this method is to extract and confirm the research factors. Factors are usually in different categories. Then, the second step determines the internal relationships among these factors. Finally, the final calculation of elements' weights is completed by constructing ANP super matrices [39]. It is one of the most widely used and essential methods in projects. There are two approaches to solving ANP models introduced in the literature (super-matrix and multiplication approach). The super-matrix approach is the basis of this research due to its widespread popularity.

FANP method. Characterization of systems with complex behaviors is often replete with uncertainty. We can present such systems with stochastic and fuzzy demonstrations. Therefore, such constraining assumptions are often part and parcel of dealing with complex systems using mathematical models. So, the resulting answers would be far from reality and ineffective in real-world cases. In brief, resorting to fuzzy simulation makes for a straightforward and comprehensible model dealing with complicated systems and uncertain situations [41]. The fuzzy ANP method is also a MADM method, which is related to the fuzzy field. This method is performed using the super-matrix approach. The weight of the criteria is calculated using methods like the Chang method, and the final weight is obtained using the ANP super-matrix approach [42].

1. Identify criteria, sub-criteria, or research options: In this phase, we extract the components and factors of the research using literature or questioning experts. The FANP simply determines the relationships between the criteria.
2. Determining the relationships between components and factors: The FDEMATEL method is a widely used technique in MADM. Its purpose is to study how factors

impact each other or get impacted by others and determine internal relationships. This approach uses the sub-matrix of factors [43].

3. Forming pairwise comparison tables and weight calculation: The pairwise comparison tables and the weights of criteria and sub-criteria are formed and calculated based on research network diagrams. The fuzzy nine spectrums are the idea behind the pairwise comparisons. First, the experts answer the pairwise comparisons and fill out the questionnaires. Then, the FANP incompatibility rate is calculated, and then we merge the comparisons using the geometric mean method. After that, we calculate the weights. In contrast to ANP, FANP performs pairwise comparisons of criteria using fuzzy numbers. These numbers do not refer to a value but a correlated set of feasible values or weights in the range of zero and one [44]. The weights are called the membership function [45]. In various FANP studies, the triangular fuzzy membership function is widely used (Figure 2).

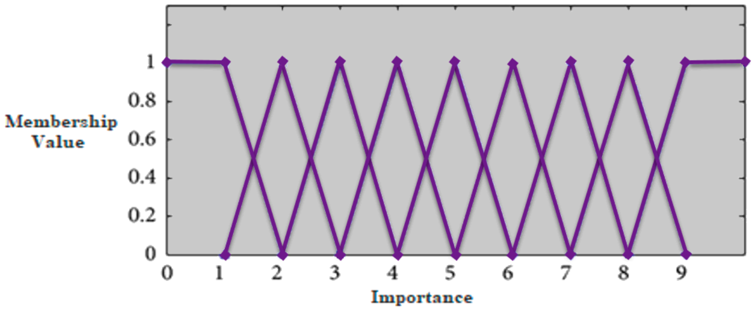

Figure 2. Triangular fuzzy membership functions used in FANP.

If we use the triangular function, then a triple fuzzy number is used instead of a single number as the importance of each item relative to the other one (Table 2). This triple number indicates the lower, middle, and upper limits of the membership function associated with that non-fuzzy number:

$$\mu_{\tilde{A}}(x) = \tilde{A} = (L, M, U) \quad (1)$$

Table 2. Fuzzy numbers corresponding to different importance.

$\mu_{\tilde{A}}(x)$	x	Importance
(1, 1, 1)	1	Identical
(1, 2, 3)	2	
(2, 3, 4)	3	Relative
(3, 4, 5)	4	
(4, 5, 6)	5	Relatively high
(5, 6, 7)	6	
(6, 7, 8)	7	High
(7, 8, 9)	8	
(9, 9, 9)	9	Very high

Inverse importance, indicating lower significance in the ANP, is calculated using Equation (2):

$$\tilde{A}^{-1} = (L, M, U)^{-1} = \left(\frac{1}{U}, \frac{1}{M}, \frac{1}{L}\right) \quad (2)$$

The weight calculation of each criterion or the candidate is by a geometric mean after obtaining the fuzzy pairwise preferences [46]. Equation (3) calculates the geometric mean of the fuzzy numbers:

$$\tilde{r}_{i,j} = \left(\left(\prod_{j=1}^{n} L_j \right)^{\frac{1}{n}}, \left(\prod_{j=1}^{n} M_j \right)^{\frac{1}{n}}, \left(\prod_{j=1}^{n} U_j \right)^{\frac{1}{n}} \right) \tag{3}$$

where i is the row number, j is the preferences table column number, and n is the number of criteria or candidates compared to each other in the questionnaire. Multiplication of two fuzzy numbers is performed using Equation (4):

$$\begin{array}{l} \tilde{B}_1 \otimes \tilde{B}_2 = (L_1, M_1, U_1) \otimes (L_2, M_2, U_2) = \\ (L_1 \times L_2, M_1 \times M_2, U_1 \times U_2) \end{array} \tag{4}$$

