An advanced optimization technique for integrating IoT and cloud computing on manufacturing performance for supply chain management

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Abstract

The discipline of Supply Chain Management (SCM) is getting more difficult to master. It is necessary to address information silos on the demand and production frontiers of goods in order to execute the de-coupling factor in the preferences of customers who are engaged in a supply chain to optimize business performance, which in today's world has become a difficulty. The so-called "Amazon Effect" has, once again, compelled competitors to rethink their approaches to achieving maximum efficiency. The Analytic Hierarchy Process (AHP), which is part of the Multi-Criteria Decision Making (MCDM) Approaches, has been used to offer the preferences of clients of various criteria versus various features (products). AHP is used to compute the weights of criteria, then rank the various alternatives. The AHP method is used to build the pairwise comparison between criteria to check the importance of these criteria. The AHP method checks the consistency of the experts to ensure all data is consistent.

Keywords: Cloud Computing; IoT; AHP; Supply Chain Management; Big Data

1. Introduction

The whole digital marketplace is presently experiencing a new competitiveness horizon, and this is having a tremendous influence on the e-commerce and online marketplaces as a result of changes in the buying behaviors, interests, and expectations that customers have. The term "Amazon Effect" is often used to allude to this phenomenon. The retail industry has been shaken up significantly, which has necessitated a greater degree of price agility to preserve the status quo of consistent pricing. In tandem with this development, Supply Chain Management (often abbreviated as SCM) is taking on an expanding significant role. It is also growing more complicated daily. It is necessary to properly discuss data silos on the customer and supplier fronts of goods to implement a de-coupling implementing plans to the preferences of clients who are engaged in a supply chain to optimize operational effectiveness, and this has evolved into a challenge in today's society. The so-called "Amazon Effect" has resulted in a number of different companies being required to rethink their approaches to achieving maximum efficiency[1]–[3].

Due to the Amazon effect, the quickness, or explosiveness and adaptability, of the Supply Chain (SC) of one organization impacted the skills of the key stakeholders of the supply chain to quickly adapt to the fluctuation in the corporate environment. This was the case because the SC of one organization impacted the skills of the SC of partner organizations. They said that IoT should contain a fast adaptation or agility as part of its functionality. Increases in the responsiveness and adaptability of businesses' flexible manufacturing systems (FMS) were directly responsible for these increases in

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firms' levels of competitiveness. At first, it was believed that a variable production system could've been accomplished via automation by shortening the amount of time needed for set-up and boosting either the product mix or the production volume. On the other hand, reports indicated that excessive product innovation or quantity or overwhelming occurrence of non-standard elements in the formulation of a product did not significantly improve customer happiness, although product complexity rose. Therefore, it was determined that normalizing the product variety, standardizing the packaging, and cutting down on promotional efforts were all necessary in order to leverage the relationship with the supplier. It is possible to quote and comprehend the instance of Procter & Gamble in order to decrease levels of complexity and increase levels of agility. SCM takes into consideration the four principles of an organization, which include sourcing, purchasing, essential activities that are needed to commence the supply, and logistics, to meet the ever-changing demands of the market. SCM also promotes a variety of ways that assist connect the chain of producers, distributors, and vendors to achieve the lowest possible cost for the provision of services[4]–[6].

Via the use of the Internet of Things (IoT), 'things' can be recognized through the provision of systems that are suited for detecting them through RFID and Wireless Sensor Networks (WSN). It was observed that the Internet of Things and cloud computing are closely related technologies. It was hypothesized that cloud computing, which is a flexible and adaptable IT architecture, will end up becoming the only viable alternative for sustaining enormous amounts of data that are very unexpected. It is necessary to store, analyze, and have access to the vast amounts of data that are being produced as a result of the extensive connectivity of various 'things' all over the globe. These data must be created with the extensive interconnection of various 'things' across the world. IoT and cloud computing is going to have to work together to store the enormous amounts of data that are produced throughout the computation. This is what is known as big data storage and insights. The cloud will thus function very efficiently as the brain to enhance and perfect the justice system and the World Wide Web perceiving process[7]–[9].

