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ORIGINAL RESEARCH

Fuzzy assisted human resource management for supply chain management issues

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Abstract
In addition, weights for criterion and links between dimensions and criteria were obtained using the Decision-making trial and evaluation laboratory and fuzzy analytical hierarchy process. Both methods can be combined since they serve various goals; earlier studies proposed using three-way type-1 fuzzy sets to achieve criteria weights and linkages across dimensions and criteria. The topics of HRM and Operation Management , respectively, include human resource management (HRM) and supply chain management (SCM). Although academics in each sector continue to advance SCM and HRM's role in developing more sustainable companies, integrating these two modern topics has been significantly delayed based on a more significant integration gap between HRM and SCM and fuzzy. The findings suggest that the educational criterion is more important than the other criteria since it is a cause and affects HRM directly. The research findings show that the suggested F-HRM-SCM technique is feasible, suggesting the educational criterion as the most persuasive factor in human resources management. Therefore, the study aims to provide the HRM-SCM connection with a synergistic and inclusive framework and suggest the research agenda for this integration. After achieving these aims, this paper highlights the consequences of fuzzy HRM-SCM integration in organizational sustainability and genuinely sustainable supply chains for academics, managers, and practitioners. The experimental results demonstrate that the proposed F-HRM-SCM model enhances the supply chain performance ratio of 98.9%, an efficiency ratio of 97.8%, employee satisfaction ratio of 96.7%, decision-making level by 98.2%, prediction ratio of 95.5%, and F1-score ratio of 97.4% compared to other existing approaches.

Keywords Human resource management · Supply chain · Fuzzy · Analytic hierarchy process

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1 Overview of human resource management for supply chain management

Supply Chain Management is the progress of expansion, development, execution, and monitoring of the supply chain processes professionally utilizing Information and Technology in their stride (Khudhair et al., 2020). SCM encompasses all operations beginning with raw material procurements, storages, work-in-process inventories, and completed items, i.e., from point-of-consumption and point-of-origin, guaranteeing organizational productivity while satisfying customer demands and pleasing the customer (Manogaran et al., 2020). Human resources ethics violations can lead to a wide range of legal issues, both civil and criminal, for both the company and its employees. BBB, Equal Employment Opportunity Commission, and other regulatory agencies receive a higher number of complaints from victims of ethics violations in the HR department than others (such as product development or accounting). Discrimination and hostile-work-environment issues can be avoided by companies with comprehensive ethics programs in place. This means lower costs for both litigation and settlements. Simultaneously, due to growing globalization, competition, privatization, liberalization, commoditization, and technological advancements, SCs have grown extremely complex (Malik et al., 2020). Despite the awareness that properly managing the Supply Chain may give a critical competitive benefit, there appears to be a lack of recognition that this element is dependent on human capital performance in the supply chain (Kumar et al., 2020). The value of a worker's experience and skills is called human capital. A company's human capital includes assets like education and training and intelligence, skills, and health. An intangible asset or quality not listed on a company's balance sheet is an "intangible asset." Increased productivity and profitability are linked to human capital. The more a company invests in its employees, the more likely it is to be successful and productive.

Human resource management that is effective and strategic may provide an equally solid foundation for competitive benefit, and very little of this knowledge has been applied to managing a team and training and developing people in the SC (Ramprasad & Amudha, 2014). Deliberately managing HR in the SC necessitates HR configurations and updated HR development aligned with the larger corporate strategy (Öztürk & Yildizbaşi, 2020). The company's involvement in HR development is required to enhance employee performance and control employee comfort and job satisfaction (Amudha, 2021). Competent Human Resource Management (HRM) and its tried-and-true techniques such as job design, recruiting, selecting and orienting, performance management, pay, training, and development may instill a sense of drive toward well-organized and successful work management (Gheisari et al., 2021). The data triangle is the foundation of the term quality employed in the organizational setting. In strategic HR management, HR department plays the main role and has a durable impact in strategic decision at the managerial level. Human resource management at the micro level (human resource practices and policies) is essential and not adequate for companies to gain a sustainable competitive benefit (Billah et al., 2021). To stand strong in the face of competition, businesses must adopt a strategic method to human resource management. Everything that makes a product, from raw materials to finished goods, is considered part of supply chain management. Maximizing customer value and gaining a competitive edge in the marketplace involves actively streamlining a company's supply-side activities.

The success or failure of a company is unlikely to be completely determined by its strategic HRM practices; nonetheless, these practices are possible to be critical to the cause. (Raut et al., 2020). The first round of evaluation between the employee and their manager and the second round of evaluation between their managers and their bosses before the third round. The HR

manager is included in the third round, the employee is not. Fuzzy logic-based systems and models can be found ubiquitously in our everyday life. Therefore, fuzzy set theories entice more and more attention (Nguyen et al., 2021). In fuzzy set theory, operators can use the assumed data to describe membership function to portray a component with fuzzy subsets (Khan et al., 2021). On every occasion the output and input parameters are known, it can utilize training information to design a rules base to system behavior of the to-be-controlled model (Ngan et al., 2019). Users can relate some methods to regulating the fuzzy system to acceptable efficiency (Muñoz-Pascual et al., 2020). Therefore, the analytical hierarchy process is prolonged by integrating the fundamental concepts of fuzzy sets theory (Manogaran et al., 2021). This technique is commonly known as the fuzzy AHP. The fuzzy AHP has been established, in which the pair-wise comparisons in the decision matrices are fuzzy numbers (Krishnan et al., 2021). The judgments are assessed systematically via subjective ratings like 'among three and five times less significant and 'roughly three times more essential (Asghar et al., 2021). The decision-makers are provided the power to choose the linguistic parameter that reproduces their confidence (Li et al., 2021). The fuzzy analytical hierarchy process employs fuzzy arithmetics and fuzzy aggregation operators to resolve the hierarchical structure of issues (Ezhilmaran & Adhiyaman, 2016). The fuzzy analytical hierarchy process calculation is done as per the normal analytical hierarchy process technique for weighting the criteria of decision issues in human resource management and supply chain management (Manickam & Devarasan, 2018).