The weight of each item is calculated using Equation (5):

$$\tilde{\omega}_i = \tilde{r}_i \otimes (\tilde{r}_1 \oplus \tilde{r}_2 \oplus \ldots \oplus \tilde{r}_n)^{-1} \tag{5}$$

The sum of two fuzzy numbers is calculated using Equation (6):

$$\begin{array}{l} \tilde{B}_1 \oplus \tilde{B}_2 = (L_1, M_1, U_1) \oplus (L_2, M_2, U_2) = \\ (L_1 + L_2, M_1 + M_2, U_1 + U_2) \end{array} \tag{6}$$

The calculated weights are fuzzy numbers. The next phase is the defuzzification of the numbers to obtain the importance of each item. There are many known methods of defuzzification, like the center of sums (COS), the center of gravity (COG), the centroid of area (COA), the bisector of area (BOA), the weighted average, and maxima methods [47]. The weighted average is the method used in this section. This method is proper for fuzzy sets with membership functions generating symmetrical output and results very near to the COA technique. This method is less computationally intensive. The weight of each membership function is its maximum membership value. The value is as follows:

$$w_i = \frac{\sum \mu(x_i).x_i}{\sum \mu(x_i)} \tag{7}$$

4 Forming the super matrix: The calculated weights in the third step are the basement for the initial ANP super matrix. The matrix elements are the relative computed weights. After that, the weighted super matrix is the result of normalizing the initial matrix. The sum of the weights must be equal to one or one hundred percent, which might be unachievable after the calculations. Therefore, the normalized weight is:

$$w_i = \frac{w_i}{\sum_{k=1}^{n} w_k} \tag{8}$$

5 Boundary matrix and final weight criteria: The weighted matrix powered by k creates the limit matrix (k is an optional number). It contains the last criteria, sub-criteria, or research options weights.

3.2. Ordinal Priority Approach

Most group decision-making methods merely provide a ranking scheme for prioritizing options without considering their dominance over one another. Some others calculate the attributes' weights first, determining the decision-making attributes by aggregating experts' ideas based on the ranking outcomes of the options. However, it is possible to involve the options, attributes, and professionals simultaneously as three sides of the decision-making triangle to specify the degree of importance. The OPA considers the features of each side simultaneously for decision-making problems. Decision-making primary components in OPA are experts, alternatives and attributes [15].

The sets, variables, and parameters used in the OPA mathematical prototype are as follows:

I: Experts set $\forall i \in I$.

J: Attributes set $\forall j \in J$.

K: Alternatives set $\forall k \in K$.

i: Expert index $(1, \ldots, p)$.

j: Attribute preference index $(1, \ldots, n)$.

k: Alternative index $(1, \ldots, m)$.

Z: Objective function.

W_{ijk}^{r}: The kth alternative weight or importance based on the jth attribute at the rth rank by the ith expert.

A_{ijk}^{r}: The kth alternative based on attribute j at rank r by expert i.

The following stages lead to ranking the k alternatives:

1. Attributes' ranking by each of the experts.
2. Experts' ranking based on the educational level, organizational chart, experience, background, etc.
3. Alternatives' ranking based on each attribute by the experts.

Paper [15] introduced the OPA central concept. A comprehensive model considers all aspects of decision-making problems, including criteria, alternatives, and experts. A_{ijk}^{r} is the kth alternative based on attribute j by expert i at rank r. In other words, the experts expressed independent views based on preferences for attributes and alternatives. As a result, we discover $i \times j$ orders for k known options. The following equation is the options' order based on each expert and attribute:

$$A_{ijk}^{1} \geq A_{ijk}^{2} \geq \cdots \geq A_{ijk}^{r} \geq A_{ijk}^{r+1} \geq \cdots \geq A_{ijk}^{m} \; \forall i, j, k \quad (9)$$

The only appropriate $A_{ijt}^{r} \geq A_{ijl}^{r+1}$ inequality inference is that W_{ijt}^{r} should be equal to or larger than W_{ijl}^{r+1}:

$$W_{ijk}^{1} \geq W_{ijk}^{2} \geq \cdots \geq W_{ijk}^{r} \geq W_{ijk}^{r+1} \geq \cdots \geq W_{ijk}^{m} \; \forall i, j, k \quad (10)$$

As another way to state the above, differences in the consecutive ranks of weights in Equation (10) can be separated:

$$\begin{array}{l} W_{ijk}^{1} - W_{ijk}^{2} \geq 0, \\ W_{ijk}^{2} - W_{ijk}^{3} \geq 0, \\ \cdots \\ W_{ijk}^{r} - W_{ijk}^{r+1} \geq 0, \\ \cdots \\ W_{ijk}^{m-1} - W_{ijk}^{m} \geq 0 \end{array} \quad (11)$$

Based on experts' views, we conclude that the rth option is more important than $r + 1$st in Equation (10). Multiplying both sides of Equation (11) by i, j, and r results in a revised version (Equation (12)). Indeed, Equation (12) can help present the objective function (Equation (13)), which plays a crucial role in the main body of the model.

$$i\left(j\left(r\left(W_{ijk}^{r} - W_{ijk}^{r+1}\right)\right)\right) \geq 0 \quad \forall i, j, r \quad (12)$$

