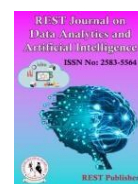




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Stakeholder Performance Evaluation in Humanitarian Supply Chain Management Using Weighted Sum Model

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Abstract: Supply chain management (SCM) involves the coordination and integration of all activities related to the flow of goods, services, information, and finance from raw material suppliers to end consumers. It aims to improve efficiency, reduce costs, and enhance customer satisfaction by optimizing procurement, production, logistics, and distribution processes. Effective SCM ensures smooth communication and collaboration among stakeholders, including suppliers, manufacturers, distributors, and retailers. In today's competitive and globalized environment, SCM emphasizes sustainability, agility, and resilience, which helps organizations adapt to market fluctuations, manage risks, and maintain consistent value delivery across the entire supply chain network. Alternative: Donor, Aid agencies, Government, NGOs, Military. Evolution parameters: Funding, Coordination, Infrastructure, Transparency. According to the results, Donor, ranked highest, while Floods, Users NGOs, lowest. According to the WSM Method approach, Wheat has the highest value Supply Chain Management.

Keyword: Efficiency, Integration, Sustainability, Logistics, Procurement, Optimization, Resilience, Collaboration, Transparency, Agility.

1. INTRODUCTION

Humanitarian Supply Chain Management (HSCM) ensures efficient and timely aid delivery during crises like disasters, conflicts, and pandemics. It addresses challenges such as limited funding, uncertain demand, and damaged infrastructure to maintain effective coordination and support for affected communities [1]. Recognized as an emerging field of study in economics, supply chain management addresses many situations where achieving an accurate assessment of the variables that influence decision-making can be extremely challenging. [2]. The primary goal of supply chain management is to maximize value throughout the chain, ensuring smooth integration and optimal efficiency. Selecting appropriate suppliers plays a key role in achieving this objective as it helps reduce material procurement costs, increase business competitiveness, and improve flexibility and product quality [3]. Sustainable supply chain management (SSCM) refers to a set of integrated methodologies and practices aimed at achieving harmony across organizations and within the different functions of an organization involved in the supply chain. Its focus extends beyond traditional supply chain goals by incorporating environmental, social, and economic dimensions into management decisions [4]. Emergency supply chain management focuses on sourcing and delivering essential supplies like food, medicine, and clothing from government and non-government organizations. During disasters, it ensures rapid response and recovery as critical services such as healthcare, transport, and communication often face severe disruptions [5]. As customer expectations continue to rise, the need for efficient and adaptive supply chain management becomes increasingly important. Supply chain management serves as a powerful tool for maintaining competitiveness, as it involves the effective integration of operations from the procurement of raw materials to the transformation of finished goods and their eventual distribution to end users [6]. To address this issue, integrating the pathogenic set with the three main components of the neuromorphic set – the truth-member, the false-member, and the uncertainty-member – provides a more precise and flexible framework for analysis [7]. A structured approach not only enhances objectivity and consistency in decision-making but also strengthens the overall efficiency and resilience of the supply chain management (SCM) system [8]. When crises are not effectively controlled, they can cause major breakdowns in

supply chain management, hindering the flow of essential goods and services [9]. In supply chain management, network configuration plays a key role in helping companies achieve competitive advantage and effectively meet market needs. A well-designed supply chain network determines how resources, suppliers, production facilities, and distribution channels are strategically aligned [10]. The introductory section establishes the foundation of the study by emphasizing the important role of supplier selection within the broader framework of supply chain management. It outlines how effective supplier selection directly impacts operational efficiency, cost optimization, and overall competitiveness [11]. Supply chain management (SCM) is a system of decision-making processes that was conceptualized by Keith Oliver in 1982, and is a history of SCM, from managing the distribution, raw material, manufacturing, and other stakeholders to adding value to goods and services to satisfy customers [12]. The purpose of this study is to identify essential criteria that help a company's supply chain management (SCM) system achieve agility and adaptability in a dynamic business environment. Agility in SCM is crucial for effectively responding to market fluctuations, customer demands, and unexpected disruptions [13]. Key benefits of supply chain management in additive manufacturing (AM) include improved agility, mass customization, lean operations, and regulatory compliance. [14]. Global Supply Chain Management (GSCM) emphasizes integrating environmental sustainability across all stages—from design and sourcing to production and distribution. Its main goal is to reduce environmental impact while improving efficiency, competitiveness, and achieving a sustainable balance between economic growth and ecological responsibility [15].