The major contribution of the article is.

- Designing the F-HRM-SCM model to analyze the key factors in establishing supply chain management.
- Evaluating the mathematical model of AHP and type-1 fuzzy sets to achieve criteria weights and linkages across dimensions and criteria.
- The simulation results have been accomplished, and the recommended model enhances the supply chain performance and decision-making ratio compared to other models.

The rest of the study is arranged as follows: Sect. 2 discusses the background study of supply chain management. In Sect. 3, the F-HRM-SCM model has been recommended. In Sect. 4, simulation results have been performed. Finally, Sect. 5 concludes the research paper.

2 Background study on supply chain management

Anil Kumar et al. (Kumar et al., 2019) suggested a hybrid method of the Best Worst Method and Decision-Making Trial and Evaluation Laboratory (BWM-DEMATEL) for implementing green supply chain management. The GSCM-oriented soft dimensions are prioritized using BWM, and their interrelationships are extracted using DEMATEL. According to the findings, 'Top management commitment,' 'Employee participation,' 'Organizational culture,' and 'Teamwork' are the most highly valued causal soft aspects in effective GSCM implementation. This research would assist industry managers, and practitioners determine where to focus on GSCM principles in the context of soft dimensions for long-term company growth.

Abbas Mardani et al. (Mardani et al., 2020) proposed the Structural Equation Modelling (SEM) for evaluating Green and Sustainable Supply Chain Management. In this article, they recognized and defined, reviewed, and considered the selected article in different essential perspectives, such as application part, research issue and study gap, type of technique, method, study purpose, country of authors, name of variables, related theory, publication

year, unit of analysis, number of samples, hypotheses, and scope, number of instances, name of authors. The results of this review research exposed that earlier works had employed Structural Equation Modelling in green SCM.

Nosheen Anwar et al. (Anwar et al., 2020) discussed the Ability-Motivation-Opportunity (AMO) theory for Green Human Resource Management. The goal of this research is first to investigate the impact of Green HRM practices (green competence constructing practices, green motivation improving practices, and green worker participation practices) on the academic workforce's organizational citizenship behavior toward the environment (OCBE) and, as a result, its impact on environmental performance. Secondly, the role of OCBE in mediating the association between each of the Green HRM practices and environmental performance is measured.

Hossein Sayyadi Tooranloo et al. (Li et al., 2020) deliberated the Fuzzy AHP and Fuzzy Type-2 DEMATEL (FAHP-DEMATEL) for sustainable human resource management (SHRM). The current paper aims to identify these elements. Based on existing theoretical underpinnings and expert perspectives, the variables influencing the execution of human resource management were grouped into three types: economic, social, and environmental aspects. Determine the weight of the indicated factors based on their lack of independence. The findings demonstrate that the environmental dimension was one of the effective variables and was regarded as the cause; nevertheless, the social and economic dimensions were influenced and were deemed the consequences. The most relevant elements were those related to the environment.

Based on the survey, there are several existing methods to implement efficient HRM in supply chain management. The design and evaluation of a supply chain's network is a critical and difficult decision. A new method for assessing the efficiency of a supply chain network is presented in this paper. Cost factors are the primary metric, divided into four groups: production costs, disruption costs, coordination costs, and vulnerability costs. In addition, some assumptions are made to quantify these cost factors. When searching for an optimal supply chain network design, numerical analysis demonstrates its efficiency and effectiveness. Hence in this article, the F-HRM-SCM model has been proposed. The following section discusses the suggested model briefly.

3 Fuzzy assisted human resource management for supply chain management (F-HRM-SCM)

Supply chain management oversees goods and services and the processes that turn raw resources into finished items. It entails aggressively streamlining a firm's supply-side operations to optimize consumer value and achieve a competitive advantage in the market. This model's top-level has five distinct operations known as SCM components: Plan, Source, Make, Deliver, and Return. The researchers examined the concept of the supply chain and its control using management indicators, emphasizing operation management and information technology IT systems. However, the relationship between SC and human resource management and employee aspects is still absent. With the shifting perspective of human resource management, more organizations deliberate it as a partner. Sustainable HRM has been seen as a genetic approach to human resources management with the organization's view to be pursued.

In contrast to its minimal involvement with its original development in implementing that strategy, HR aggressively executes a total strategic design. In the changing economic

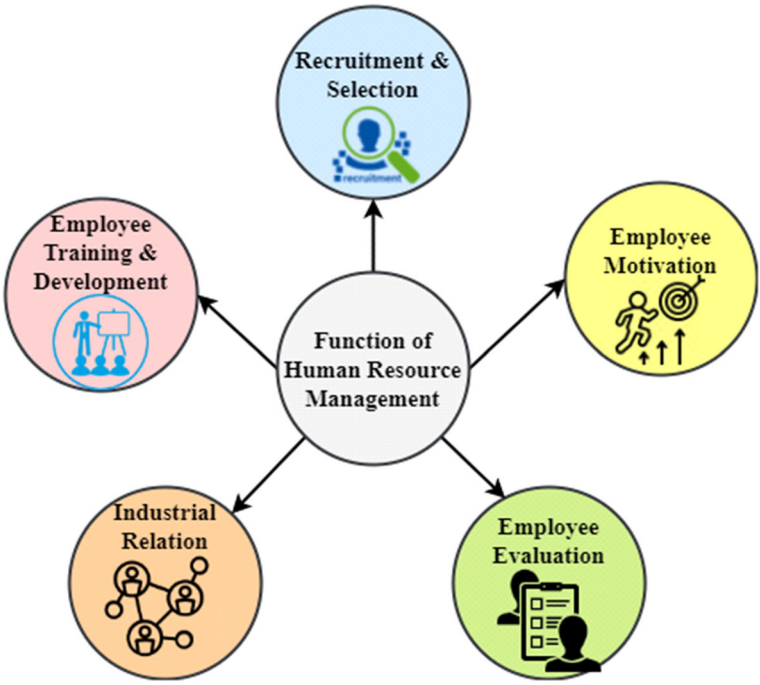

Fig. 1 Function of HRM

circumstances, this must be changed. While HR professionals play an essential role in supporting and promoting the value of human resources throughout the organization, it is the senior human resource executives who must demonstrate this value more insistently. HRD, Executives, and employees must work together to guarantee that the initiatives industrialized and designed by the human resource team are driving business performance and allowing people to accomplish outcomes.