The researchers of this work have focused their attention not on choosing the cloud method which is the most suitable for the problem at hand; rather, they have proposed adding a module to it by detaching all of the choices or requirements of the contractors (shuttles) on a case-by-case basis using AHP. This is done to make the fundamental metadata easier to understand and to make the SCM as a whole less complicated to achieve optimization. As a result, the purpose of this study is to firmly couple AHP, the Internet of Things, and Cloud Computing in sequence to have an optimized SCMS in which the choices of clients (users) will be given primary importance, and the actual system will be more straightforward. The use of all three of these methods together will make it possible to create a robust and highly effective optimized solution for the analysis of physiological data streams.

The following is the structure of this study: In Section 2, some work that is linked to the selection issue is presented. In the third section, we will talk about the benefits of combining big data with cloud computing. Section 4 shows the IoT in supply chain management. In Section 5, we provide a concise explanation of the recommended technique that will be followed to accomplish our objective. Section 6, we provide empirical research that illustrates the efficiency and efficacy of our decision-making technique. Finally, the conclusions of this paper are presented in the last section.

2. Related Work

Nevertheless, in order to maximize the effectiveness of the management of the whole supply chain, it is ultimately necessary to concentrate on the requirements and preferences of the customers. The customer's preferences are to be given first priority, resulting in a pressing need to put into practice a method that would facilitate a reduction in the chain's exposure to unneeded complexity and hardship. For instance, for certain customers, speed may be the most important factor, and if speed is starting to become the most important factor, preferences for other criteria would often shift as a result. Therefore, research into the use of AHP in this field has been carried out so that overall optimization may be achieved.

To assess, rating, and select the best cloud technology to house and handle big data projects, Boutkhoum et al. [10] proposed a mixed decision-making approach that is based on appropriate samples, fuzzy AHP, and fuzzy TOPSIS. In reality, many companies' top strategic focus is developing long-term competitive advantages via the use of cutting-edge innovations, procedures, and institutional arrangements like big data and the cloud. Because the state of technology is always changing, many companies are wondering how they might take advantage of big data by harnessing the technological agility that cloud computing can offer. In this setting, choosing the best cloud

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solution to house big data projects is a complicated matter that calls for careful consideration. Therefore, we present a four-step mixed decision-making technique to help consumers choose the cloud solution that best suits their needs. In the first step, a decision-making panel uses an Affinity Diagram to figure out how to measure something. In the second phase, a FAHP method is used to allocate relative importance for each focused on measuring; in the third phase, an FTOPSIS process uses these " the most important as inputs to assess and assess the effectiveness of every option, taking into account the varying significance of the specific criteria. In their research, there are 4 main levels of analysis. In the first step of the technique that we have provided, the Affinity Diagram is used so that the group may decide on the discovery of parameters that everyone agrees upon. The group in charge of making decisions exchanges knowledge, expertise, and opinions to arrive at a mutual agreement on the factors that should be influential. In stage 2, the FAHP method is used to break down the difficulty of choosing its component pieces and to form structures of the relevant factors to calculate the weights for the criterion and the sub-criteria. At the end of the process, they used the FTOPSIS method to calculate an overall output rating to assess the effectiveness of every option. We then carry out a sensitivity analysis in order to approximate the risks that the decision maker is exposed to and determine the impact that the weighting of criteria has on the decision-making process as a whole. The use of the suggested proposed method not only enables the policymakers of a corporation to identify the important standards, but it also enables them to start comparing, assessing, and choosing the best-suggested options, thereby preventing ambiguity and doubt in the decision makers' ratings.

During the process of multi-criteria decision processes, Prajapati et al. [11] employed FAHP and FTOPSIS. These approaches were also helpful in the development of a novel hybrid method referred to in their research as "fuzzy TOPSIS AHP." There has been no research that compares fuzzy AHP with fuzzy TOPSIS AHP in the context of marine logistics. This means that comparative analyses of MCDM have not been conducted. In the research that was done, a great number of specialists contributed their thoughts on the order of importance of various marine logistics factors. Sustainability of the ecosystem, production and demand, logistics, and port choice are the factors that have been picked for precedence. However, the comparative examination of the data indicated that the two sets of findings were significantly different from one another. The study also suggested a new technique for researchers to employ the mixed methodology of fuzzy TOPSIS Pairwise comparisons in their future investigations. The purpose of the research was to develop new ways to enhance the current maritime model, which assists individuals in establishing connections with marine logistics companies. Additionally, the study intends to give this model to academics so that it may be used in their studies about marine logistics.