2. MATERIALS AND METHODS

The Weighted Sum Method (WSM) is some popular multi-criteria decision-making (MCDM) technique that simplifies complex evaluations. It assigns importance-based weights to each criterion, multiplies them by performance scores, and sums the results. The alternative with the highest total weighted score is identified as the most optimal choice [1]. In pursuit of a more efficient algorithm and overcoming the limitations of existing metaheuristic (MH) methods, the authors introduced and studied a new hybrid metaheuristic approach called population-based incremental learning using an ensemble of genetic algorithms, grey wolf optimizers, water cycle algorithms, and weighted sums [2]. Accurate modelling of IoT data traffic using the Weighted Sum Model (WSM) helps in effectively analyzing and predicting network performance. By assigning weights to key parameters, WSM ensures balanced evaluation, improves decision-making in managing data flow, bandwidth allocation, and overall IoT system performance [3]. The expert allocation algorithm for the cloud-based Agricultural Advisory Service Information System (CASIS) uses a weighted sum model (WSM) to efficiently allocate experts based on criteria such as expertise, availability, and response time [4]. Emergency supply chain management focuses on obtaining and distributing essential resources such as food, medicine, clothing, and other supplies from government and non-government organizations. During disasters, it ensures the continuity of critical services such as health, transportation, and communications, minimizes disruption, and effectively supports affected communities [5]. These models help analysts make better decisions and provide a clear rationale for the choices made. In our case, we use the Weighted Sum Model, which is one of the simplest and easiest to understand approaches [6]. The weighted composite method simplifies multi-objective problems by converting them into a single optimization model, assigning weights to each objective to facilitate efficient evaluation and selection of the best solution [7]. In this study, a multiple-input multiple-output (MIMO) system is analyzed, assuming a single antenna at each node. The focus is on optimizing the beam former design to increase the weighted sum ratio (WSR), thereby improving communication efficiency, signal strength, and overall network performance [8]. This study presents efficient solutions to optimize the Weighted Sum Model (WSM) in multicellular networks, addressing challenges posed by channel uncertainties to enhance network performance and communication reliability [9]. This study introduces efficient solutions for optimizing the Weighted Sum Model (WSM) in multicellular networks, focusing on managing channel uncertainties to improve network performance, improve communication reliability, and ensure optimal performance in multiple interconnected network cells [10].

Alternative:

- Donors: Provide essential financial and material resources that help relief efforts operate effectively and reach affected populations quickly. Their contributions form the foundation for other organizations to develop their relief strategies.
- Aid agencies: Act as intermediaries between donors and implementing organizations to ensure that funds and resources are used effectively and distributed to areas most in need. They also provide expertise in logistics, planning, and needs assessment.
- Government: Are responsible for setting policies, coordinating national responses, and ensuring that aid is consistent with local norms and priorities. They play a key role in integrating humanitarian efforts with

long-term recovery and development plans.

- NGOs: Complement government efforts by providing field assistance, mobilizing communities, and ensuring that relief efforts are people-centered and inclusive.
- Military: Contributes its logistical capabilities, manpower, and infrastructure to support transportation, communications, and rescue operations in emergency situations.

Evolution parameter:

- Funding: Provides the financial backbone needed to implement programs, deliver aid, and sustain long-term recovery efforts. Without adequate funding, even the most well-planned efforts fail to achieve their intended impact.
- Coordination: Ensures that all stakeholders, governments, NGOs, donors, and other partners—work together effectively, avoiding duplication of efforts and ensuring that resources are used effectively.
- Infrastructure: Plays a critical role in enabling the smooth flow of goods, services, and communications during both normal operations and emergencies. Strong infrastructure ensures timely delivery of aid and supports economic stability.
- Transparency: Builds trust among stakeholders and beneficiaries by ensuring accountability in the use of resources. It helps prevent corruption, promotes ethical practices, and encourages continued donors and public support. Together, these four elements create a strong and reliable system that enhances effectiveness, credibility, and long-term sustainability in humanitarian and development projects.

3. ANALYSIS AND DISCUSSION

TABLE 1. Supply Chain Management

DATA SET				
	Funding	Coordination	Infrastructure	Transparency
Donor	5.00	6.25	7.75	7.75
Aid agencies	5.50	5.00	5.75	7.00
Government	7.75	5.00	5.00	3.25
NGOs	5.00	7.00	2.38	5.00
Military	7.75	7.50	7.50	5.00

The table 1 highlights varying performance levels among five key stakeholders in supply chain management. Government and Military lead in Funding (7.75), reflecting strong financial and resource capacity. Military also excels in Coordination (7.50) and Infrastructure (7.50), showing operational strength. Donors perform well in Infrastructure (7.75) and Transparency (7.75), indicating accountability and efficiency. NGOs show strong Coordination (7.00) but weak Infrastructure (2.38), while Aid Agencies maintain balanced yet moderate performance. The Government lags in Transparency (3.25), suggesting a need for improved accountability.