Figure 1 shows the function of HRM. There is a need for considerable attention and resources to attract, recruit and retain skilled, engaged, and motivated staff. This work includes numerous elements: job description, job postings publicity, screening of applications, interviews, bids and wages, and benefits trading. The appropriate group of skilled people can enhance their profile and assist them in reaching profitability to ensure their performance is successful and effective. The HR department provides all workers with on-the-job training and refresher training. The absence of training options raises employee dissatisfaction. Training methods must thus be simplified across all sites to make communication and resource sharing a straightforward process. Another important component of training to promote the development of their new abilities is measurement and monitoring. The practice of measuring employee performance and productivity is performance evaluation or performance evaluation. The evaluation is carried out based on certain preestablished criteria aligned with the organization's objectives. The success or failure of the company is influenced by performance management and an appropriate evaluation of human resources. The success of an organization depends very much on the efficient use of the assessment systems, including a selection of the appropriate evaluation techniques. "Scientific technique" refers to any systematic approach to obtaining scientific information or obtaining a desired product or

material. Techniques of analysis, such as those that reveal the atomic or molecular composition. Techniques for characterizing a material, such as ones that measure a specific property.

Even today, the compensation package, monitoring, and non-traditional perks are the true motivators and the methods by which fresh and talented workers will be attracted and retained. To guarantee improved industrial relations is the continuation of excellent connections and morality between employees, employers, and employers. For the company's continuing survival, compliance with industrial, labor, tax, and employability legislation is important. HR should focus on a government mandate, laws, and policy on employment practice, working conditions, tax allowances, work hours, overtime, break periods, minimum wages, and policies on discrimination, since non-compliance may influence productivity and, ultimately, corporate profitability. Companies seek a distinctive competitive advantage or solutions to meet industrial requirements and regulations.

Data mining is to extract from a huge amount of imperfect, fuzzy, noisy, random information, the procedure of not knowing in progress, and possibly beneficial data and knowledge. Data mining is termed knowledge extraction and mining. In the data mining procedure, data mining processes are the most vital. The data mining model can extract HR data from several databases about the job situation of workers in the company. The most critical roles of human resource management are.

- Management of human resources
- Selection and recruitment
- Management of performance
- Continuing education and advancement
- We are planning for the future of your career
- The evaluation of its functions
- Rewards

3.1 Relations between workers and their employers

Utilizing fuzzy mining models and information extracted from the data warehouse, this study can determine the categories of cadres in the business and identify that a staff belongs to these categories. Since the gathered information are often not the numbers in the secure interval of [0, 1], this raw information must be normalized in real information. Figure 2 shows the proposed F-HRM-SCM model. For instance, there are samples in sample sets, and their mean values are computed as the succeeding formulation:

$$v(j) = \frac{\sum_{j=1}^{m} v_j - 1}{\sum_{j=1}^{m} \left| v_j^2 \right|} \tag{1}$$

Then, compute the standard deviation $W - l$ of this raw information. Then, compute the normalized values v of every data within the locked interval of [0, 1], and the succeeding extreme valuesformulation must be utilized:

$$u(l) = \frac{\sum_{j=1}^{m} v_j - l}{\sum_{j=1}^{m} \left| v_j^2 \right|} \tag{2}$$

A hash-based model has been proposed for effectivelyproducing frequency sets. Over experiments, it can be determined that the majorcomputation for the discovery frequency set is to create frequent 2 item sets. Utilizing this property to initialize hashing methods to

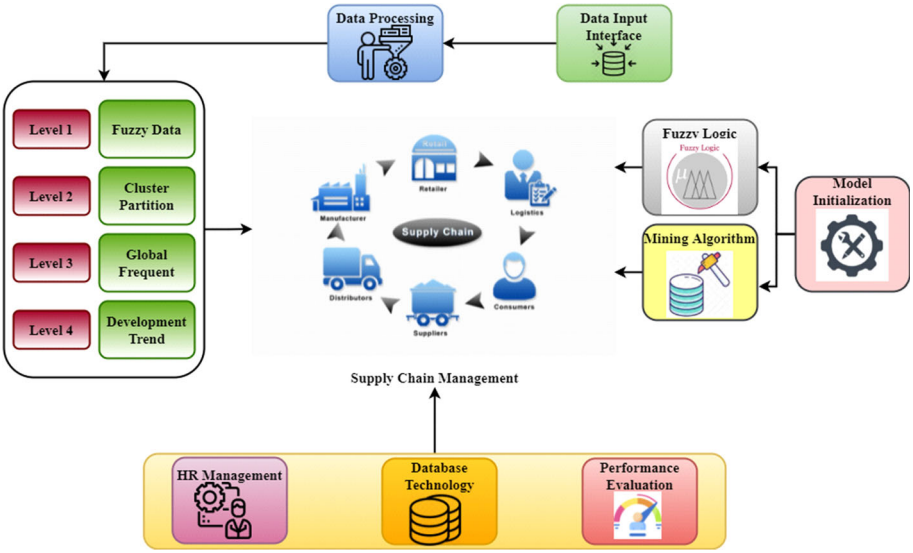

Fig. 2 Proposed F-HRM-SCM model

enhance the technique of producing frequent 2 item sets. The implementation of the modulus resemblanceassociation can be articulated as similarity matrices:

$$w(l) = \lim_{m\to\infty}\sqrt{\frac{1}{m\sum(v(j,l) - v(l))}} \tag{3}$$

Association rule is a generalmethod in association analysis to discover the association between items in the same events. C denotes set of the transaction, where every transaction T indicates a set of items and $T \in K$. Every transaction T has a unique identification TID. If the item set is Y and $y \in T$, it can be said that transaction T consists of Y. An association rule is such a form of relationship: $y \Rightarrow X$, Y, and X are, correspondingly, termed the conclusion and premise of association rules $Y \Rightarrow X$. The support number of item sets y is signified as W. The formulationidentifies whether certain nodes w in T and a node l in v that makes the association rules x exist. If it exists, switch node and alter nodes W to be after nodes q.