Equations (9) to (12) determine the alternatives' weights. The same procedure can be used to accomplish attributes and experts. Therefore, solving the mathematical model

(Equation (13)) will obtain the proper weights. The model aims to maximize the alternatives' priority for each attribute and expert. They have created a mathematical model (Equation (13)) maximizing the dominance (the kth option over $k+1$st due to placing at the rth rank as compared with $r+1$st) and considering the degree of preference for the two positions.

$$\begin{aligned} & Max\left\{i\left(j\left(r\left(W_{ijk}^{r}-W_{ijk}^{r+1}\right)\right)\right), ijmW_{ijk}^{m}\right\} \forall i,j,r \\ & S.t: \\ & \sum_{i=1}^{p}\sum_{j=1}^{n}\sum_{k=1}^{m} W_{ijk}^{r}=1 \ \ \forall r \\ & W_{ijk}^{r} \geq 0 \end{aligned} \tag{13}$$

where i, j, and r are the model's parameters that decision-makers should provide, and W_{ijk}^{r} and W_{ijk}^{r+1} are the model's decision variables obtained after solving it. According to the number of options and ranks for decision-making, we form a multi-objective non-linear mathematical model. Solving model (13) results in maximizing the minimization objectives as follows:

$$\begin{aligned} & Max\ Min\left\{i\left(j\left(r\left(W_{ijk}^{r}-W_{ijk}^{r+1}\right)\right)\right), ijmW_{ijk}^{m}\right\} \forall i,j,r \\ & S.t: \\ & \sum_{i=1}^{p}\sum_{j=1}^{n}\sum_{k=1}^{m} W_{ijk}^{r}=1\ \forall r \\ & W_{ijk}^{r} \geq 0 \end{aligned} \tag{14}$$

Solving model (14) is complicated because the model is a non-linear programming problem, so we convert it into a linear programming one to acquire the global solution. Modifying the variables can convert the model into a linear mathematical model:

$$Z = Min\left\{i\left(j\left(r\left(W_{ijk}^{r}-W_{ijk}^{r+1}\right)\right)\right), ijmW_{ijk}^{m}\right\} \tag{15}$$

The linear mathematical model is the result of substituting Equation (7) into model (6). Solving this model enables us to obtain suitable weights (importance) and every alternative's rank in compliance with expert and attribute ranks.

$$\begin{aligned} & Max\ Z \\ & S.t: \\ & Z \leq i\left(j\left(r\left(W_{ijk}^{r}-W_{ijk}^{r+1}\right)\right)\right) \forall i,j,r \\ & Z \leq ijmW_{ijk}^{m}\ \forall i,j \\ & \sum_{i=1}^{p}\sum_{j=1}^{n}\sum_{k=1}^{m} W_{ijk}^{r}=1 \ \ \forall r \\ & W_{ijk}^{r} \geq 0 \end{aligned} \tag{16}$$

The kth alternative is the decision variable of the model, and the calculation of its cardinal weight (W_{ijk}^{r}) is performed using the jth attribute at rth rank by the ith expert. Model (16) determines the ranks and weights of the experts and attributes. The model's variables are $i \times j \times k$, and the number of constraints is $i \times j \times (k+1)$. If an attribute is not considered essential, it has no role in the decision-making procedure based on an expert's opinion. That situation reduces the model's number of constraints and variables to the value acquired from the alternatives' multiplication of the eliminated attribute. Based on the analyst's view, the indexes i, j, and r represent particular importance. Producing multiple values for each alternative is performed by solving the linear mathematical model for specialist (i) and attribute (j), simply because a ranking of a single alternative might be different based on experts' views and various attributes.

$$W_k = \sum_{i=1}^{p} \sum_{j=1}^{n} W_{ijk}^{r} \ \forall k \tag{17}$$

The attributes' weights are:

$$W_j = \sum_{i=1}^{p} \sum_{k=1}^{m} W_{ijk}^{r} \ \forall j \tag{18}$$

The experts' weights are:

$$W_i = \sum_{j=1}^{n} \sum_{k=1}^{m} W_{ijk}^{r} \ \forall i \tag{19}$$

The mathematical model is linear, and solving it produces multiple values for each alternative for expert (i) and attribute (j), simply because a ranking of a single alternative might be different based on experts' opinions and various attributes:

Step 1: Determining the attributes: The selection of the critical attributes is completed by analyst opinion. Also, there might be some attributes with sub-attributes in the decision-making process. Finally, the sub-attributes' weights guide us to the attributes' weights. In other words, decision-making applies the hierarchical decision-making final level diagram (i.e., attributes).

Step 2: Specifying and ranking the experts (in the case of group decision-making): We can specify specialists who participate in the decision-making process based on their expertise, and several factors, such as experience, education level, and organizational chart, help us rank them. The reflection of this ranking is in the prioritization.

Step 3: Ranking the attributes: This step is used to prioritize the attributes. In group decision-making, specialists prioritize the attributes utilizing their expertise. Suppose some specialists define attributes as not critical or containing insufficient knowledge to remark on including a particular attribute. In that case, they are free to not choose those attributes in the mathematical model and the ranking procedure. Also, if an expert prioritizes some attributes equally, they will be present in the prioritization procedure.

