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Research Article

Implementation of Sustainable Supply Chain Management considering Barriers and Hybrid Multiple-Criteria Decision Analysis in the Healthcare Industry

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This research aims to find the barriers that affect the implementation of sustainable supply chain management (SSCM) and rank them using hybrid multiple-criteria decision analysis (MCDA) methods in the healthcare industry. As companies seek to earn revenue by providing goods or services to customers, they must also consider social responsibility, economics, and the environment as other multiple external factors. One of the most crucial factors is the company's stewardship of the environment, but economic factors must be regarded when keeping the environment clean by balancing the economic situation to make a profit. This study extracts the barriers to implementing SSCM from previous studies, adapts these barriers to the healthcare industry, and ranks them using a hybrid best-worst method (BWM) and combined compromise solution (CoCoSo) method. The result indicates that hospital 7 should rank SSCM higher than the other six healthcare centers evaluated. Moreover, among the barriers, high disposal costs is the most crucial factor when considering implementing SSCM.

1. Introduction

Healthcare is one of the most significant industries that play a critical role in life. It is also a crucial factor in assessing a country's level of development [1]. The healthcare industry can help people survive illnesses, and it can be a source of profit for a country in terms of attracting healthcare tourism [2]. Even though healthcare is one of the most significant sources of pollutant materials for the environment, recycling such materials requires large budgets and unique processes [3]. However, providing materials for hospitals and healthcare centers is very important [4]. A delay in delivering critical materials and facilities to these centers translates into multiple deaths [5]. Hence, implementing supply chain management (SCM) with a protected environment at a fair profit is an arduous task.

SCM is converting raw materials into final goods or services delivered to end-users, encompassing procurement, processing, inventory, shipping, etc [6]. Designing the best approach for these activities decreases production costs and increases customer satisfaction [7]. The SCM process consists of many parts, each having a crucial role in delivering the best result [8]. Many other relevant concepts have emerged after the SCM concept such as green SCM, fourth-party logistics (4PL), third-party logistics (3PL), etc. One such concept is sustainable SCM (SSCM), which is closely

related to green SCM. Whereas green SCM focuses on environmental issues only; SSCM, in addition to environmental issues, encompasses substantial other problems such as economics [9]. Hence, SSCM is a more developed and complex approach than green SCM.

SSCM has many barriers to implementation in the real world [10]. However, companies are challenged to design improvement programs to eliminate these barriers because of limited resources in terms of human resources (HR), financial issues, information, time, etc. Therefore, first and foremost, barriers must be identified. Second, barriers must be customized according to the research environment and then ranked to find each barrier's degree of importance. Many methods have been used for ranking factors. One of the most popular and valuable methods is multi-criteria decision analysis (MCDA). In this study, the best-worst method (BWM) and the combined compromise solution (CoCoSo) method will be applied to rank both the barriers and the hospitals to find which hospitals need to give more attention to implementing SSCM.

The contribution of this research is the combination of BWM and CoCoSo methods to rank barriers to implementing sustainable supply chain management (SSCM) in the healthcare industry. Although ranking barriers to SSCM is one of the most popular topics among researchers, using a combination of BWM and CoCoSo is a novel approach to implementing SSCM in the healthcare industry. The next section will describe the reasons for combining these methods.

The research questions of this study are as follows:

RQ1. What are the barriers to implementing SSCM in the healthcare industry?

RQ2. What are the weights of these customized barriers?

RQ3. Which of these hospitals must put a focus on eliminating SSCM barriers?

The rest of the study is organized as follows: Section 2 gives the literature review. Section 3 describes the research methodology, while Section 4 consists of the data analysis. The final section covers the conclusion and managerial implementation.

2. Literature Review

SSCM seeks to protect the environment, but implementing this method and other methods faces many barriers. Hence, many studies have been done to learn how to mitigate these barriers.

Regarding the implementation of SSCM, Paul et al. [11] did a review study about using MCDA in SSCM. Their study lists which kinds of MCDA methods have been applied in SSCM. Kouhizadeh et al. [12] explored the barriers to using blockchain in SSCM and found 21 barriers categorized into technological context; organizational context; environmental context from an SCM standpoint; environmental context from an external perspective; and then the relationship among these methods was identified according to the decision-making trial and evaluation laboratory (DEMATEL) method. The result indicated that supply chain and technology were the most significant barriers to using blockchain in implementing SSCM. Moktadri et al. [13] modelled the relationship of barriers to SSCM in the leather industry using Grey-DEMATEL. They found 35 barriers to implementing SSCM in the leather industry in Bangladesh. The relationship between these barriers was then identified using the DEMATEL method in an uncertain environment (Grey method). The result suggested that the largest barriers included (a) lack of awareness of local customers in green products and (b) lack of commitment from top management. Moreover, the most common barriers were the lack of reverse logistic practices and outdated machinery. Yadav et al. [14] designed a model to eliminate barriers to SSCM in an Industry 4.0 environment in the automobile industry. First, the barriers to SSCM were extracted then they were ranked based on Elimination and Choice Expressing Reality (ELECTRE) and BWM, both MCDA methods. The results indicated that among 28 barriers, the highest were lack of budget, technology, and HR; conflict between free trade and the product sustainability policy; provisions; and a penurious commitment from management to adopting sustainability. Then, using Industry 4.0, they sought to find a solution to tackling these barriers among 22 solutions. The best solutions were the companying adopting the 6 Rs, lifecycle analysis and environmental product design, and automation of supply chain activities. Paliwal et al. [15] undertook a review of previous studies using blockchain in SSCM. They classified related research into eight categories.