$$x(y) = \frac{|v(j,l) - v(l)||w(l)|}{|v(j,l) - v(l)| - |w(l)|} \tag{4}$$

The support degree of item sets y is noted as support (y), where f indicates the number of transactions in transaction sets C, if support (y) is not. If it is less than the minimum support stated by the user, then y denotes frequent itemsets, mentioned as frequency set (or high itemset); otherwise, y indicates infrequent itemsets, denoted as non-frequency set (or small itemset). The item set y has a support degree of support. Suppose there is $sup\%$ transaction support item set y in C. The support degree of the relationship rules $Y \Rightarrow X$ is noted as support; that is, the transactions in C consist of YV Y (both y and X) percentages.

For every mode determined, the mean index is computed, where w indicates the total number of patterns, l denotes the number of histories in the warehouse from which patterns (i.e., j patterns) are derived, and q denotes the overall number of histories from which patternsare

derived.

$$r(j,i) = \frac{\sum \min(v(j,l), v(i,l))}{\sum \max(v(j,l), v(i,l)) + \sum \min(v(j,l), v(i,l))} \tag{5}$$

Gather experts' opinions and build the mean matrix Z: Provided l as a committee member, an $m \times m$ matrix $z^{(e)}$ is shaped for e th experts, which denotes the direct-relation among criteria (m signifies the number of criteria). Everycomponent of this matrix $\left(z_{ji}^{(e)}\right)$ signifies the degree to which the criterion D_j distresses the criterion D_i. The fuzzy matrices Z, which specifies the combined opinions of experts, is determinedusingexpression (6).

$$z_{ji} = \frac{\sum_{e=1}^{l} z_{ji}^{(e)}}{l} \tag{6}$$

Compute the standardizedfirst direct-relation matrices C. The normalized direct-relation matrices $C = \left[c_{ji}\right]$ is shown as follows:

$$C = \begin{bmatrix} c_{11} & c_{12} & \cdots & c_{1m} \\ c_{21} & c_{22} & \cdots & c2m \\ \cdots & \cdots & \cdots & \cdots \\ c_{m1} & c_{m2} & \cdots & c_{mn} \end{bmatrix} \tag{7}$$

Every value of thesematricesis in the range [0, 1] and iscomputed based on expressions (8) and (9).

$$c_{ji} = \frac{z_{ji}}{R} = \left(\frac{z_{ji}{}^{(k)}}{r^{(k)}}, \frac{z_{ji}{}^{(n)}}{r^{(n)}}, \frac{z_{ji}{}^{(r)}}{r^{(r)}}\right) \tag{8}$$

$$R = \max\left(\sum_{i=1}^{m} z_{ji}\right) = \left(r^{(k)}, r^{(n)}, r^{(r)}\right) \tag{9}$$

Compute the overall relation matrices T. The overallrelation matrices T is determined by expression (10).

$$T = \lim_{s\to\infty}\left(C + C^2 + \cdots + C^s\right) = C(1-C)^{-1} \tag{10}$$

Nowmatrices J is $m \times m$ identity matrices. Consequently, the overall relation matrice-saresignified as an expression (11).

$$T = \begin{bmatrix} t_{11} & t_{12} & \cdots & t_{1m} \\ t_{21} & t_{22} & \cdots & t_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ t_{m1} & t_{m2} & \cdots & t_{mn} \end{bmatrix} \tag{11}$$

As shown in Eq. (11) where $t_{ji} = \left(t_{ji}^{(k)}, t_{ji}^{(n)}, t_{ji}^{(r)}\right)$ signifies the indirect possessions of factors j on factors i. Formerly the overall relation matrices T aredefuzzifiedutilizingexpression (12).

$$t_{ji} = \left(t_{ji}^{(k)} + 4 \bullet t_{ji}^{(n)} + t_{ji}^{(r)}\right)/6 \tag{12}$$

Compute the sum of row and column of the matrices T. In this stage, the sum of the row and column of the matrices T, which are signified by R_j and C_j, correspondingly, are

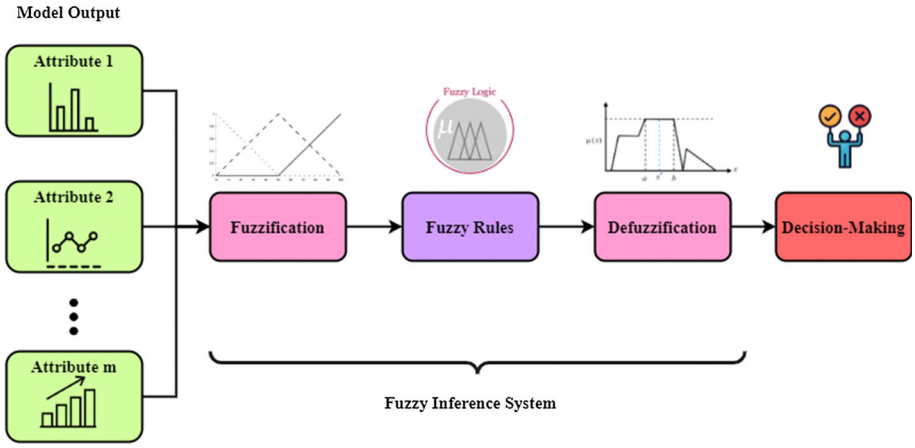

Fig. 3 Fuzzy logic for decision-making

calculatedusing the subsequentexpressions:

$$C_j = \sum_{j=1}^{m} t_{ji} \quad j = 1, 2, \ldots .m \tag{13}$$

$$R_j = \sum_{i=1}^{n} t_{ji} \quad i = 1, 2, \ldots n \tag{14}$$

As inferred from Eqs. (13) and (14), where m and n are the numbers of criteria and alternatives, correspondingly.