The purpose of the work of Sayed et al [12] is to demonstrate how the concept of the M-TOPSIS technique may be successfully used to address the stochastic fuzzy multi-level multi-objective fractional decision-making (ML-MOFDM) issue. Baky and El Sayed's altered TOPSIS technique was further extended by this author to handle the ML-MOFDM issue. This was accomplished by using the benefits offered by the FGP and TOPSIS techniques for MODM issues. The TOPSIS methodology changes the MODM issue into a collection of warring bi-objective distance measures that may be expressed using the membership values of fuzzy set theory. The TOPSIS methodology employs the max–min operator to resolve any conflicts that may arise between the newly introduced criteria. On the other hand, the FGP technique is applied in the updated TOPSIS technique to overcome the disagreement that arises between the new guidelines. The most significant benefit of the strategy that has been suggested is the fact that the stochastic fuzzy ML-MOFDM issue can be solved without resorting to the use of the Taylor series to convert comparatively small features into first-order polynomials. This eliminates the mistake that is caused by the remembrance. The usefulness of the improved TOPSIS strategy for the stochastic fuzzy ML-MOFDM issue is shown via the use of a mathematical demonstration as well as a case analysis of the master production issue. The analysis of the differences and similarities between the adjusted TOPSIS strategy, the FGP approach, and the technique of Lachhwani demonstrates that the effective option of the updated TOPSIS strategy and the FGP strategy is identical and is preferable to the answer of Lachhwani. In addition to this, we use the M-TOPSIS algorithm to solve the stochastic fuzzy bi-level master production issue.

3. Big Data and Cloud Computing

"Big data and cloud computing are merging in the same," Tim Byers of Motley Fool said in a meeting at the South by Southwest (SXSW) Conference in March 2013, explaining that "cloud services are

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required for big data collection and developments, and big data is a huge commercial case for shifting to the cloud." Because big data requires a significant amount of processing power and massive amounts of storage space, many businesses are focusing their efforts today on determining how they can make the most of the capacity and flexibility offered by cloud computing to gain from big data. The fact that big data may give the capacity to leverage inexpensive technology for performing global queries via many data sets and delivering the resulting sets in a timely way is, in fact, the connection between these two techniques. On the other hand, cloud computing offers the fundamental motor all over the use of Hadoop as a class of remote data platforms. Cloud computing is well-known for its ability to bring pace to advancement, rapid expandability and quickness, and lower total costs of ownership to this connection. To be more specific, as Talia pointed out, cloud computing offers an architecture that can effectively act as a foundation to handle the variety and difficulty of data kinds to carry out big data analysis. This was mentioned in the context of cloud computing. Within the scope of this discussion, Bollier and Firestone emphasized the capability and promise of cluster computers to provide an environment that is conducive to the expansion of data. Nevertheless, according to Miller's argument, the absence of available information, along with improper use of analytical methodologies, may lead to inaccurate and expensive conclusions being made about the treatment of offloaded decisions. At this moment, using the importation services provided by cloud providers has made it simpler and quicker to upload all of a company's current data to the cloud. Any company may send the discs that contain their data straight to the cloud vendors, and once they get the discs, the data will be put into one of their data centers. When it comes to keeping data digitally in the cloud, this final process has to adhere to the same security best practices.

4. RFID-IoT system in supply chain management

RFID and Internet of Things technologies, with the qualities they now possess, such as automatic individual products, ubiquitous networks, and real-time data transfer, contribute to the supply chain in a variety of different ways. The evolution of RFID and the Internet of Things may be tracked through the many phases of supply chain management, including production, delivery and distribution, inventories, and retail store operations. The categorization was prompted by recent research that highlighted the fact that many studies do not include product shipment and redistribution in their supply chain operations. This finding served as the impetus for the categorization. Because the grey region of categorization isn't well defined, the supply chain management procedure is rendered unclear, which drives up both the cost and the risk of the chain[13–15].

RFID and Internet of Things technologies, when used in the supply chain in the appropriate ways, may contribute to the reduction of production costs as well as improvements in customer satisfaction, continuous improvements, multiple-party interaction, and customer service. Analytic modeling, modeling work, research papers, tests, and return on investment (ROI) evaluations were used by Sarac et al. to comment on the influence that the implementation of Rfid systems will have on the supply chain[16]–[20].