Kumar et al. [16] designed the SSCM method according to Industry 4.0. In this research, the primary barriers to implementing SSCM are extracted and then the barriers are ranked based on ELECTRE and the Analytical Hierarchy Process (AHP). The result indicated that ineffective strategies combined with a lack of funds were the most significant barriers. Torkabadi et al. [17] implemented hybrid MCDM (multiple-criteria decision-making) methods for improving SSCM. The study, which focuses on sustainable production and consumption in terms of SSCM and its barriers, used a fuzzy analytical network process (FANP) to rank these barriers with the most significant barrier being the organization dimension. Gardas et al. [18] evaluated SSCM in the oil and gas industry. This research identified the SSCM factors that affected business operating performance using the ISM method. The results indicated which of these factors affected the others. Gupta et al. [19] illustrated how to cope with barriers to implement SSCM and used BWM for ranking these barriers. Their results suggested that a lack of expertise, "lack of R&D capabilities," "commitment to use traditional technology," "high priority to investment in the latest technology," and "fear of loss of flexibility and over workload" were the most critical factors. Delmonic et al. [20] evaluated barriers to the implementation of SSCM in emerging economies. The study showed that organizational culture was the most crucial factor. Sanchez-Flores et al. [21] carried out a literature review of SSCM in emerging

economies and evaluated 56 papers from 2010 to 2020, compiling and organizing the relevant factors.

Moheimani et al. [22] studied hospital preparation when they faced the COVID-19 disaster by rough set. They evaluated 25 hospitals in Tehran and showed how these hospitals could cope with this disaster by using fit rules. Sarkar and Sana [23] used a data mining method to predict disease in the healthcare industry. By using two-step DSS, the best prognosis for these diseases is obtained. The result pointed out that this model can predict the illnesses for initial diagnosis. Moheimani et al. [24] evaluated agile hospitals whenever they faced disaster by using interval type-2 fuzzy. In this study, the relationship between agile and disaster management is evaluated according to four agile steps for hospitals. The result indicated which hospital is agile whenever it is faced with disaster.

Table 1 shows the method employed in previous studies.

2.1. Research Gap. Although many papers about ranking barriers to SSCM implementation have been published using MCDA methods both in certainty and uncertainty environments, this study sought to use the hybrid MCDA methods with high accuracy and reliability. Hence, the BWM and CoCoSo methods were combined to form a hybrid MCDA method with high accuracy and reliability. The healthcare industry is one that disposes dangerous substances into the environment, while destroying or recycling used hospital equipment is very hard and costly. Therefore, SSCM is crucial for the hospital in the environment as equipment must be provided for all patients. Hence, balancing between SSCM and providing equipment for the patient is essential. This research demonstrates that hospitals must focus on that to not only implement SSCM, but also provide all necessary patient equipment and afterwards recycle or destroy them without harmful effects on the environment. As Table 1 implies, no paper has been published about ranking barriers to SSCM using these two methods, especially in healthcare industries. Some DMs were selected for answering the questionnaires. These DMs have expertise in the hospital subjects and training and in SSCM, so these DMs can answer these questionnaires accurately. Some of the drawbacks of the Analytical Hierarchy Process (AHP) methods, such as less pairwise and increased model accuracy, have been removed by BWM. Moreover, BWM is more user-friendly than other families such as AHP, Analytical Network Process (ANP), etc.

Most of the MCDA methods generate a single result such as the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), VIekriterijumsko KOmpromisno Rangiranje (VIKOR), multi-objective optimization based on ratio analysis (MOORA), and multiple objective optimization based on ratio analysis plus full multiplicative form (MULTIMOORA). However, one of the crucial advantages of using the CoCoSo method is that the result generates three aggregate rankings, which leads to increased accuracy and reliability [25].

Table 1: Previous studies.

Author(s)	Methods
[12]	DEMATEL
[13]	Grey-DEMATEL
[14]	ELECTRE-BWM
[16]	ELECTRE-AHP
[17]	Fuzzy-ANP
[18]	ISM
[19]	BWM
This research	CoCoSo-BWM

Table 2: Barriers to implementing SSCM.

Author(s)	Barriers
[28, 29]	Lack of legislation
[30]	Lack of strategy
[31, 32]	Lack of highly skilled workforce
[33, 34]	Organizational culture
[35, 36]	Lack of management support
[32, 34]	Lack of training
[37, 38]	Lack of sustainability awareness
[39, 40]	High cost of sustainability
[41, 42]	High disposal cost
[43, 44]	Limitation of knowledge
[34, 45]	Lack of waste management technology
[32, 34]	Lack of sustainable supplier

Table 3: DM composition.