Figure 3 shows the fuzzy logic for decision-making. Simulate the values of the attributes over time. This can be completed utilizing stochastic dynamic models. In management, one of the most common examples of making a decision is deciding on production facilities. You will have to increase your production capacity as your business grows and demand increases. Decide how much capacity is needed to meet demand most efficiently.

In the fuzzification stage, convert the anticipated crisp value of attribute into fuzzy one, i.e., membership value of various sets pre-described by experts in line with threshold value based on their subjective judgments. In the inference stage, assess every pre-described rule to execute the reasoning progression. In the defuzzification stage, use the maximum membership standard technique for recognizing the degree of severity of events.

Compute the first weight coefficient of the criteria. The first weight of every criterion is computed on expression (15)

Compute the first weight coefficient of the criteria. The first weight of every criterion is computed on expression (15)

$$S_j = \sqrt{\left(C_j + R_j\right)^2 + \left(C_j - R_j\right)^2} \tag{15}$$

Standardization and computation of the last weight coefficient of the criteria. After identifying the weight of every criterion, the weight isstandardizedby:

$$S_j = \frac{S_j}{\sum_{j=1}^{m} S_j} \tag{16}$$

The last criterion function for the alternativeiscomputed by summing across the rows of the matrices. The alternative is then ranked based on the value determined.

There are several core functions of human resource management that include strategic planning, operational management of employees, recruitment, staffing, etc.

This research conducts an empirical study of the human resource management issue to test the suggested combined technique. In this human resource management assessment, three decision-makers have been invited to assess the criteria and dimensions of the human resource management issue. Employee recruitment, hiring, deployment, and management are part of human resource management (HRM). When it comes to human resources management (HRM), "HR" is frequently used. Managing employees as a company's most valuable resource focus on human resources management (HRM). The causal relationships of accidents in construction are assessed using the fuzzy DEMATEL method. For the subjective and imprecise nature of human judgment, this combination is used. The fuzzy set theory makes use of interval sets rather than real numbers. Fuzzy numbers are used to represent linguistic concepts.

Figure 4 shows the hierarchical structure of HRM and SCM. In the second tier of the hierarchical structure, it can be observed that HRM has three dimensions: input, infrastructures, and output. The third tier of the hierarchy is based around the eight criteria: value, education, collaboration, R&D costs, labor market, intermediate outputs, human capital, and immediate outputs. The pair-wise comparison is built between all criteria in the hierarchy system's dimensions using fuzzy numbers and linguistic parameters.