5. Solution Methodology

When it comes to making judgments, the AHP is a powerful and complex instrument, which incorporates conflicting standards in the decision-making process. Saaty was the one who first defined how to build a decision issue and introduced the AHP approach. The AHP technique creates a hierarchical structure out of the many goals, components, and sub-factors that are considered. When using the AHP approach, the collecting of information is a very simple process. The AHP begins with a comparison of two separate elements or options that affect the decision-making criteria. These comparisons may be made with the input of specialists in the relevant fields to get the most accurate results[21]–[23]. These responses from the poll of experts, with their respective experiences, views, and biases, are very important, as they will contribute to the prioritization of the elements. Because it includes not just one or two but a large number of experts, the average of all contributions for each comparison will need to be calculated before the pair-wise matrix can be constructed. Take, for instance, the case where one hundred experts are weighing in on the relative significance of "feature 1" and "feature 2."

When comparing 'n' numbers of elements against one another, a pair-wise comparison matrix called 'X_{ij}' is produced. The value of x_{ij} indicates how intensely important each item is in the grid, where I may range from 1 to n and j from 1 to n. Because rows and columns are made up of identical features,

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it follows that if the degree of significance of factor 1 with regard to feature 2, then the degree of significance of feature 2 with regard to feature 1 is x_{ij}, which is equal to $1/x_{ij}$.

The AHP method is used to achieve the weights of the criteria concerned with IoT, cloud computing, and SCM.

1: Constructing a hierarchical model of the MCDM issue is the first step.

The top level of the graphic provides a thorough explanation of the problem's focal point, while level 2 of the hierarchy organization explains the issue's qualities or standards. At the very bottom of the grade is a description of the various MCDM issue solutions.

2: Constructing the pair-wise comparison matrix is the second step.

When it comes to MCDM challenges, the replies from DMs are mostly centered on the DMs' opinions of how they would rate the stated criteria. The DMs were asked to define ratings for the aspects related to MCDM difficulties using nine different AHP linguistic scales, ranging from "similarly vital" to "much more significant." The 9 scales of language, range from 1 to 9.

$$X = \begin{bmatrix} 1 & x_{12} & \cdots & x_{1n} \\ & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & 1 \end{bmatrix} \tag{1}$$

$$X = \begin{bmatrix} 1 & x_{12} & \cdots & x_{1n} \\ & \vdots & \ddots & \vdots \\ 1/x_{n1} & \frac{1}{x_{n2}} & \cdots & 1 \end{bmatrix} \tag{2}$$

3: Normalize the comparison matrix by dividing each value in the comparison matrix by the sum of each column to compute the normalization matrix as:

$$NO_{ij} = \frac{x_{ij}}{\sum x_j} \tag{3}$$

4: Compute the weights of the criteria

Weights of criteria are computed by the row average, by computing the sum of each row and dividing it by the number of criteria.

$$W_j = \frac{\sum NO_i}{n} \tag{4}$$

5: Obtain the consistency ratio (CR) comparative matrix decision to proceed.

It is essential to take into account the consistency ratio to guarantee that decision-makers will produce consistent judgments. The consistency and inconsistency indices are established, not only by taking into account the pair-wise comparisons of alternatives with hesitation degrees but also by taking into account the preference connections that exist between the criteria and the alternatives that are provided by the DM. The random index, often known as RI, is the mean consistency index calculated using a large number of random elements from reciprocal arrays of the same rank. The relative importance (RI) of each factor is proportional to the number of factors being compared.

$$CR = \frac{RI - \frac{\sum x_{ij}}{n}}{n-1} \tag{5}$$

6: Build the decision matrix

The decision matrix between criteria and alternatives is built.

7: Multiply the weights of criteria by the decision matrix values.

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8: Rank the alternatives based on the highest value of the previous step.