DMs	Education	Years of experience
DM1	PhD	27
DM2	PhD	25
DM3	MSc	29
DM4	PhD	31
DM5	MSc	26
DM6	MSc	27
DM7	PhD	28

3. Research Methodology

3.1. MCDA Techniques

3.1.1. Best-Worst Method. The BWM method is a kind of MCDA method that ranks factors according to pairwise comparison. This method is the invention of Rezaei [26]. The computation of this method involves several steps:

Step 1. The criteria and alternatives of the model (C) are found as follows:

$$C = \{c_1, c_2, \ldots, c_n\}. \quad (1)$$

Step 2. The best criterion is identified and denoted as B. Then, this criterion is compared with the rest of the criteria according to a 1–9 scale. The preferences of the best criterion B are indicated as $A_B = (a_{B1}, a_{B2}, \ldots, a_{Bn})$. The criterion of a_{BB} is 1.

Step 3. The worst criterion is denoted as W. This criterion is compared with the other criteria according to a

Table 4: Screening the barriers to SSCM.

	DM1	DM2	DM3	DM4	DM5	DM6	DM7	Average	Result
Lack of legislation	5	5	5	4	4	5	4	4.57	Accepted
Lack of strategy	3	4	4	3	3	4	5	3.71	Rejected
Lack of highly skilled workforce	4	5	5	4	3	4	5	4.28	Accepted
Organizational culture	4	4	3	3	4		5	3.83	Rejected
Lack of management support	5	5	5	4	4	3	4	4.28	Accepted
Lack of training	3	3	4	3	5	3	4	3.57	Rejected
Lack of sustainability awareness	5	5	5	4	4	3	4	4.28	Accepted
High cost of sustainability	4	4	5	5	4	3	4	4.14	Accepted
High disposal cost	4	4	4	5	5	3	4	4.14	Accepted
Limitation of knowledge	5	5	4	4	3	4	5	4.28	Accepted
Lack of waste management technology	4	4	5	5	5	5	3	4.42	Accepted
Lack of sustainable supplier	3	4	5	4	5	3	4	4	Accepted

1–9 scale. The worst preference of the worst criterion is indicated as $A_w = (a_{w1}, a_{w2}, \ldots, a_{wn})$. The a_{ww} is 1.

Step 4. Weights (W) are obtained per the following formula, which are $(W_1^*, W_2^*, \ldots, W_n^*)$.

The maximum absolute differences $|w_B/w_j - a_{Bj}|$ and $|w_j/w_w - a_{wj}|$ such as the ratio of weights related to best relative preferences are minimized for all j, while n shows the number of iterations and j demonstrates the number of criteria. The following equation shows this computation [26]:

$$\min \max_j \left\{ \left| \frac{w_B}{w_j} - a_{Bj} \right|, \left| \frac{w_j}{w_w} - a_{wj} \right| \right\}. \tag{2}$$

Subject to

$$\sum_j w_j = 1, w_j \geq 0, \text{for all } j. \tag{3}$$

The following is another form of equation (3) [25]:

$$\max_j \left\{ \left| w_B/w_j - a_{Bj} \right|, \left| w_j/w_w - a_{wj} \right| \right\} \tag{4}$$

$$\min \xi$$

Subject to

$$\left| \frac{w_B}{w_j} - a_{Bj} \right| \leq \xi \text{ for all } j,$$

$$\left| \frac{w_j}{w_w} - a_{wj} \right| \leq \xi \text{ for all } j, \tag{5}$$

$$\sum_j w_j = 1, w_j \geq 0 \text{ for all } j.$$

3.1.2. CoCoSo Method. The combined compromise solution (CoCoSo) method is one of the MCDA methods that uses a decision matrix for computation data. This model consists of two kinds of MCDA methods:

(i) Simple additive weighting (SAW) and

(ii) Exponentially weighted product (EWP) [27].

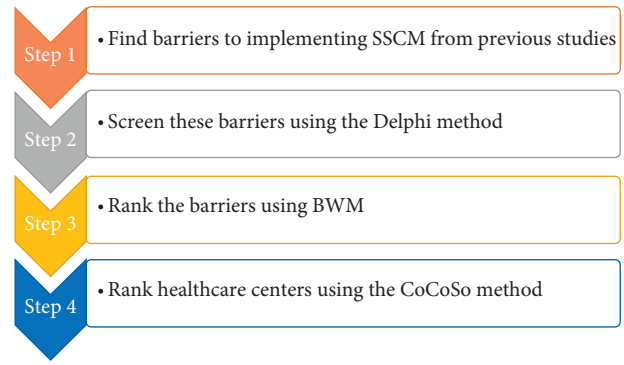

Figure 1: Research methodology procedure.

The steps of the CoCoSo method are as follows:

Step 1:

Create decision matrix

$$x_{ij} = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix}. \tag{6}$$

x_{ij} is the preference of a DM for criterion j to alternative i.

Step 2:

Normalize the decision matrix according to the following equations:

$$r_{ij} = \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}, \tag{7}$$

$$r_{ij} = \frac{\max_i x_{ij} - x_{ij}}{\max_i x_{ij} - \min_i x_{ij}}. \tag{8}$$

Step 3:

Compute the sum of the sequences of weighted comparability (Si) and the power-weighted comparability sequence (Pi) for each estimated alternative: w_j is weights of criteria obtained from BWM.

Table 5: Preferences of DMs for best criterion.