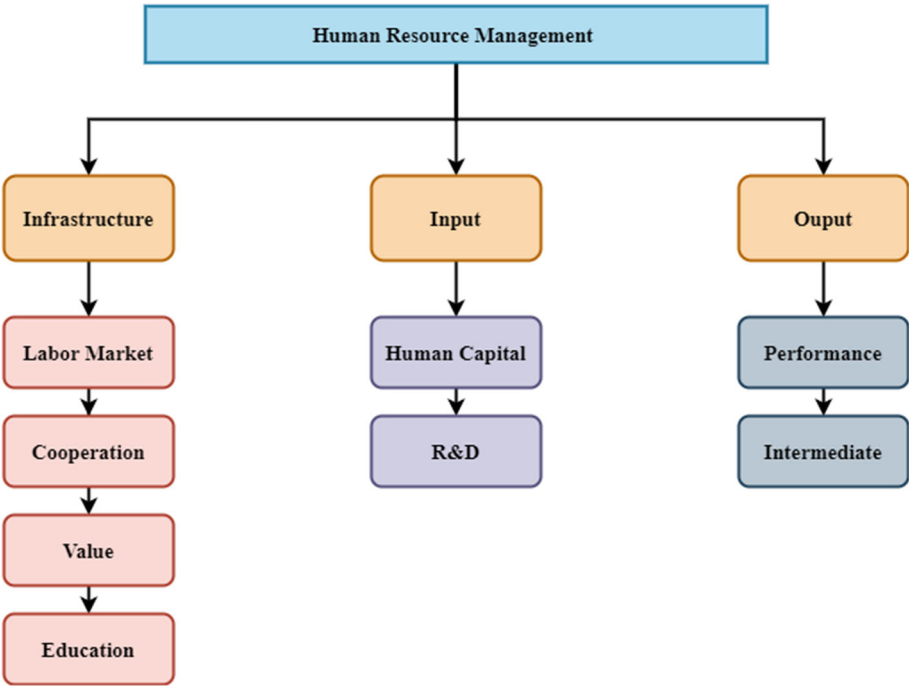

Fig. 4 Hierarchical structure of HRM and SCM

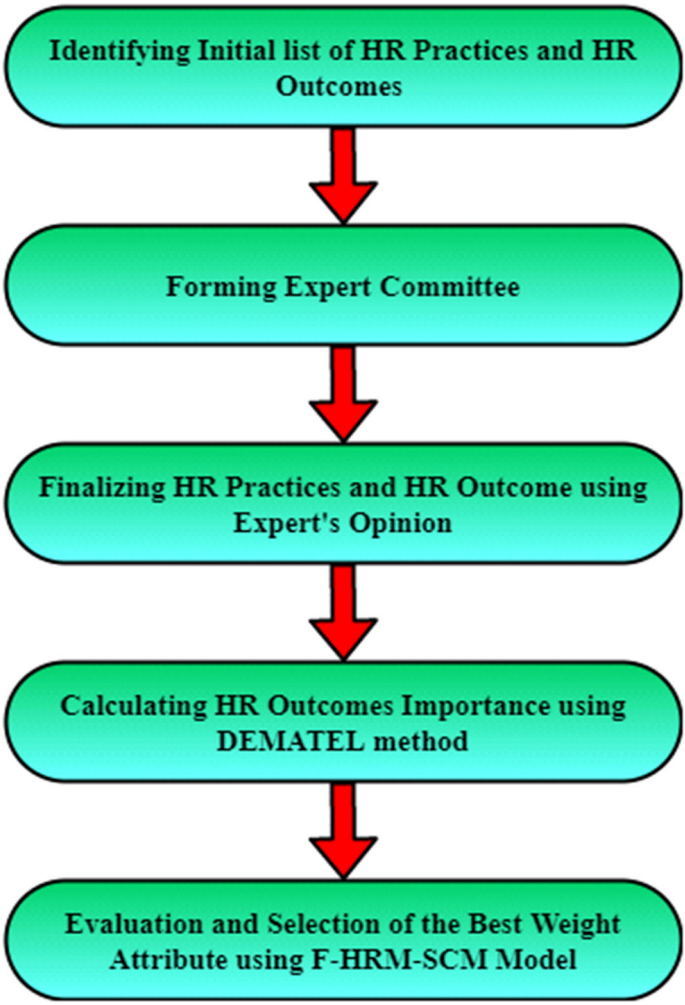

Fig. 5 Flow chart of fuzzy weight criteria evaluation system

Figure 5 shows the flow chart of the fuzzy weight criteria evaluation system. The first list of human resource practices and human resource consequences is first recognized through a literature review. This list is subsequently presented to a human resource committee, which chooses certain human resource results associated with banking sector goals. Contribute to the organization's objectives. Uses and develops human resources most efficiently and effectively possible. Identifies and meets the individual's needs. Maintains a high level of employee morale, to the company's benefit, it provides well-trained and motivated workers. Improves the ability of the employee to do their current job. Inter-team and intra-team collaboration is fostered.

The committee accomplishes this by simulating human resource management key performance indicators (KPI) and incorporating them into decision criteria. Human resource results

are not autonomous and are interconnected. Approaches such as the analytic hierarchy process (AHP), stepwise weight assessment ratio analysis (SWARA), and best–worst method (BWM) are not appropriate for evaluating the relative significance of human resource results and their influence on selection because of this critical issue. The DEMATEL technique has been utilized in this study to determine the criteria weights between the approaches that may consider the connections between the criteria. To that aim, the committee members used their expertise in language factors to identify the connections between the criteria. The criteria were then weighted using the DEMATEL technique. Following that, the committee completed the list of high-performance human resource practices. Human resource management methods and the perspectives of DMs, predominantly board members, have been particularly important in establishing the list. The committee was then requested to explain in linguistic parameters the degree of influence human resource practices have on achieving specific HR objectives based on their specialist expertise of HRM. The F-HRM-SCM technique is used in the following phases to generate alternative scores and rank human resource practices.

In conclusion, the developed model is applied in the supply chain sector. The design and evaluation of a supply chain's network is a critical and difficult decision. A new method for assessing the efficiency of a supply chain network is presented in this paper. Cost factors are the primary metric, divided into four groups: production costs, disruption costs, coordination costs, and vulnerability costs. In addition, some assumptions are made to quantify these cost factors. When searching for an optimal supply chain network design, numerical analysis demonstrates its efficiency and effectiveness. Precisely, the proposed framework serves as decision support tools, and the findings are provided to supply chain industry DMs with a perspective of the rules and limitations they face when selecting the concluding list of high-performance human resource practices and budget distributions. Compared to other popular methods, the proposed F-HRM-SCM model enhances the supply chain performance, efficiency ratio, employee satisfaction ratio, decision-making level, prediction ratio, and F1-score ratio.

3.2 Simulation results and discussion

The experimental result of the suggested F-HRM-SCM model has been performed based on the performance metrics such as supply chain performance, efficiency ratio, employee satisfaction ratio, decision-making level, prediction ratio, and F1-score ratio.

3.3 Supply chain performance ratio

SC Performance denotes the prolonged supply chain's activities in meeting end-client needs, involving on-time delivery, product availability, and every vital inventory and capability in the SC to deliver that performance responsively. Performance of most processes is measured from 5 perspectives: Responsiveness, Reliability, Cost, Flexibility, and Asset. Fuzzy logic is appropriate for dealing with subjectivity and uncertainty, which becomes an interesting auxiliary method to managing the performance of supply chains. A descriptive quantitative method has been adopted as a research technique based on the prediction model. The practical implication of the study can be viewed from the perspective of human resource practices and supply chain controlling for the enhanced business performance matrix. Such a relationship is essential for the business managers and main decision-makers dealing with supply chain management, control, and human resource practices. Furthermore, the value/originality of

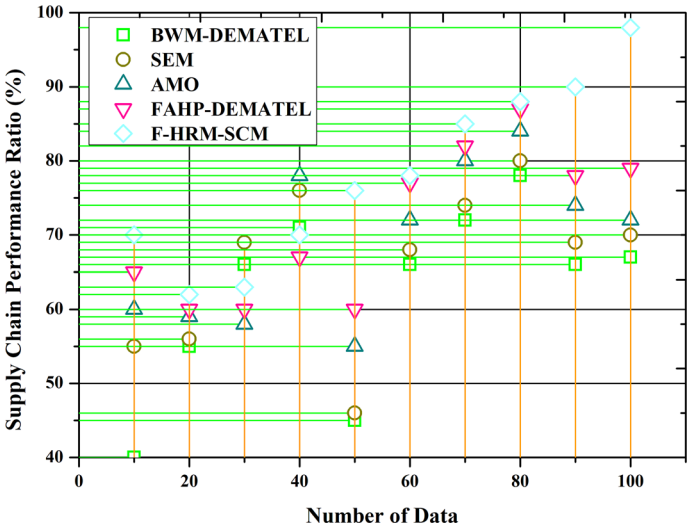

Fig. 6 Supply chain performance ratio

the study can be measured in the sense that it has concentrated on the notion of the interdisciplinary field like supply chain controlling, HRM, and best practices. Figure 6 shows the supply chain performance ratio.