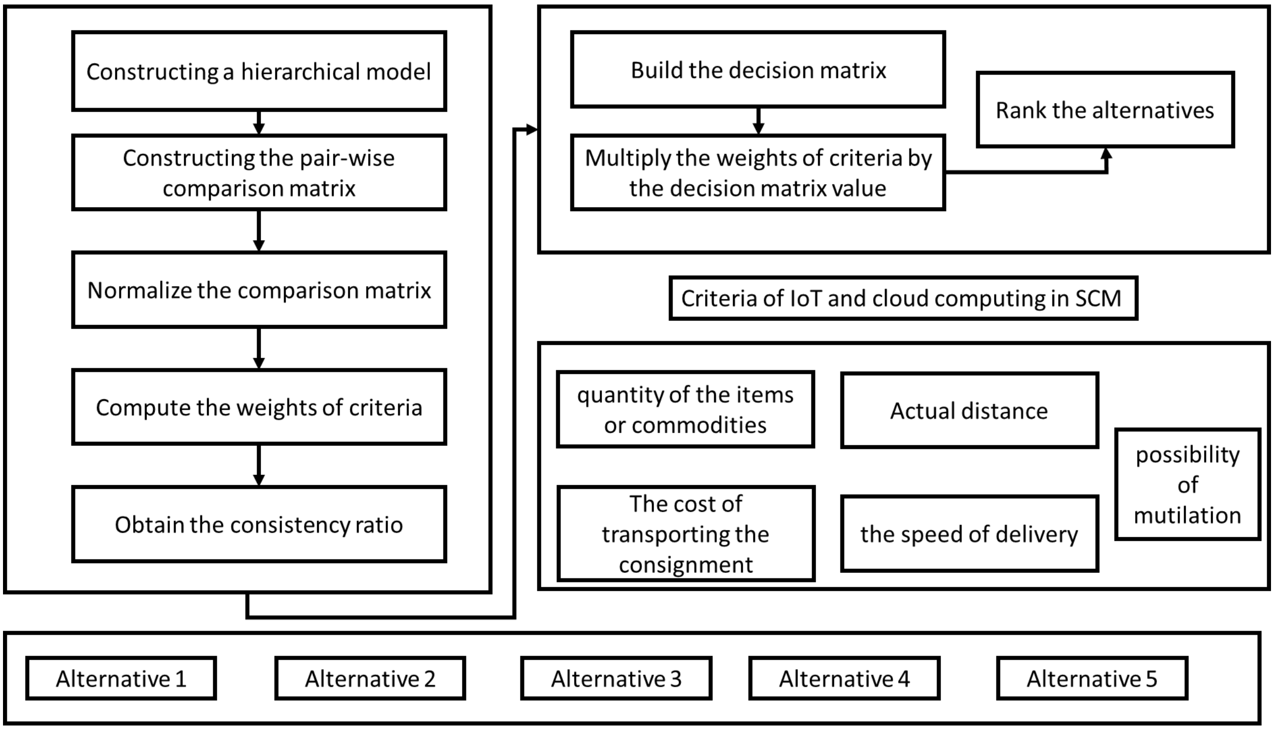

Figure 1: The proposed work.

6. Outcomes

In this section, we apply the methodology to compute the weights of criteria and rank the alternatives. The AHP method used to compute the weights of criteria. Then it used to rank and select best alternatives. First, Constructing a hierarchical model of the MCDM issue is the first step. Define the main problem, and collect criteria and alternatives. The criteria and alternatives are organized as follows: Customers are responsible for decoupling the criteria of the transporters to appropriately rank them, and this is done so that the supplier may choose the transporter with the highest rating when the time comes for transportation. The following are the conditions that must be met:

1. SCMC1 is the quantity of the items or commodities, measured in kilograms, that the client has requested or placed an order for. All of the goods and commodities that are going to be sent out of this location are of a commercial (sold) character.

2. SCMC2 The cost of transporting the consignment by the particular carrier, which may include both delivery and, in certain instances, collection of the cargo The INR currency is used.

3. SCMC3 ⇒ Actual distance. In this study, all of the prices were derived using domestic shipping scenarios, which means that both the point of origin and the point of destination were located inside India.

4. SCMC4 represents the speed of delivery that the consumer requires, expressed as either expedited delivery or economical shipping.

5. There is a possibility of mutilation (SCMC5). When the risk is borne by the consumer, it is considered to be high. When the risk is carried by the carrier, it is considered to be moderate or low.

As can be seen from the preceding criteria, the first, second, third, and fifth criteria are all concerned with costs; hence, the lower the value, the more favorable the outcome will be. The fourth and last factor is the benefit criterion, and the rule states that the better the outcome, the bigger the value.

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These characteristics have been analyzed in order to identify the transporter that is most suitable for this particular scenario. The phonetic symbols SCMA1, SCMA2, SCMA3, SCMA4, and SCMA5 have been assigned to the properties in corresponding order.

The following criteria are used in the analysis of each case:

1. the number of packets is one.