Step 4: Ranking the alternatives in each attribute: This step determines each alternative's rank for each attribute. In group decision-making, experts rank the options by viewing each attribute. The ranking is as follows:

$$\left(A_{ijk}^{1}, A_{ijk}^{2}, \cdots, A_{ijk}^{m}\right) \tag{20}$$

Step 5: Ranking the alternatives in each attribute: A linear mathematical model (Equation (16)) determines the optimal weight of the kth alternative based on the jth attribute at rank r in group decision-making. If we consider individual decision-making, the value of i in the model is always one. Then, the final weights (for the alternatives, attributes, and experts) are calculated using Equations (17) to (19). Subsequently, the acquired weights are responsible for the ranking:

$$\left(W_{ijk}^{1}, W_{ijk}^{2}, \cdots, W_{ijk}^{m}\right) \tag{21}$$

4. Implementing MADM Methods and Results

In this section, we intend to create a model using two MADM methods (FANP and OPA). This model can rank agility attributes for a sustainable supply chain. For this purpose, we create a network model for the independent variables and related criteria. Super Decisions software V3.2 is the tool used to perform the analysis.

4.1. Analysis Using FANP

For the purpose of this research, here, we create a network model for the independent variables and related criteria. Super Decisions software is the tool used to perform the analysis.

Step 1: The first step in the FANP method is specifying the criteria, sub-criteria, and research options. The challenges are examined in the business supply chain environment by the assessors in the organization. There are four capabilities, six enablers, and 93 attributes identified in the case organization of [31] (Table 3). Organizational experts also approve these capabilities, enablers, and attributes to sustain a green industrial supply chain in our case organization (SAIPA).

Step 2: The statistical population was 100 experts in the SAIPA company who were willing to fill out the pairwise questionnaires. The organizational experts ranked the factors in the distributed questionnaires. They considered the sustainability of a GSC in their judgments among factors. Finally, Table 4 shows the calculated weights.

Table 3. Attributes, enablers, and capabilities for assessing agility in supply chains [31].

C#	i	E_i	j	Attribute (A_{ij})
Responsiveness	1	Organization management	1	Material planning [48–51]
			2	Integrated logistic networks [48–51]
			3	Virtual logistics [48–51]
			4	Innovative organization [48–51]
			5	Organizational structure [49,50,52]
			6	Distribution networks [48,50,53,54]
			7	Transportation facilities [48,50–52,54]
			8	Warehousing and procurement [48,50,54,55]
			9	Order processing and fulfillment strategy [48,50–52,54]
			10	IT integration in managing supply chain [48,50–52,54]
			11	Integration of IT in product development [50,52,54]
			12	Integration of IT in outsourcing efficiency [50,52,54]
			13	Integration of IT in reverse logistics [50–52,54]
			14	Fast team building [50,52,54]
			15	Interchangeability of personnel [50,52,54]
			16	Team decision-making [50,52,54]
			17	Manufacturing capabilities [50,52,54]
			18	Process and technological capabilities [50,52,54]
			19	Other companies cooperation [50,52,54]
			20	Supply planning demand [50,52,54]

Table 3. *Cont.*

C#	i	E_i	j	Attribute (A_{ij})
Competency	2	Strategic management	1	Innovative infrastructure [50,54,55]
			2	Functional and departmental integration [56,57]
			3	Participative management style [50,54]
			4	Synchronized material movement [48,50,54,55]
			5	Effective training [48,50,54,55]
			6	Well-defined forms and procedures [48,50,54,55]
			7	Agility flexible software [48,50,54,55]
			8	Data management framework [50,54,58]
			9	Minimum price product design [54,55]
			10	Supply chain paradigm suitable design [49,58,59]
			11	Rapid decision-making [50,54]
			12	High management commitment [49,50,58]
			13	Management goal [50,60]
			14	Frequent management employee meetings [50,54]
			15	Short-range planning [50,54]
			16	Customer delight [50,54]
			17	Transparent information sharing [50,52,54]
			18	Corporate and business strategies [50,54,61]
			19	Streamlining of processes [50,54]
			20	Excellent communication [48,50,54]
			21	Proper scheduling of activities [48,50,54]
			22	Easy maintainability and serviceability [50,54]
			23	Removing organizational walls [50]
			24	Pull production system [50,51,54]
			25	Parallel operations [48,50,54]
			26	Effective utilization of time [50,54]
			27	Strategic SCM network [50,54]
			28	Quality ensured at every stage [48,50,52,54]
			29	Zero-inventory system [50,51,54]
			30	Time compression technologies [48,50,54]
			31	Product development methods [50,52,54,55]
			32	Producing new product [48,50,52,54]
			33	Time schedule-based policy for procurement [50,54]
			34	Process/service/product design on quality [50,54]