Best	Lack of legislation	Lack of highly skilled workforce	Lack of management support	Lack of sustainability awareness	High cost of sustainability	High disposal cost	Limitation of knowledge	Lack of waste management technology	Lack of sustainable supplier
High disposal cost	9	8	9	7	9	1	8	8	9

$$S_i = \sum_{j=1}^{n} \left(w_j r_{ij}\right). \tag{9}$$

$$P_i = \sum_{j-1}^{n} \left(r_{ij}\right)^{w_j}. \tag{10}$$

Step 4:

Compute the similar weights of the alternatives:

Use three aggregate evaluation scores to produce relative performance scores for the other options, which are as follows:

$$k_{ia} = \frac{P_i + S_i}{\sum_{i=1}^{m} \left(P_i + S_i\right)}, \tag{11}$$

$$k_{ib} = \frac{S_i}{S_i} + \frac{P_i}{P_i}, \tag{12}$$

$$k_{ic} = \frac{\lambda\left(S_i\right) + (1-\lambda)\left(P_i\right)}{\left(\lambda S_i + (1-\lambda)P_i\right)}, \quad 0 \ll \lambda \ll 1. \tag{13}$$

Equation (11) expresses the arithmetic mean of the sum of the weighted product model (WPM) and weighted sum model (WSM) scores. Meanwhile in (12), the best alternative shows the sum of the relative WPM and WSM scores. Also, a balanced/accurate compromise score of the WPM and WSM models is computed in equation (13). Also, in Equation (13), λ (the threshold $\lambda = 0.5$) ranges from 0 to 1, as selected by the decision-maker.

Step 5:

The ranking of the alternatives is calculated based on k_{i} values.

The rank of alternatives k_{i} is demonstrated below [27].

$$k_i = \left(k_{ia} k_{ib} k_{ic}\right)^{1/3} + \frac{1}{3}\left(k_{ia} + k_{ib} + k_{ic}\right). \tag{14}$$

3.2. Barriers to Implementing SSCM and Its Customization. According to previous studies, the barriers to implementing SSCM are as listed in Table 2:

3.3. Customized Barriers. Many methods have been used for screening factors. One of these methods is the Delphi method for screening factors according to the DM's viewpoint. For the preliminary screening, the questionnaire was designed according to these barriers. The questionnaires were distributed among DMs who have the best knowledge about this subject. The appropriate number of DMs is a matter of dispute among academics. Some in the scientific community believe that this number must be between 5 and 15, while others believe that this number must be more than 100. In this research, the number of DMs is seven. These DMs are not only specialists about hospital procedures, but they also have implemented many SCM projects in the healthcare industry and spent more than 100 hours in most of the SCM fields such as SSCM.

Table 6: Preferences of DMs for worst criterion.

Weakest barrier	Ranking
Lack of legislation	4
Lack of highly skilled workforce	6
Lack of management support	4
Lack of sustainability awareness	7
High cost of sustainability	7
High disposal cost	8
Limitation of knowledge	5
Lack of waste management technology	4
Lack of sustainable supplier	1

The DM information is tabulated in Table 3.

Then a related questionnaire according to the 5-point Likert scale was distributed among the DMs. If the average score equaled four or more, the factor was accepted, otherwise it was rejected. The results of the screening variables are shown in Table 4.

The result shows that only three of the twelve obstacles were eliminated with nine remaining.

3.4. Research Procedure. We adopted the following procedure in this research:

Step 1: The barriers related to implementing SSCM are compiled from previous studies.

Step 2: The barriers are screened using the Delphi method.

Step 3: The customized barriers are ranked by BWM.

Step 4: Seven healthcare centers are organized to implement SSCM using the CoCoSo method. Figure 1 shows this procedure.

4. Data Analysis

First, the barriers are ranked using the BWM. In this method, the best criterion is selected. This criterion is then

Table 7: Final weights.

	Lack of legislation	Lack of highly skilled workforce	Lack of management support	Lack of sustainability awareness	High cost of sustainability	High disposal cost	Limitation of knowledge	Lack of waste management technology	Lack of sustainable supplier
Weights	0.068	0.077	0.068	0.088	0.068	0.443	0.077	0.077	0.034

Table 8: Initial matrix.

Weights of criteria	0.0682095	0.07673569	0.0682095	0.08769793	0.0682095	0.443361754	0.076736	0.076736	0.034105
	−1	−1	−1	−1	−1	−1	−1	−1	−1
Kind of criteria	Lack of legislation	Lack of highly skilled workforce	Lack of management support	Lack of sustainability awareness	High cost of sustainability	High disposal cost	Limitation of knowledge	Lack of waste management technology	Lack of sustainable supplier
*A*1	9.29	5.91	6.76	9.39	6.29	6.22	6.17	9.27	6.57
*A*2	6.08	6.18	6.83	9.29	6.43	9.76	6.62	5.94	7.09
*A*3	9.07	9.05	7.36	5.72	5.5	9.77	9.45	7.72	7.66
*A*4	8.49	9.79	5.23	6.05	9.49	7.35	5.64	8.68	6.28
*A*5	9.58	6.4	6.93	7.47	8.48	6.29	7.51	5.1	6.38
*A*6	9.09	8.24	9.08	7.55	8.42	7.61	9.81	9.66	6.1
*A*7	5.62	9.61	5.1	8.97	7.1	6.86	7.57	5.54	5.6
Max	9.58	9.79	9.08	9.39	9.49	9.77	9.81	9.66	7.66
Min	5.62	5.91	5.1	5.72	5.5	6.22	5.64	5.1	5.6

Table 9: Normalized matrix.