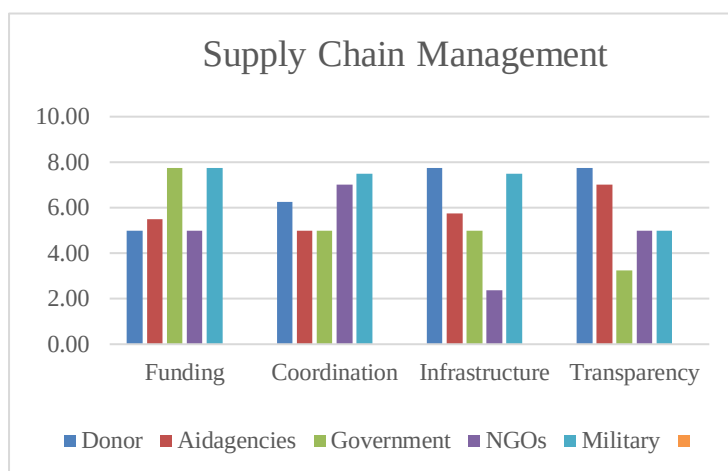


FIGURE 1. Supply Chain Management

The Figure 1 illustrates the performance of five institutions – donors, aid agencies, government, NGOs and the military across four key supply chain management metrics: finance, coordination, infrastructure and

transparency. The government and military show strong performance in financing, indicating significant resource efficiency. NGOs perform well in coordination, emphasizing their collective strength. Donor and military sectors show balanced contributions in transparency, while the government lags behind in this aspect. Infrastructure performance varies widely, with NGOs and donors performing slightly lower compared to others, the chart highlights that while financing and coordination are generally strong across sectors, transparency and infrastructure remain areas that need improvement for more efficient and agile supply chain management.

TABLE 2. Normalized

Normalized				
	Funding	Coordination	Infrastructure	Transparency
Donor	0.64516	0.83333	0.30710	0.41935
Aid agencies	0.70968	0.66667	0.41391	0.46429
Government	1.00000	0.66667	0.47600	1.00000
NGOs	0.64516	0.93333	1.00000	0.65000
Military	1.00000	1.00000	0.31733	0.65000

The table 2 normalized data illustrate the relative performance of five key actors across four supply chain dimensions. The government and military score high on financing (1.000), indicating strong financial strength and resource capacity. The military also scores high on coordination (1.000), reflecting better organizational management and operational capacity. NGOs perform well on infrastructure (1.000), demonstrating their adaptability and effectiveness in field operations. The government leads on transparency (1.000), demonstrating strong accountability practices. Meanwhile, donors and aid agencies show moderate, consistent performance across all criteria. Overall, the results highlight strengths in financing and coordination but suggest that improvements in infrastructure and transparency are necessary for greater effectiveness.

TABLE 3. Weight

Weight				
	Funding	Coordination	Infrastructure	Transparency
Donor	0.25	0.25	0.25	0.25
Aid agencies	0.25	0.25	0.25	0.25
Government	0.25	0.25	0.25	0.25
NGOs	0.25	0.25	0.25	0.25
Military	0.25	0.25	0.25	0.25

The table 3 shows that all four criteria finance, coordination, infrastructure and transparency – are assigned equal weights of 0.25 across all five stakeholders – donors, aid agencies, government, NGOs and the military. This indicates that each factor is considered equally important in assessing supply chain performance. No single criterion is given priority over another, suggesting a balanced approach to the assessment. Such balanced weighting ensures fairness and consistency in comparing stakeholders, as each aspect contributes equally to the final assessment. This method helps to achieve an unbiased analysis of supply chain performance and supports objective decision-making.

TABLE 4. Weighted normalized decision matrix

Weighted normalized decision matrix				
	Funding	Coordination	Infrastructure	Transparency
Donor	0.16129	0.20833	0.07677	0.10484
Aid agencies	0.17742	0.16667	0.10348	0.11607
Government	0.25000	0.16667	0.11900	0.25000
NGOs	0.16129	0.23333	0.25000	0.16250
Military	0.25000	0.25000	0.07933	0.16250

The table 4 weighted normalized result matrix highlights the performance of each stakeholder after applying equal weights to the four key criteria. The government and military show the highest values in financing (0.250), indicating strong financial capacity. The military also leads in coordination (0.250), reflecting better institutional performance. NGOs score the highest in infrastructure (0.250), indicating field strength and adaptability. In transparency, the government again ranks the highest (0.250), indicating stronger accountability. Donors and aid agencies show balanced but moderate performance across all factors. the results emphasize the financial and coordination dominance of the government and military, while NGOs excel in infrastructure.