Table 3. *Cont.*

C#	i	E_i	j	Attribute (A_{ij})
Flexibility	3	Strategic Commitment	1	Numerous suppliers [52]
			2	Concurrent execution activities [50,52,54]
			3	Interlinking departments [50,52,54]
			4	Networking with partners [50,53,54]
			5	Creating an agile supporting culture [59]
			6	Customers'/suppliers' trust and competence [50,52,54]
			7	Negotiation [50,52,54]
			8	Recognizing required agile capabilities [53,57,62]
			9	Understanding characteristics of the business environment [53,57,62]
			10	Core competencies integration with process excellence [53]
			11	Integrating data and intellectual property with partners [56]
			12	Integrating network associate with marketing information [50,52]
Quickness	4	Information management	1	Capturing demand information immediately [50,53,56]
			2	Keeping information on file [53,56]
			3	Efficient funds transfer [50,54,55]
			4	Partners' feedback [50]
			5	Information accessibility dimensions [50,53]
			6	World Wide Web [50,54]
			7	RFID technology incorporation [50,52,54]
			8	Response time to customer [50,52,54]
			9	Multimedia utilization [50,54]
			10	Early disturbances detection [50,53]
	5	Customer sensitivity	1	Accurate customer-based measures [50,54]
			2	Customer-driven manufacturing [50,54]
			3	Market trend analysis [50,54]
			4	Similar product structure [50,54]
			5	Product release acceleration [50,54]
			6	Opportunities to increase customer value [50,54]
			7	Effective forecasting technic [50,54]
			8	Part universalization degree [53]

Table 3. *Cont.*

C#	i	E_i	j	Attribute (A_{ij})
	6	Human competence	1	Employee's ability to support top management [53,56,59]
			2	Employee's ability to react appropriately to market changes [53,59]
			3	Employee's participation ability in strategy planning [53,56,59]
			4	Employee's ability to work proactively to identify opportunities [53,56,59]
			5	Managing supply chain resources [53,56,59]
			6	Meeting customer requirements [56,59]
			7	Evaluating supply chain operations [56,59]
			8	Continually updating and revising strategies [56,59]
			9	Minimizing resistance to change [56,59]

Table 4. Weight of attributes in enablers (organization management, strategic management, strategic commitment, information management, customer sensitivity, human competence) using FNP.

E_i	j	Attribute	Weight
Organization management	1	Material planning	0.0634
	2	Integrated logistic networks	0.0705
	3	Virtual logistics	0.0099
	4	Innovative organization	0.0711
	5	Organizational structure	0.0492
	6	Distribution networks	0.0076
	7	Transportation facilities	0.0217
	8	Warehousing and procurement	0.0426
	9	Order processing and fulfillment strategy	0.0746
	10	IT integration in managing supply chain	0.0751
	11	Integration of IT in product development	0.0123
	12	Integration of IT in outsourcing efficiency	0.0756
	13	Integration of IT in reverse logistics	0.0745
	14	Fast team building	0.0377
	15	Interchangeability of personnel	0.0623
	16	Team decision-making	0.0110
	17	Manufacturing capabilities	0.0328
	18	Process and technological capabilities	0.0713
	19	Other companies' cooperation	0.0616
	20	Supply planning demand	0.0747

Table 4. *Cont.*

E_i	j	Attribute	Weight
Strategic management	1	Innovative infrastructure	0.0380
	2	Functional and departmental integration	0.0021
	3	Participative management style	0.0493
	4	Synchronized material movement	0.0541
	5	Effective training	0.0393
	6	Well-defined forms and procedures	0.0440
	7	Agility flexible software	0.0431
	8	Data management framework	0.0226
	9	Minimum price product design	0.0380
	10	Supply chain paradigm suitable design	0.0099
	11	Rapid decision-making	0.0410
	12	High management commitment	0.0018
	13	Management goal	0.0161
	14	Frequent management employee meetings	0.0027
	15	Short-range planning	0.0056
	16	Customer delight	0.0478
	17	Transparent information sharing	0.0403
	18	Corporate and business strategies	0.0184
	19	Streamlining of processes	0.0551
	20	Excellent communication	0.0020
	21	Proper scheduling of activities	0.0255
	22	Easy maintainability and serviceability	0.0221
	23	Removing organizational walls	0.0444
	24	Pull production system	0.0461
	25	Parallel operations	0.0108
	26	Effective utilization of time	0.0284
	27	Strategic SCM network	0.0258
	28	Quality ensured at every stage	0.0375
	29	Zero-inventory system	0.0411
	30	Time compression technologies	0.0438
	31	Product development methods	0.0160
	32	Producing new product	0.0394
	33	Time schedule-based policy for procurement	0.0380
	34	Process/service/product design on quality	0.0094

Table 4. *Cont.*

E_i	j	Attribute	Weight
Strategic commitment	1	Numerous suppliers	0.1100
	2	Concurrent execution activities	0.0278
	3	Interlinking departments	0.0300
	4	Networking with partners	0.0518
	5	Creating an agile supporting culture	0.1690
	6	Customers'/suppliers' trust and competence	0.0511
	7	Negotiation	0.1638
	8	Recognizing required agile capabilities	0.0490
	9	Understanding characteristics of the business environment	0.1869
	10	Core competencies integration with process excellence	0.0703
	11	Integrating data and intellectual property with partners	0.0395
	12	Integrating network associate with marketing information	0.0505
Information management	1	Capturing demand information immediately	0.1215
	2	Keeping information on file	0.0658
	3	Efficient funds transfer	0.1654
	4	Partners' feedback	0.0420
	5	Information accessibility dimensions	0.1525
	6	World Wide Web	0.0406
	7	RFID technology incorporation	0.0818
	8	Response time to customer	0.1389
	9	Multimedia utilization	0.1733
	10	Early disturbances detection	0.0180
Customer sensitivity	1	Accurate customer-based measures	0.2112
	2	Customer-driven manufacturing	0.1762
	3	Market trend analysis	0.1106
	4	Similar product structure	0.0991
	5	Product release acceleration	0.1015
	6	Opportunities to increase customer value	0.0696
	7	Effective forecasting technic	0.1156
	8	Part universalization degree	0.1161