Weights of criteria	0.068	0.076	0.068	0.087	0.068	0.44	0.07	0.07	0.03
	−1	−1	−1	−1	−1	−1	−1	−1	−1
Kind of criteria	Lack of legislation	Lack of highly skilled workforce	Lack of management support	Lack of sustainability awareness	High cost of sustainability	High disposal cost	Limitation of knowledge	Lack of waste management technology	Lack of sustainable supplier
*A*1	0.0732	1.0000	0.5829	0.0000	0.8020	1.0000	0.8729	0.0855	0.5291
*A*2	0.8838	0.9304	0.5653	0.0272	0.7669	0.0028	0.7650	0.8158	0.2767
*A*3	0.1288	0.1907	0.4322	1.0000	1.0000	0.0000	0.0863	0.4254	0.0000
*A*4	0.2753	0.0000	0.9673	0.9101	0.0000	0.6817	1.0000	0.2149	0.6699
*A*5	0.0000	0.8737	0.5402	0.5232	0.2531	0.9803	0.5516	1.0000	0.6214
*A*6	0.1237	0.3995	0.0000	0.5014	0.2682	0.6085	0.0000	0.0000	0.7573
*A*7	1.0000	0.0464	1.0000	0.1144	0.5990	0.8197	0.5372	0.9035	1.0000

compared with the other criteria according to DM preferences. The DMs ascribe their preferences using a 9-point Likert scale. The top criterion is "high disposal cost." The mode of DM answer is used for calculation in BWM for reaching only one answer. After finding the mode of the answer, the result informs all DMs to confirm them. Table 5 shows the preferences of DMs regarding the best criterion.

The weakest criterion is "lack of sustainable suppliers." Table 6 shows the preferences of DMs regarding the worst criteria, and Table 7 points out the final weights.

The result shows the ranking and weights of each criterion. These weights were obtained according to equations (3)–(5).

High disposal cost > lack of sustainability awareness, high cost of sustainability > lack of highly skilled workforce > limitation of knowledge > lack of waste management technology, lack of legislation, lack of management support > lack of sustainable supplier.

Moreover, the inconsistency rate of this computation was 0.17. The best ratio for the accepted inconsistency rate is less than 0.18, which this research was included in this range.

The CoCoSo method was then used to rank these seven healthcare systems.

First, an initial matrix was created according to Table 8. This matrix was created according to DM preferences who ascribed scores from 1 to 10. The average scores show the final preferences (equation (6))

The normalized matrix shown in Table 9 was created according to equations (7) and (8).

Weighted comparability sequence and Si are demonstrated in Table 10 according to equation (9).

Exponentially weighted comparability sequence and Pi are displayed in Table 11 based on equation (10).

Table 10: Weighted comparability sequence.

	Lack of legislation	Lack of highly skilled workforce	Lack of management support	Lack of sustainability awareness	High cost of sustainability	High disposal cost	Limitation of knowledge	Lack of waste management technology	Lack of sustainable supplier
*A*1	0.0050	0.0767	0.0398	0.0000	0.0547	0.4434	0.0670	0.0066	0.0180
*A*2	0.0603	0.0714	0.0386	0.0024	0.0523	0.0012	0.0587	0.0626	0.0094
*A*3	0.0088	0.0146	0.0295	0.0877	0.0682	0.0000	0.0066	0.0326	0.0000
*A*4	0.0188	0.0000	0.0660	0.0798	0.0000	0.3022	0.0767	0.0165	0.0228
*A*5	0.0000	0.0670	0.0368	0.0459	0.0173	0.4346	0.0423	0.0767	0.0212
*A*6	0.0084	0.0307	0.0000	0.0440	0.0183	0.2698	0.0000	0.0000	0.0258
*A*7	0.0682	0.0036	0.0682	0.0100	0.0409	0.3634	0.0412	0.0693	0.0341

Table 11: Exponentially weighted comparability sequence.

	Lack of legislation	Lack of highly skilled workforce	Lack of management support	Lack of sustainability awareness	High cost of sustainability	High disposal cost	Limitation of knowledge	Lack of waste management technology	Lack of sustainable supplier
*A*1	0.8367	1.0000	0.9639	0.0000	0.9851	1.0000	0.9896	0.8280	0.9785
*A*2	0.9916	0.9945	0.9618	0.7291	0.9821	0.0740	0.9797	0.9845	0.9571
*A*3	0.8695	0.8806	0.9444	1.0000	1.0000	0.0000	0.8286	0.9365	0.0000
*A*4	0.9158	0.0000	0.9977	0.9918	0.0000	0.8438	1.0000	0.8887	0.9864
*A*5	0.0000	0.9897	0.9589	0.9448	0.9105	0.9912	0.9554	1.0000	0.9839
*A*6	0.8672	0.9320	0.0000	0.9412	0.9141	0.8023	0.0000	0.0000	0.9906
*A*7	1.0000	0.7901	1.0000	0.8269	0.9656	0.9156	0.9534	0.9922	1.0000

Table 12: Final weight.