3.4 Efficiency ratio

The notion of direct objectives covers creating a balance between the tasks, management for the controlling and planning, and finally, the employment of information systems. In comparison, the indirect controlling objective consists of the objective system of the business companies, profit, and business effectiveness with liquidity purposes. Evidence denotes that the development of supply chain management ensued from the incorporation of manufacturing and marketing progressions. Natural and clinical sciences research is published in Scientific Reports. According to us, you deserve to have your research published if it's scientifically valid and technically sound. Publish with us, and your research will receive the attention and coverage it deserves. There are many advantages to publishing your work in an open-access journal or journal that publishes your work on an ongoing basis. It's easy to see what people are saying about your work, thanks to Article-Level Metric.

Such incorporation has concentrated performance measurement of supply chain management practices mainly on operational problems, like resource effectiveness and cost decrease, and marketing problems, like consumer service. Internal human resources development to enhance supply chain management practices has yet to be studied formally. Figure 7 demonstrates the efficiency ratio.

3.5 Employee satisfaction ratio

The findings exposed that worker satisfaction is directly influenced by empowerment, training, and compensation and satisfaction; supply chain incorporation mediates between these

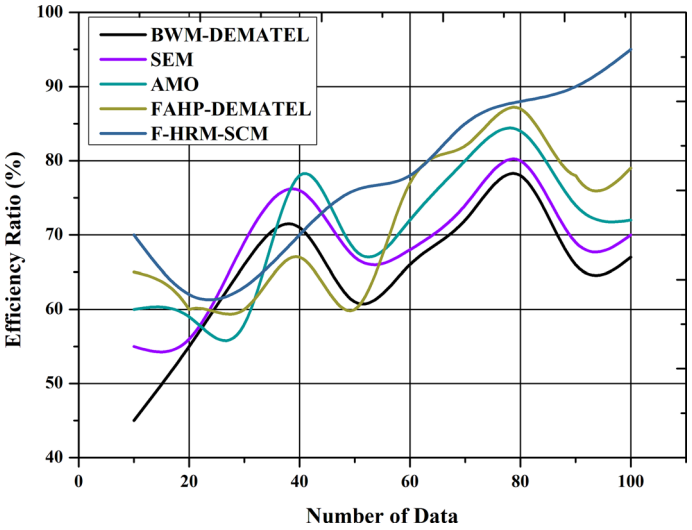

Fig. 7 Efficiency ratio

relationships. The study results are significant for the supply chain practitioners in the supply chain industry in developing policies to improve employee satisfaction via supply chain incorporation and other human resource management practices. Effective communication with satisfied employees is necessary for coordinating material, information, and money to improve firm performance. Research has shown relations between internal communication, employee satisfaction, and organizational communication. Figure 8 illustrates the employee satisfaction ratio.

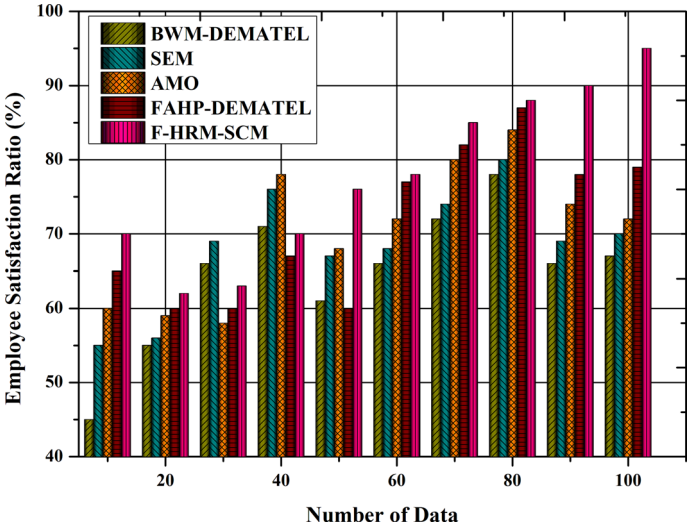

Fig. 8 Employee satisfaction ratio

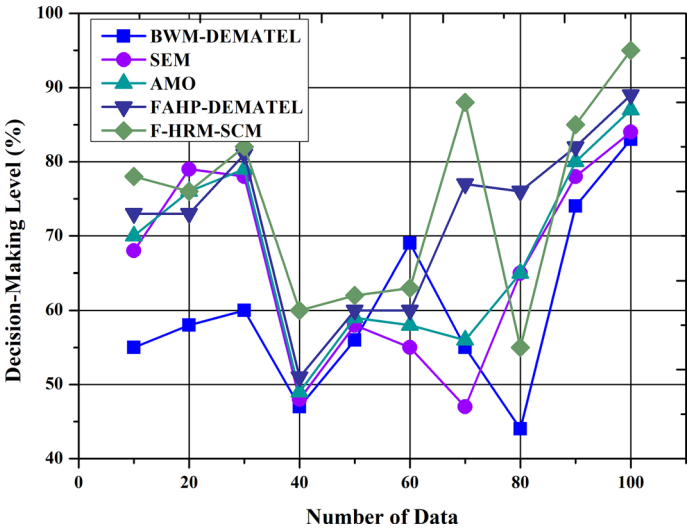

Fig. 9 Decision making level

3.6 Decision making level

For better business management, logistics controls, and supply chain control, there is a great requirement for skill needs for the core employees and department, involving finance, information technology, a human resource which can impact the strategic decisions for the business achievement. Performance measurement is a basic building block of effective companies. It establishes an important component of efficient control, planning, and decision-making by giving stakeholders and decision-makers the essential feedback to determine issues, diagnose them, and design enhancement policies consequently. In the SCM environment, measurement findings reveal the effects of policies and focus on possible opportunities for sustainable advancement. In an attempt to help executives to make helpful directed decisions to enhance the total SC performance. Figure 9 signifies the decision-making level.