2. The contents of the package are products or goods, which are referred to as a "book" in this work.

3. Total bill value

4. The amount of national distance traveled was taken into consideration equally for each of the situations.

5. The objective of the shipment is business (sold).

6. Shipping on worth: Transporter Risk.

Then constructing the pair-wise comparison matrix is the second step. There are three experts to evaluate the criteria and alternatives. Then the opinions of experts are aggregated into on matrix by using Eqs. (1,2) as shown in Table 1

Table 1: The pairwise comparison matrix

	SCMC1	SCMC2	SCMC3	SCMC4	SCMC5
SCMC1	1	3.666667	2.666667	6	7.333333
SCMC2	0.316667	1	5.333333	7.333333	3
SCMC3	0.388889	0.214286	1	6	8
SCMC4	0.412037	0.138889	0.178571	1	8
SCMC5	0.136905	0.333333	0.126323	0.125	1

Using Eq. (3) to normalize the pairwise comparison matrix as shown in table 2.

Table 2: The normalization pairwise comparison matrix

	SCMC1	SCMC2	SCMC3	SCMC4	SCMC5
SCMC1	0.443558	0.684952	0.286588	0.293279	0.268293
SCMC2	0.14046	0.186805	0.573175	0.358452	0.109756
SCMC3	0.172495	0.04003	0.10747	0.293279	0.292683
SCMC4	0.182762	0.025945	0.019191	0.04888	0.292683
SCMC5	0.060725	0.062268	0.013576	0.00611	0.036585

Then compute the weights of the criteria. Then compute the weights of the criteria by Eq. (4). The weights of the criteria are shown as: w1=0.395, w2=0.273, w3=0.181, w4=0.113, w5=0.035.

Then, obtain the consistency ratio (CR) comparative matrix decision to proceed. Using Eq. (5) to check the opinions of experts are valid or not. If the CR is less than 0.1, then the opinions of experts are valid, so ready to go to the next step.

Within the scope of this study, five distinct scenarios involving various transporter (characteristics) have been taken into consideration. The following are the characteristics:

1. DTDC (SCMA1)

3. Federal Express (SCMA2)

3. The India Postal Service (SCMA3)

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4. Gati (T4) and Gati (SCMA4)

5. DHL (SCMA5)

Then build the decision matrix as shown in table 3.

Table 3: The decision matrix

	SCMC1	SCMC2	SCMC3	SCMC4	SCMC5
SCMA1	4.333333	4	2.666667	6	7.333333
SCMA2	3.333333	3.333333	5.333333	7.333333	3
SCMA3	4.333333	5.333333	2.333333	6	8
SCMA4	5.333333	5	8	5	8
SCMA5	7	7.666667	7.666667	7.666667	4.666667

Then, multiply the weights of criteria by the decision matrix values. Table 4 shows the outcomes by multiplying the weights of the criteria by the decision matrix.

Table 4: The weights decision matrix

	SCMC1	SCMC2	SCMC3	SCMC4	SCMC5
SCMA1	1.713113	1.094919	0.483177	0.683354	0.262922
SCMA2	1.317779	0.912432	0.966354	0.83521	0.107559
SCMA3	1.713113	1.459892	0.42278	0.683354	0.286824
SCMA4	2.108447	1.368648	1.449531	0.569461	0.286824
SCMA5	2.767336	2.098594	1.389134	0.873174	0.167314

Rank the alternatives based on the highest value of the previous step. The rank of alternatives is shown in figure 2, to show the best alternative and worst alternatives.

Figure 2: The oder of options.

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Then, create a comparison between AHP method and other MCDM methods to show the reliable of the AHP method. The comparison between VIKOR and WASPAS methods. Figure 3 shows the comparison of MCDM methods.