TABLE 5. Preference Score

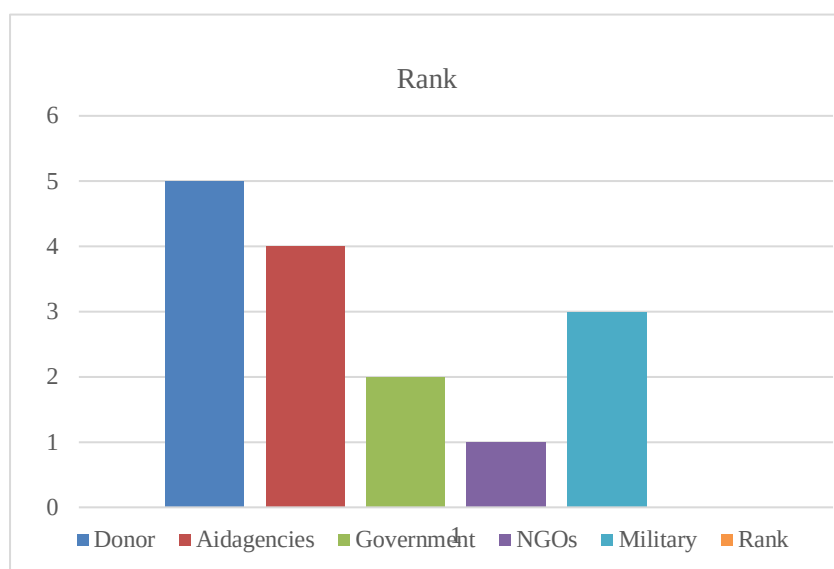
Preference Score	
Donor	0.55124
Aid agencies	0.56364
Government	0.78567
NGOs	0.80712
Military	0.74183

The table 5 priority scores indicate the overall performance ranking of stakeholders in the supply chain. NGOs have the highest score (0.80712), indicating strong overall performance and adaptability. The government (0.78567) and the military (0.74183) follow closely, reflecting strong financial and coordination capabilities. Aid agencies (0.56364) and donors (0.55124) perform moderately, indicating balanced but less dominant contributions. NGOs emerge as the most preferred and effective stakeholder in supply chain performance.

TABLE 6. Rank

Rank	
Donor	5
Aid agencies	4
Government	2
NGOs	1
Military	3

The table 6 ranking results reveal that NGOs hold the top spot (rank 1), demonstrating the highest overall efficiency and effectiveness in supply chain operations. The government is in second place, reflecting strong financial and organizational capabilities, followed by the military in third place, reflecting solid coordination and infrastructure. Aid agencies and donors are in fourth and fifth place, respectively, indicating moderate efficiency and limited impact compared to others. NGOs are the most effective contributors to supply chain management.

**FIGURE 2.** Rank

The figure 2 provides a ranking of five organizations based on overall performance in supply chain management: donors, aid agencies, government, NGOs, and the military. NGOs receive the highest ranking (1), indicating excellent performance across the assessed criteria. The government is in second place, reflecting strong performance and resource management. The military is in third place, showing reliability but moderate performance compared to the top two. Aid agencies are in fourth place, suggesting room for improvement in coordination and infrastructure. Donors are in fifth place, indicating the need for improved engagement and transparency. NGOs are highlighted as the most effective contributors to supply chain management performance.

4. CONCLUSION

Supply chain management (SCM) plays a key role in ensuring the efficient flow of goods, information and resources at all stages of production and distribution. It enhances organizational competitiveness by improving coordination, reducing operational costs and ensuring the timely delivery of goods and services. Analysis of various stakeholders such as donors, aid agencies, governments, NGOs and the military highlights that effective collaboration and resource optimization are key to achieving supply chain excellence. Furthermore, integrating modern approaches such as digital technologies, IoT and data analytics will further strengthen transparency, agility and responsiveness. Sustainability and resilience have become essential components, ensuring that supply chains remain strong even in the face of disruptions such as disasters or pandemics. Ultimately, a well-managed supply chain not only increases efficiency and profitability but also contributes to long-term organizational growth and global economic sustainability.

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