Alternatives	*KA*	Ranking	*KB*	Ranking	*KC*	Ranking	*K*	*K*	Final ranking
*A*1	0.1545	3	4.2585	3	0.9028	3	2.6125	2.6125	**3**
*A*2	0.1492	4	2.8439	5	0.8721	4	2.0064	2.0064	**5**
*A*3	0.1250	6	2.1858	7	0.7302	6	1.5979	1.5979	**7**
*A*4	0.1343	5	3.5656	4	0.7846	5	2.2163	2.2163	**4**
*A*5	0.1579	2	4.4105	1	0.9228	2	2.6933	2.6933	**2**
*A*6	0.1089	7	2.6001	6	0.6362	7	1.6798	1.6798	**6**
*A*7	0.1703	1	4.3676	2	0.9953	1	2.7491	2.7491	**1**

Table 13: Sensitivity analysis.

Lambda	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
*A*1	3	3	3	3	3	3	3	3	3
*A*2	5	5	5	5	5	5	5	5	5
*A*3	7	7	7	7	7	7	7	7	7
*A*4	4	4	4	4	4	4	4	4	4
*A*5	2	2	2	2	2	2	2	2	2
*A*6	6	6	6	6	6	6	6	6	6
*A*7	1	1	1	1	1	1	1	1	1

The final weights are shown in Table 12. Lambda is 0.5. The final weights were found according to equations (11)–(14).

4.1. Sensitivity Analysis. In this section, the different Lambda amounts were ranked from 0.1 to 0.9 to find whether this change affected the result. Table 13 shows the sensitive analysis of the result.

The result of this sensitivity analysis suggested that with different Lambda amounts, between 0.1 and 0.9, all responses are the same as each other.

5. Conclusion and Managerial Implementation

SSCM has a critical role in industries. Many companies are eager to implement SSCM whether arbitrarily or by legal force. Additionally, other vital factors such as customer sentiment force them to adopt SSCM. The method advanced in this work considers all comprehensive factors such as environment, economics, and society for implementing SCM. However, implementing SSCM is not a trivial task as there are many barriers to SSCM and therefore companies must cope with all of them. Unfortunately, none of the companies can directly access resources such as HR, budget, etc., so they must first rank these factors and then, according to their priority, design improvement projects to eliminate them. This study sought to do so in the healthcare industry, which is an industry that significantly pollutes the environment, thus hospitals must allocate more of their budget to process these materials, including seeking ways to increase revenues to tackle the lack of funding. Additional funding must be allocated to develop their departments, acquire new technology to treat disease, and help the poor with affordable

health treatment pricing or free of charge, so this contradiction surrounding the implementation of SSCM must be balanced. The two research questions tackled in this research are outlined in the introduction.

First, related barriers are compiled from previous studies to address the first question. Twelve factors have been extracted for addressing this question of earlier research, but these factors must be customized. The Delphi method, which is used in this research, helps customize these factors. Using this method showed that nine of them were accepted among these factors and three were rejected. The second research question sought to find which of the seven hospitals had the implementation of SSCM as its highest priority, which was achieved using CoCoSo and BWM. First, all customized barriers are weighted using BWM, a model with several advantages compared to the AHP method. Among these barriers, high disposal costs was given the highest priority, which means that hospitals must pay more attention to this factor. Then, seven healthcare industries are ranked using CoCoSo. The result of ranking hospitals by the CoCoSo method demonstrated that hospital 7 must focus on implementing SSCM. This method has the advantage over other similar techniques in that the result is obtained in just three stages.

This study demonstrated a road map for the healthcare industry to implement SSCM. This industry is critical because it directly impacts people's lives. Healthcare is a hybrid industry because it must focus on earning revenue while still respecting environmental issues. Hence, the implementation of SSCM is vital for this industry. The limitation of this research is that the DMs who contributed to this research are doctors and head nurses and unfamiliar with MCDA methods. For future research, researchers could investigate an uncertain environment using a variety of kinds of fuzzy numbers such as Pythagorean, hesitant, and so on.

Data Availability

Data available on request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] J. Dai and R. Menhas, "Sustainable development goals, sports and physical activity: the localization of health-related sustainable development goals through sports in China: a narrative review," *Risk Management and Healthcare Policy*, vol. 13, 2020.

[2] Y. Mahendradhata, "Proceed with caution: potential challenges and risks of developing healthcare tourism in Indonesia," *Global Public Health*, vol. 14, no. 3, pp. 340–350, 2019.

[3] G. Gautam, K. Khanal, and T. Bondurant, "An analysis of the health sector functions of all three levels of government as per Functional Analysis and Assignments and relevant policies," 2020.

[4] B. A. Jnr, "Use of telemedicine and virtual care for remote treatment in response to COVID-19 pandemic," *Journal of Medical Systems*, vol. 44, no. 7, 2020.