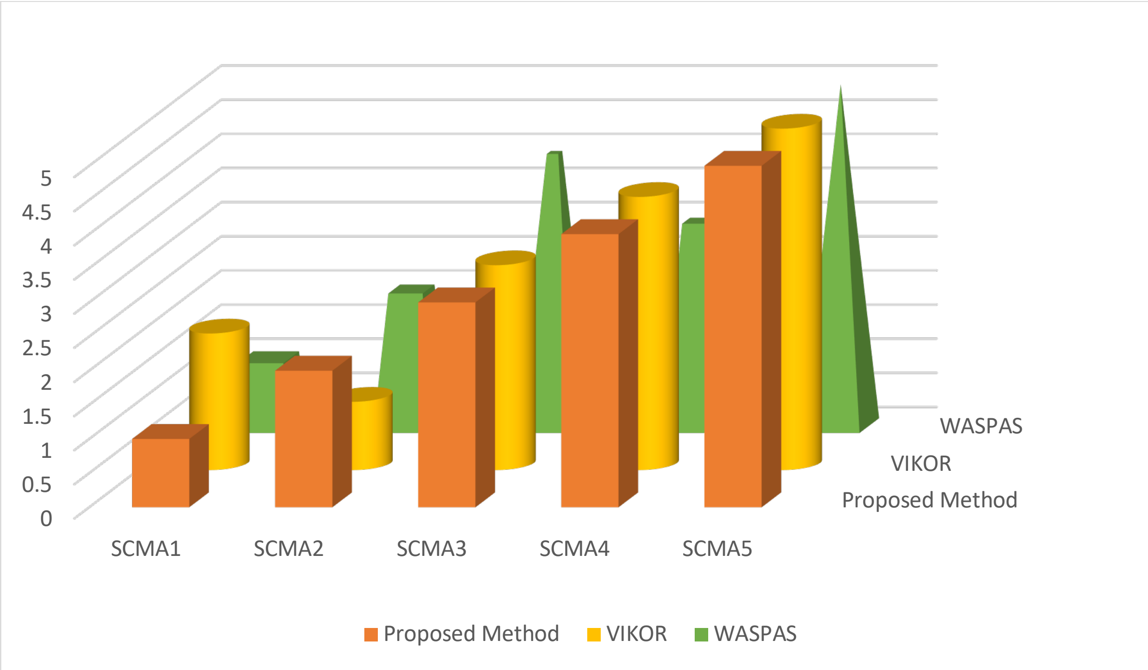

Figure 3: The comparison between MCDM methods.

7. Conclusion

The combination of AHP, the Internet of Things, and cloud computing has the potential to provide management for the improvement of the whole supply chain. From this, the next deductions may be drawn: The authors have focused their efforts on separating the choices of operators via the use of AHP and merging the most favored solution with the cloud environment that already exists. The inclusion of this decoupling point on customer preferences in addition to the amount of stock and safety supply may result in a significant improvement to the service level. The cost of transportation may be optimized by using a ranking of desires according to the weights that are applied on a case-by-case basis. This process will undoubtedly improve customer relationship management (CRM), as the evaluation of transporters was done on the basis of the demand of consumers, as well as time, an appropriate MST can be deduced from the established DAG of being such. This was possible due to the fact that the evaluation of transporters was done based on the preferences of customers. Adjustments to derived MSTs can be made in accordance with real-time needs.

References

[1] R. Katoch, "IoT research in supply chain management and logistics: A bibliometric analysis using vosviewer software," *Materials Today: Proceedings*, vol. 56, pp. 2505–2515, 2022.

[2] W. C. Tan and M. S. Sidhu, "Review of RFID and IoT integration in supply chain management," *Operations Research Perspectives*, p. 100229, 2022.

[3] N. Singh, A. Charak, M. Tyagi, and R. S. Walia, "Effect of IoT in Supply Chain Management—A Review," *Recent Advances in Operations Management Applications*, pp. 283–297, 2022.

[4] Y. Khan, M. B. M. Su'ud, M. M. Alam, S. F. Ahmad, A. Y. A. B. Ahmad, and N. Khan, "Application of Internet of Things (IoT) in Sustainable Supply Chain Management," *Sustainability*, vol. 15, no. 1, p. 694, 2022.

[5] M. Ben-Daya, E. Hassini, and Z. Bahroun, "A conceptual framework for understanding the impact of internet of things on supply chain management," *Operations and Supply Chain Management: An International Journal*, vol. 15, no. 2, pp. 251–268, 2022.