3.7 Prediction ratio

Fuzzy technology and data mining can extract information on the human resource conditions of the personnel in the organization from many databases. It aims to help analysts find possible links between information and find ignored components useful in predicting trends and decision-making behavior. It is utilized to detect meaningful relations and links in a large number of data between item sets. Management of human resources faces huge amounts of data and requires technology to determine valuable information. The present model can effectively perform data entry, queries, statistics, or other functions, and the relationships and regulations existing in the data cannot be found. Compensation is one of the main predictors of job satisfaction. Previous research has carried out one study in the supply chain industry, and compensation has been discovered as the main predictor of work satisfaction. Figure 10 displays the prediction ratio.

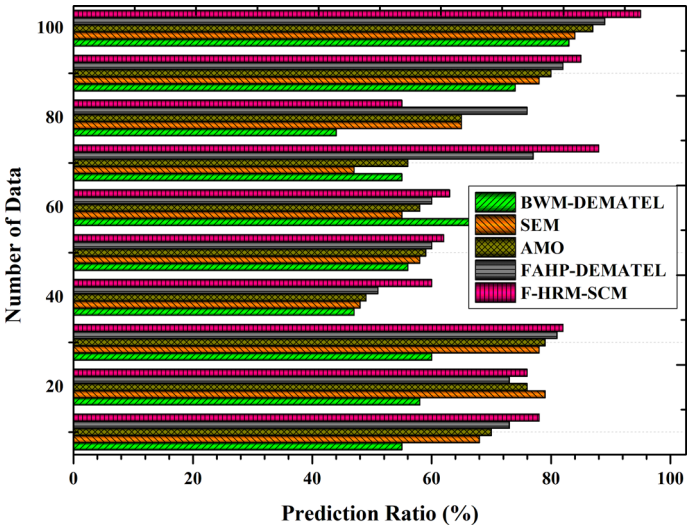

Fig. 10 Prediction ratio

3.8 F1-Score ratio

The F1 score or F measure is described as the harmonic mean between recall and precision. It is utilized as a statistical measure to rate supply chain performance. An F-measure spreads its best value at 1 and worst value at 0. A low F-measure is an indication of both poor recall and poor precision. Thus, this score proceeds both false positive and false negative into account. Accuracy is utilized when the True Positives and True negatives are more significant, while F measure is utilized when the False Negative and False Positive are vital. In most real-life classification issues, imbalanced class delivery occurs, and therefore, F-measure is a better metric to assess our system. The suggested F-HRM-SCM method improves the F-measure ratio compared to other existing models. Figure 11 displays the F1-Score ratio of the recommended F-HRM-SCM method.

The proposed F-HRM-SCM model improves the supply chain performance, efficiency ratio, employee satisfaction ratio, decision-making level, prediction ratio, and F1-score ratio compared to other existing Best Worst Method and Decision-Making Trial and Evaluation Laboratory (BWM-DEMATEL), Structural Equation Modelling (SEM), Ability-Motivation-Opportunity (AMO) theory, Fuzzy AHP, and Fuzzy Type-2 DEMATEL (FAHP-DEMATEL) models.

4 Conclusion and future scope

This study recommends many ways to gain a competitive benefit by manipulating HRM factors even if competitors have efficiently established SCM practices. Because of the innovative and customized supply chain techniques and the geographical position and associated supply chains restrictions, the consequences of our scientific research would be for manufacturing companies.

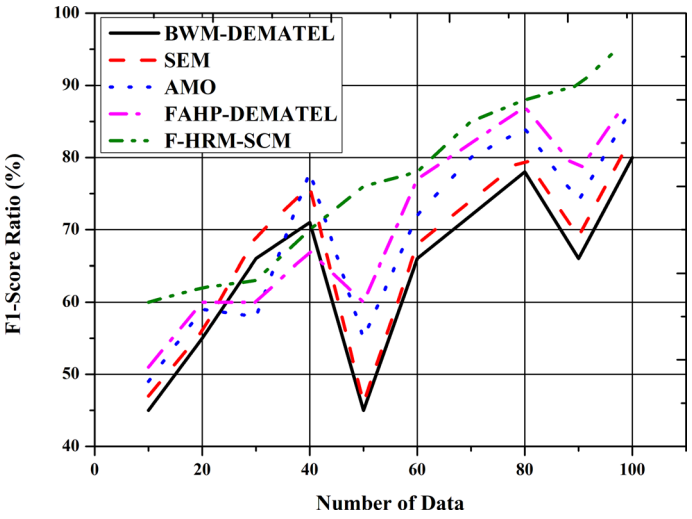

Fig. 11 F1-Score ratio

Integration is merging or combining two or more approaches to give a better and more efficient outcome. In addition, ambiguous and imprecise assessments have made the outcome in detecting causal diagrams less successful. This research has created a novel study to resolve issues by integrating the fuzzy DEMATEL and AHP type-1. Three policy-makers were asked to assess three aspects and eight criteria for the integration approach presented for human resources management. The education requirements from the infrastructure component were agreed on by consensus as to the most important criterion for the management of human resources. To verify the validity of the research, the number of decision-makers must be checked. The experimental results demonstrate that the proposed F-HRM-SCM model enhances the supply chain performance ratio of 98.9%, an efficiency ratio of 97.8%, employee satisfaction ratio of 96.7%, decision-making level by 98.2%, prediction ratio of 95.5%, and F1-score ratio of 97.4% compared to other existing approaches. Future studies consider a higher number of decision-makers. The revised threshold value is anticipated to give different Fuzzy DEMATEL and establish a new network relationship map.

Further study is required to check the given approach. It is necessary. Other genuine case studies in group policy issues, including supplier choices and customer satisfaction, may be tested in the manner proposed.

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