[5] M. I. K. Sk, B. Paswan, A. Anand, and N. A. Mondal, "Praying until death: revisiting three delays model to contextualize the socio-cultural factors associated with maternal deaths in a region with high prevalence of eclampsia in India," *BMC Pregnancy and Childbirth*, vol. 19, no. 1, 2019.

[6] A. Karbassi Yazdi, P. F. Wanke, T. Hanne, and E. Bottani, "A decision-support approach under uncertainty for evaluating reverse logistics capabilities of healthcare providers in Iran," *Journal of Enterprise Information Management*, vol. 33, no. 5, pp. 991–1022, 2020.

[7] A. Karbassi Yazdi, F. M. Muneeb, P. F. Wanke, O. Figueiredo, and I. Mushtaq, "Critical success factors for competitive advantage in Iranian pharmaceutical companies: a comprehensive MCDM approach," *Mathematical Problems in Engineering*, vol. 2021, Article ID 8846808, 17 pages, 2021.

[8] H. M. Alzoubi and R. Yanamandra, "Investigating the mediating role of information sharing strategy on agile supply chain," *Uncertain Supply Chain Management*, vol. 8, pp. 273–284, 2020.

[9] A. K. Yazdi, Y. J. Wang, and A. R. Komijan, "Green supply chain management in an emerging economy: prioritizing critical success factors using grey-permutation and genetic algorithm," *International Journal of Logistics Systems and Management*, vol. 35, no. 1, p. 1, 2020.

[10] J. Heidary Dahooie, A. Zamani Babgohari, I. Meidutė-Kavaliauskienė, and K. Govindan, "Prioritising sustainable supply chain management practices by their impact on multiple interacting barriers," *The International Journal of Sustainable Development and World Ecology*, vol. 28, no. 3, pp. 267–290, 2021.

[11] A. Paul, N. Shukla, S. K. Paul, and A. Trianni, "Sustainable supply chain management and multi-criteria decision-making methods: a systematic review," *Sustainability*, vol. 13, no. 13, 2021.

[12] M. Kouhizadeh, S. Saberi, and J. Sarkis, "Blockchain technology and the sustainable supply chain: theoretically exploring adoption barriers," *International Journal of Production Economics*, vol. 231, Article ID 107831, 2021.

[13] M. A. Moktadir, S. M. Ali, R. Rajesh, and S. K. Paul, "Modeling the interrelationships among barriers to sustainable supply chain management in leather industry," *Journal of Cleaner Production*, vol. 181, pp. 631–651, 2018.

[14] G. Yadav, S. Luthra, S. K. Jakhar, S. K. Mangla, and D. P. Rai, "A framework to overcome sustainable supply chain challenges through solution measures of industry 4.0 and circular economy: an automotive case," *Journal of Cleaner Production*, vol. 254, Article ID 120112, 2020.

[15] V. Paliwal, S. Chandra, and S. Sharma, "Blockchain technology for sustainable supply chain management: a systematic literature review and a classification framework," *Sustainability*, vol. 12, no. 18, 2020.

[16] P. Kumar, R. K. Singh, and V. Kumar, "Managing supply chains for sustainable operations in the era of industry 4.0 and circular economy: analysis of barriers," *Resources, Conservation and Recycling*, vol. 164, Article ID 105215, 2021.

[17] A. M. Torkabadi, E. Pourjavad, and R. V. Mayorga, "An integrated fuzzy MCDM approach to improve sustainable consumption and production trends in supply chain," *Sustainable Production and Consumption*, vol. 16, pp. 99–109, 2018.

[18] B. B. Gardas, R. D. Raut, and B. Narkhede, "Determinants of sustainable supply chain management: a case study from the oil and gas supply chain," *Sustainable Production and Consumption*, vol. 17, pp. 241–253, 2019.

[19] H. Gupta, S. Kusi-Sarpong, and J. Rezaei, "Barriers and overcoming strategies to supply chain sustainability innovation," *Resources, Conservation and Recycling*, vol. 161, Article ID 104819, 2020.

[20] D. Delmonico, C. J. C. Jabbour, S. C. F. Pereira, A. B. L. de Sousa Jabbour, D. W. S. Renwick, and A. M. T. Thomé, "Unveiling barriers to sustainable public procurement in emerging economies: evidence from a leading sustainable supply chain initiative in Latin America," *Resources, Conservation and Recycling*, vol. 134, pp. 70–79, 2018.

[21] R. B. Sánchez-Flores, S. E. Cruz-Sotelo, S. Ojeda-Benitez, and M. E. Ramírez-Barreto, "Sustainable supply chain management—a literature review on emerging economies," *Sustainability*, vol. 12, no. 17, 2020.

[22] A. Moheimani, R. Sheikh, S. M. H. Hosseini, and S. S. Sana, "Assessing the preparedness of hospitals facing disasters using the rough set theory: guidelines for more preparedness to cope with the COVID-19," *International Journal of Systems Science: Operations & Logistics*, pp. 1–16, 2021.

[23] B. K. Sarkar and S. S. Sana, "An e-healthcare system for disease prediction using hybrid data mining technique," *Journal of Modelling in Management*, vol. 14, no. 3, pp. 628–661, 2019.