Doi: https://doi.org/10.54216/JISIoT.070203

Received: May 27, 2022 Accepted: December 21, 2022

[6] S. M. Nagarajan, G. G. Deverajan, P. Chatterjee, W. Alnumay, and V. Muthukumaran, "Integration of IoT based routing process for food supply chain management in sustainable smart cities," *Sustainable Cities and Society*, vol. 76, p. 103448, 2022.
[7] K. Lee, P. Romzi, J. Hanaysha, H. Alzoubi, and M. Alshurideh, "Investigating the impact of benefits and challenges of IOT adoption on supply chain performance and organizational performance: An empirical study in Malaysia," *Uncertain Supply Chain Management*, vol. 10, no. 2, pp. 537–550, 2022.
[8] X. Li *et al.*, "Blockchain-enabled IoT-BIM platform for supply chain management in modular construction," *Journal of construction engineering and management*, vol. 148, no. 2, p. 4021195, 2022.
[9] H. Nozari, J. Ghahremani-Nahr, M. Fallah, and A. Szmelter-Jarosz, "Assessment of cyber risks in an IoT-based supply chain using a fuzzy decision-making method," *International Journal of Innovation in Management, Economics and Social Sciences*, vol. 2, no. 1, 2022.
[10] O. Boutkhoum, M. Hanine, T. Agouti, and A. Tikniouine, "A decision-making approach based on fuzzy AHP-TOPSIS methodology for selecting the appropriate cloud solution to manage big data projects," *International Journal of System Assurance Engineering and Management*, vol. 8, no. 2, pp. 1237–1253, 2017.
[11] D. Prajapati, Y. Daultani, N. Cheikhrouhou, and S. Pratap, "Identification and ranking of key factors impacting efficiency of Indian shipping logistics sector," *Opsearch*, vol. 57, no. 3, pp. 765–786, 2020.
[12] M. A. El Sayed, I. A. Baky, and P. Singh, "A modified TOPSIS approach for solving stochastic fuzzy multi-level multi-objective fractional decision making problem," *Opsearch*, vol. 57, no. 4, pp. 1374–1403, 2020.
[13] Shereen Zaki,Mahmoud M. Ismail,Mahmoud M. Ibrahim, Optimizing Supply Chain Management with Retail Analysis Technique, Journal of American Journal of Business and Operations Research, Vol. 2 , No. 2 , (2021) : 82-88 (Doi : https://doi.org/10.54216/AJBOR.020202)
[14] Irina V. Pustokhina, Blockchain technology in the international supply chains, Journal of International Journal of Wireless and Ad Hoc Communication, Vol. 1 , No. 1 , (2020) : 16-25 (Doi : https://doi.org/10.54216/IJWAC.010103)
[15] Mahmoud Ismail,Shereen Zaki,Mahmoud Ibrahim, An analytical approach for evaluating sustainable supply chain solutions during the COVID-19 pandemic: Benefits and better explanations, Journal of Journal of Cybersecurity and Information Management, Vol. 6 , No. 2 , (2021) : 108-117 (Doi : https://doi.org/10.54216/JCIM.060204)
[16] A. F. Velani, V. S. Narwane, and B. B. Gardas, "Contribution of Internet of things in water supply chain management: A bibliometric and content analysis," *Journal of Modelling in Management*, 2022.
[17] S. Meena and T. Girija, "A Conceptual Study In Understanding The Impact Of Internet Of Things Towards Supply Chain Management," *Journal of Positive School Psychology*, pp. 2763–2767, 2022.
[18] R. Ashima, A. Haleem, S. Bahl, D. Nandan, and M. Javaid, "Automation of AM Via IoT Towards Implementation of e-logistics in Supply Chain for Industry 4.0," in *Recent Advances in Mechanical Engineering*, Springer, 2023, pp. 181–189.
[19] R. Behl and S. Dhir, "Role of IOT in Supply Chain Innovation: A Survey Analysis," in *2022 International Mobile and Embedded Technology Conference (MECON)*, 2022, pp. 33–36.
[20] A. S. M. T. Hasan, S. Sabah, R. U. Haque, A. Daria, A. Rasool, and Q. Jiang, "Towards Convergence of IoT and Blockchain for Secure Supply Chain Transaction," *Symmetry*, vol. 14, no. 1, p. 64, 2022.
[21] P. K. Marhavilas, M. Filippidis, G. K. Koulinas, and D. E. Koulouriotis, "Safety-assessment by hybridizing the MCDM/AHP & HAZOP-DMRA techniques through safety's level colored maps: Implementation in a petrochemical industry," *Alexandria Engineering Journal*, vol. 61, no. 9, pp. 6959–6977, 2022.
[22] Mona Mohamed, Enhancement Operations Management in Supply Chain based on Intelligent Support Techniques: A Case study., Journal of American Journal of Business and Operations Research, Vol. 2 , No. 2 , (2021) : 73-81 (Doi : https://doi.org/10.54216/AJBOR.020201)
[23] J. Gyani, A. Ahmed, and M. A. Haq, "MCDM and various prioritization methods in AHP for CSS: A comprehensive review," *IEEE Access*, 2022.

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