Table 4. *Cont.*

E_i	j	Attribute	Weight
Human competence	1	Employee's ability to support top management	0.1330
	2	Employee's ability to react appropriately to market changes	0.1293
	3	Employee's participation ability in strategy planning	0.1048
	4	Employee's ability to work proactively to identify opportunities	0.0616
	5	Managing supply chain resources	0.1321
	6	Meeting customer requirements	0.0867
	7	Evaluating supply chain operations	0.0571
	8	Continually updating and revising strategies	0.1528
	9	Minimizing resistance to change	0.1425

The integration of IT in outsourcing efficiency is the first attribute and IT integration in managing the supply chain is the second attribute in organization management. The streamlining of processes is the first attribute and synchronized material movement is the second attribute in strategic management. Understanding the characteristics of the business environment is the first attribute and creating an agile supporting culture is the second attribute in strategic management. Multimedia utilization is the first attribute and the World Wide Web is the second attribute in information management. Accurate customer-based measures are the first attribute and customer-driven manufacturing is the second attribute in customer sensitivity. Continually updating and revising strategies is the first attribute and minimizing resistance to change is the second attribute in human competence. The first three capabilities contain just one enabler. The last one contains three enablers. So, the weights are computed using fuzzy calculations (Table 5).

Table 5. Weight of enablers in quickness (capability 4) using fuzzy calculation.

i	Enabler	Weight
1	Information management	0.4410
2	Customer sensitivity	0.4903
3	Human competence	0.0687

Customer sensitivity is the first enabler, and information management is the second enabler in human quickness found by fuzzy calculation. After ranking enablers, the next step is to rank the capabilities using FANP calculations.

The results identified that quickness, flexibility, competency, and responsiveness take the first to the fourth place by ranking the capabilities (Table 6). The accurate customer-based measures attribute is in the group of the most significant enabler (customer sensitivity), so it is the most important one. The customer sensitivity enabler belongs to the most significant capability (quickness). Quickness is the most significant capability. If we design supply chains for the SAIPA company, we can rank them using the weights calculated using the FANP.

Table 6. Weight of capabilities using fuzzy calculation.

j	Capability	Weight
1	Responsiveness	0.1013
2	Competency	0.1990
3	Flexibility	0.3485
4	Quickness	0.3512

4.2. Analysis Using OPA

Here, we face a numerical group decision-making problem. Accordingly, the decision-making goal is to rank three attributes based on some earlier-determined enablers. Table 7 shows an example of prioritizing attributes by three experts working in SAIPA supply chain management:

Table 7. Prioritizing attributes by three experts.

Expert	Enabler	First Priority	Second Priority	Third Priority
1	Organization management	Distribution networks	Order processing and fulfillment strategy	Organizational structure
	Strategic management	Data management framework	Effective utilization of time	Excellent communication
	Strategic commitment	Numerous suppliers	Customers'/suppliers' trust and competence	Recognizing required agile capabilities
	Information management	World Wide Web	Multimedia utilization	Early disturbances detection
	Customer sensitivity	Customer-driven manufacturing	Opportunities to increase customer value	Part universalization degree
	Human competence	Employee's ability to work proactively to identify opportunities	Managing supply chain resources	Employee's ability to react appropriately to market changes
2	Organization management	Integrated logistic networks	Material planning	Virtual logistics
	Strategic management	Participative management style	Functional and departmental integration	Innovative infrastructure
	Strategic commitment	Numerous suppliers	Interlinking departments	Concurrent execution activities
	Information management	Keeping information on file	Capturing demand information immediately	Efficient funds transfer
	Customer sensitivity	Customer-driven manufacturing	Market trend analysis	Accurate customer-based measures
	Human competence	Employee's ability to support top management	Employee's ability to react appropriately to market changes	Employee's participation ability in strategy planning

Table 7. *Cont.*

Expert	Enabler	First Priority	Second Priority	Third Priority
3	Organization management	Transportation facilities	Organizational structure	Distribution networks
	Strategic management	Process/service/product design on quality	Product development methods	Parallel operations
	Strategic commitment	Networking with partners	Recognizing required agile capabilities	Understanding characteristics of the business environment
	Information management	World Wide Web	Multimedia utilization	Response time to customer
	Customer sensitivity	Effective forecasting technic	Similar product structure	Part universalization degree
	Human competence	Employee's ability to support top management	Employee's ability to react appropriately to market changes	Employee's participation ability in strategy planning

The first expert's priority is distribution networks in organization management. Order processing and fulfillment strategy and organizational structure are the second and third priorities, respectively. After prioritizing the attributes by all experts, we can obtain the weights of capabilities, attributes, and enablers. Finally, Table 8 shows the calculated weights.