[24] A. Moheimani, R. Sheikh, S. M. H. Hosseini, and S. S. Sana, "Assessing the agility of hospitals in disaster management: application of interval type-2 fuzzy Flowsort inference system," *Soft Computing*, vol. 25, no. 5, pp. 3955–3974, 2021.

[25] X. Mi and H. Liao, "Renewable energy investments by a combined compromise solution method with stochastic information," *Journal of Cleaner Production*, vol. 276, Article ID 123351, 2020.

[26] J. Rezaei, "Best-worst multi-criteria decision-making method," *Omega*, vol. 53, pp. 49–57, 2015.

[27] M. Yazdani, P. Zarate, E. K. Zavadskas, and Z. Turskis, "A Combined Compromise Solution (CoCoSo) method for multi-criteria decision-making problems," *Management Decision*, vol. 57, 2019.

[28] F. S. Abdulgader, R. Eid, and B. Daneshvar Rouyendegh, "Development of decision support model for selecting a maintenance plan using a fuzzy MCDM approach: a theoretical framework," *Applied Computational Intelligence and Soft Computing*, vol. 2018, Article ID 9346945, 14 pages, 2018.

[29] S. S. Kamble, A. Gunasekaran, and S. A. Gawankar, "Achieving sustainable performance in a data-driven agriculture supply chain: a review for research and applications," *International Journal of Production Economics*, vol. 219, pp. 179–194, 2020.

[30] R. M. Vanalle, G. M. D. Ganga, M. Godinho Filho, and W. C. Lucato, "Green supply chain management: an investigation of pressures, practices, and performance within the Brazilian automotive supply chain," *Journal of Cleaner Production*, vol. 151, pp. 250–259, 2017.

[31] N. Oelze, "Sustainable supply chain management implementation–enablers and barriers in the textile industry," *Sustainability*, vol. 9, no. 8, 2017.

[32] A. B. Patel and T. N. Desai, "A systematic review and meta-analysis of recent developments in sustainable supply chain management," *International Journal of Logistics Research and Applications*, vol. 22, no. 4, pp. 349–370, 2019.

[33] K. Fantazy and S. A. A. Tipu, "Exploring the relationships of the culture of competitiveness and knowledge development to sustainable supply chain management and organizational performance," *Journal of Enterprise Information Management*, vol. 32, no. 6, pp. 936–963, 2019.

[34] M. H. Islam, M. R. Sarker, M. I. Hossain, K. Ali, and K. M. A. Noor, "Towards sustainable supply chain management (SSCM): a case of leather industry," *Journal of Operations and Strategic Planning*, vol. 3, no. 1, pp. 81–98, 2020.

[35] O. Narimissa, A. K. Farahani, and S. M. A. Zavardehi, "Drivers and barriers for implementation and improvement of sustainable supply chain management," *Sustainable Development*, vol. 28, no. 1, pp. 247–258, 2020.

[36] W. Muchaendepi, C. Mbowa, J. Kanyepe, and M. Mutingi, "Challenges faced by the mining sector in implementing sustainable supply chain management in Zimbabwe," *Procedia Manufacturing*, vol. 33, pp. 493–500, 2019.

[37] M. Gong, Y. Gao, L. Koh, C. Sutcliffe, and J. Cullen, "The role of customer awareness in promoting firm sustainability and sustainable supply chain management," *International Journal of Production Economics*, vol. 217, pp. 88–96, 2019.

[38] K. Jermsittiparsert, W. Joemsittiprasert, and S. Phonwattana, "Mediating role of sustainability capability in determining sustainable supply chain management in tourism industry of Thailand," *International Journal of Supply Chain Management*, vol. 8, no. 3, pp. 47–58, 2019.

[39] I. Tamayo-Torres, L. Gutierrez-Gutierrez, and A. Ruiz-Moreno, "Boosting sustainability and financial performance: the role of supply chain controversies," *International Journal of Production Research*, vol. 57, no. 11, pp. 3719–3734, 2019.

[40] J. Wang, Y. Zhang, and M. Goh, "Moderating the role of firm size in sustainable performance improvement through sustainable supply chain management," *Sustainability*, vol. 10, no. 5, p. 1654, 2018.

[41] C. Khandelwal and M. K. Barua, "Modelling the barriers to implement SSCM in Indian plastic manufacturing sector," *International Journal of Business Excellence*, vol. 1, no. 1, 2019.

[42] İ. Erol and V. M. Nurtaniş, "An investigation into sustainable supply chain management practices in a developing country," *International Journal of eBusiness and eGovernment Studies*, vol. 11, no. 2, pp. 104–118, 2019.

[43] R. Mehdikhani and C. Valmohammadi, "Strategic collaboration and sustainable supply chain management: the mediating role of internal and external knowledge sharing," *Journal of Enterprise Information Management*, vol. 32, no. 5, pp. 778–806, 2019.

[44] L. Marques, "Sustainable supply network management: a systematic literature review from a knowledge perspective," *International Journal of Productivity and Performance Management*, vol. 68, no. 6, pp. 1164–1190, 2019.

[45] B. D. Azevedo, L. F. Scavarda, and R. G. G. Caiado, "Urban solid waste management in developing countries from the sustainable supply chain management perspective: a case study of Brazil's largest slum," *Journal of Cleaner Production*, vol. 233, pp. 1377–1386, 2019.