Table 8. Weight of attributes in enablers (organization management, strategic management, strategic commitment, information management, customer sensitivity, human competence) using OPA.

E_i	j	Attribute	Weight
Organization management	1	Material planning	0.0623
	2	Integrated logistic networks	0.0603
	3	Virtual logistics	0.0102
	4	Innovative organization	0.0701
	5	Organizational structure	0.0502
	6	Distribution networks	0.0107
	7	Transportation facilities	0.0200
	8	Warehousing and procurement	0.0402
	9	Order processing and fulfillment strategy	0.0757
	10	IT integration in managing supply chain	0.0752
	11	Integration of IT in product development	0.0204
	12	Integration of IT in outsourcing efficiency	0.0808
	13	Integration of IT in reverse logistics	0.0703
	14	Fast team building	0.0400
	15	Interchangeability of personnel	0.0601
	16	Team decision-making	0.0050
	17	Manufacturing capabilities	0.0303
	18	Process and technological capabilities	0.0702
	19	Other companies' cooperation	0.0620
	20	Supply planning demand	0.0853

Table 8. *Cont.*

E_i	j	Attribute	Weight
Strategic management	1	Innovative infrastructure	0.0368
	2	Functional and departmental integration	0.0031
	3	Participative management style	0.0523
	4	Synchronized material movement	0.0440
	5	Effective training	0.0508
	6	Well-defined forms and procedures	0.0395
	7	Agility flexible software	0.0478
	8	Data management framework	0.0190
	9	Minimum price product design	0.0403
	10	Supply chain paradigm suitable design	0.0091
	11	Rapid decision-making	0.0436
	12	High management commitment	0.0012
	13	Management goal	0.0261
	14	Frequent management employee meetings	0.0020
	15	Short-range planning	0.0071
	16	Customer delight	0.0446
	17	Transparent information sharing	0.0458
	18	Corporate and business strategies	0.0790
	19	Streamlining of processes	0.0568
	20	Excellent communication	0.0017
	21	Proper scheduling of activities	0.0265
	22	Easy maintainability and serviceability	0.0203
	23	Removing organizational walls	0.0468
	24	Pull production system	0.0394
	25	Parallel operations	0.0136
	26	Effective utilization of time	0.0172
	27	Strategic SCM network	0.0272
	28	Quality ensured at every stage	0.0336
	29	Zero-inventory system	0.0424
	30	Time compression technologies	0.0318
	31	Product development methods	0.0183
	32	Producing new product	0.0286
	33	Time schedule-based policy for procurement	0.0400
	34	Process/service/product design on quality	0.0385

Table 8. *Cont.*

E_i	j	Attribute	Weight
Strategic commitment	1	Numerous suppliers	0.1160
	2	Concurrent execution activities	0.0225
	3	Interlinking departments	0.0338
	4	Networking with partners	0.0438
	5	Creating an agile supporting culture	0.1640
	6	Customers'/suppliers' trust and competence	0.0521
	7	Negotiation	0.1496
	8	Recognizing required agile capabilities	0.0510
	9	Understanding characteristics of the business environment	0.1735
	10	Core competencies integration with process excellence	0.0637
	11	Integrating data and intellectual property with partners	0.0426
	12	Integrating network associate with marketing information	0.0771
Information management	1	Capturing demand information immediately	0.1227
	2	Keeping information on file	0.0683
	3	Efficient funds transfer	0.1774
	4	Partners' feedback	0.0408
	5	Information accessibility dimensions	0.1504
	6	World Wide Web	0.0429
	7	RFID technology incorporation	0.0843
	8	Response time to customer	0.1454
	9	Multimedia utilization	0.1529
	10	Early disturbances detection	0.0045
Customer sensitivity	1	Accurate customer-based measures	0.2001
	2	Customer-driven manufacturing	0.1335
	3	Market trend analysis	0.1073
	4	Similar product structure	0.0998
	5	Product release acceleration	0.1016
	6	Opportunities to increase customer value	0.0686
	7	Effective forecasting technic	0.1200
	8	Part universalization degree	0.1690

Table 8. *Cont.*

E_i	j	Attribute	Weight
Human competence	1	Employee's ability to support top management	0.2000
	2	Employee's ability to react appropriately to market changes	0.1052
	3	Employee's participation ability in strategy planning	0.1162
	4	Employee's ability to work proactively to identify opportunities	0.0681
	5	Managing supply chain resources	0.1655
	6	Meeting customer requirements	0.0715
	7	Evaluating supply chain operations	0.0442
	8	Continually updating and revising strategies	0.1562
	9	Minimizing resistance to change	0.0730

Supply planning demand is the first attribute and integration of IT in outsourcing efficiency is the second attribute in organization management. Corporate and business strategies is the first attribute and streamlining of processes is the second attribute in strategic management. Understanding the characteristics of the business environment is the first attribute and creating an agile supporting culture is the second attribute in information management. Efficient funds transfer is the first attribute and multimedia utilization is the second attribute in information management. Accurate customer-based measures is the first attribute and part universalization degree is the second attribute in customer sensitivity. Employee's ability to support top management is the first attribute and managing supply chain resources is the second attribute in human competence.

The first three capabilities contain just one enabler. The last one contains three enablers. So, the weights are computed using OPA calculation (Table 9).

Table 9. Weight of enablers in quickness (capability 4) using OPA.

i	Enabler	Weight
1	Information management	0.1622
2	Customer sensitivity	0.1587
3	Human competence	0.0317

Information management is the first enabler, and customer sensitivity is the second enabler in human quickness. The result differs from FANP's, where customer sensitivity is the first and information management is the second enabler.

The OPA results identified that quickness, flexibility, competency, and responsiveness take the first to fourth places, exactly the same as FANP. The efficient funds transfer attribute is in the group of the most significant enabler (information management), so it is the most important one. The information management enabler belongs to the most significant capability (quickness). Quickness is the most significant capability (Table 10).

Table 10. Weight of capabilities using OPA.

j	Capability	Weight
1	Responsiveness	0.1126
2	Competency	0.2005
3	Flexibility	0.3253
4	Quickness	0.3526

5. Discussion

According to our review, there are four capabilities for assessing agility in supply chains. They are responsiveness, competency, flexibility, and quickness. Responsiveness includes just one enabler (organization management). Competency also contains one enabler (strategic management). Flexibility is the same, and its enabler is strategic commitment. Quickness includes three enablers. They are information management, customer sensitivity, and human competence. Organization management has 20 attributes. Strategic management has 34 attributes. Strategic commitment has 12. Information management has ten, customer sensitivity has eight, and human competence has nine attributes.

MADM methods were used in this research to rank the factors. They both ranked quickness as the first capability. Their data gathering and computations are different, and the complexity is more evident when the problem has more criteria or attributes. Using rank instead of other input data is a core concept in the OPA method and is a positive perspective toward MADM problems. The OPA facilitates decision-making because it contains uncomplicated comparisons as input data. Providing input data is challenging in many MADM methods because they require pairwise comparisons and precise numbers. In the OPA, arranging alternatives or attributes is only required for decision-making. In our case we had 10 questions for capabilities, 3 questions for enablers, and 1019 questions for attributes in pairwise comparisons. This volume of the comparisons made data collection very challenging using MADM methods like FANP. The problem becomes even more complicated when we want to rank supply chains based on the results. Additionally, in the OPA, the mathematical model is highly advantageous in reducing the steps, and we obtain all the demanded data after solving it. This method solves all kinds of MADM problems, like group decision-making, even with incomplete input data. The result showed that the ranking of attributes using the FANP or OPA is very similar. The main difference was in the quickness capability, where the OPA found that information management was the most significant enabler in a green sustainable supply chain. However, FANP found that customer sensitivity was the most critical one. If we design supply chains for the SAIPA company, we can rank these chains using the weights calculated using the FANP or OPA.

6. Conclusions

A sustainable network between a company and its suppliers, producers, and distributors of products is vital. This network includes various people, activities, information, resources, and entities. ASCs focus on rapidly responding to market changes. Integrating business partners can breed an ASC that enables new capabilities to react to continually fragmenting and rapidly transforming markets. Some critical enablers of the ASC include the end-to-end visibility of information, the dynamics of structures and relationship configuration, and event-driven and event-based management. We reviewed the literature to find the enablers, attributes, and capabilities, and the experts approved them for a sustainable GSC. All these factors were ranked using the FANP and OPA methods. After investigation, the FANP identified that accurate customer-based measures are the most significant attribute, customer sensitivity is the most important among all enablers, and quickness is the most significant capability. The OPA found that efficient funds transfer is the most influential attribute, information management is the most critical enabler, and quickness is the first capability. According to the present study's findings, attention to significant factors is proposed to SAIPA managers and decision-makers to develop more agile and sustainable GSCs. The model can compare different supply chains because of the nature of MADM, so if there are diverse supply chains, the model can rank them based on their sustainability using the agility ratings. The results showed that MADM methods like FANP can constitute models for the SAIPA supply chain where the situation is intricate and uncertain. On the other hand, the FANP requires complex calculations and unjust data collection, in the case of this paper. In these circumstances, the OPA is a promising technique to rank the factors and makes a platform to compare different supply chains based on their sustainability.

Author Contributions: All authors contributed to this study's conception and design. S.S. and S.M.S. performed the data collection and analysis. They both wrote the first draft and read and approved the final manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: The authors declare that they received no funds, grants, or other support during the preparation of this manuscript.

Institutional Review Board Statement: This research did not include any investigations involving animals, nor did it take place in any confidential or protected areas. Corresponding locations did not require any specific permissions.

Informed Consent Statement: The authors voluntarily agreed to take part in this study. We consent to use of our contents in presentations related to this study. The authors give our consent for the publication of identifiable details, which can include images, literature, the research method, results, and details within the text to be published in the Environmental Science and Pollution Research journal.

Data Availability Statement: Data are contained within the article.

Conflicts of Interest: The authors have no relevant financial or non-financial interest to disclose.

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