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Analyzing and Ranking of Critical Success Factors of Humanitarian Supply Chain During COVID-19 Pandemic

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Abstract

Every year, natural disasters and unforeseen events such as earthquakes, floods, hurricanes, droughts and fires occur indifferent parts of the world or, like COVID-19 pandemic, affects the entire globally. In this regard, the lack of proper preparation and confrontation with these accidents will cause heavy losses and damages to the nations and their assets which is sometimes irreparable. Humanitarian supply chains include all actors who are all on supposed to reduce the pain of the victims of the accident and are cooperating with each other to provide services to the victims of these accidents.

The goal of a humanitarian supply chain, unlike a commercial supply chain, is not to make more profit, but saving the lives of mostly innocent people is preventing the crisis from escalating. Also, economic and social factors can disrupt the humanitarian supply chain too. Providing equipment, resources and facilities for relief operations and rescuing as well as meeting the needs of the victims is one of the most important issues in humanitarian action. Choosing right suppliers in the humanitarian supply chain is mainly based on two main criteria of "Technical Production Capability" and also "Response Support Capability" where the success factors in this chain focus on the agent environment, technology and organization. Obstacles to the implementation of the humanitarian supply chain are classified into five groups of "force barrier human", "structural barriers", "technological barriers", cultural barriers" and "financial barriers". In addition to this topic, other issues such as the destruction of supply chain infrastructure like transportation infrastructure, warehouses storage of equipment and relief needs as a risk can also disrupt the humanitarian supply chain. Understanding such risks enables the humanitarian supply chain to be able to detect and deal with all unexpected events.

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Introduction

Historically, there have been events and crises that may not have been so widespread, but the number of floods, earthquakes, terrorist attacks, strikes, protests and infectious diseases are rising continuously. The world in the recent decades did not meet such a widespread and integrated crisis and currently, the shortcomings of various sectors and industries are identified in the crisis. The supply chains weaknesses are appeared in a different feature, more than anything else in shortage of materials and consumer and health needs of the people, and this issue made experts thinking of issues related to humanitarian supply chains.

The nature of natural disasters is such that response to them must be done in a short time. In order to achieve these goals, the humanitarian supply chain is a key Environment in which any improvement can achieve effective results (Ahmad Jafarnejad, Hamid Hashemi Patrodi and Hamidreza Talaie, 1396). The environmental issue as well as speed, variety, flexibility and integration in production line come along with customer relationship and mass customization concept should come to light in today's research study (Pilevari,2008). As the external environment is changing day by day, they need to be even more prepared and increase their capabilities. Unfortunately, most producers face a supply crisis due to a weakness in their resource strategy, a weakness that should have been covered up years ago. We are now in a different situation with regard to the COVID-19 pandemic. On the one hand, the main and secondary suppliers of the humanitarian supply chain, who themselves are involved in the limitations and disorders caused by this new virus and sometimes are not able to respond; and on the other hand, the number of people who need help is increasing day by day, and also communication bridges and physical exchanges with many countries are stopped or disrupted due to health, religious, political, etc. Given that humanitarian supply chains in the COVID-19 pandemic are at risk, it has led to the formation of a concept called resilience in humanitarian supply chains.

The humanitarian supply chain includes a network of suppliers, manufacturers, distributors who assist in the supply of raw materials and transportation. Supply chain management is the process of planning, executing and controlling operations related to supply chain and relocation and inventory with the aim of minimizing costs and maximizing efficiency and profit. Due to the decline in production in different countries and the restriction of intercity travel, many problems in the supply chain of businesses has been created, so it is necessary to reduce the supply of raw materials through innovative measures. In other words, issues such as unpredictability of procurement, unpredictability of demand, unpredictability of the time and place of the accident are the most important challenges in the humanitarian supply chain. Therefore, we are always faced with uncertainty to provide equipment and facilities.

It should be noted that this new virus, by destroying small and medium-sized businesses, in addition to a serious blow to the economic structure of countries, has put millions of people in difficult economic conditions, even starving. People who are no longer able to cope with the situation and they cannot deal with it and really need help (Zheng, Chen & Zhang and Junru, 2021).

Suppliers should provide all materials in a good quality and condition, and also with a low-cost price. To come up with this importance, they need to understand, identify and classify the effective risks on the supply chain. In this article, while

explaining the concept of supply chain uncertainty, identifying supply chain risks and determining the severity of their effect, risk management in the supply chain is stated as one of the main tasks of management. In addition, other issues such as the loss of supply chain infrastructure such as transportation infrastructure, equipment storage depots and relief needs are also issuing that can disrupt the humanitarian supply chain.

Sometimes, despite the lack of damage to communication routes, due to the volume of traffic caused by the influx of people and relief forces to the Environment, the supply chain is practically disrupted and rescue operations will be hampered. Loss of communication infrastructure, deficiencies in the provision of human resources, financial constraints, government policies in providing relief to relief workers and affected people, environmental restrictions on access to affected Environment shortages in warehouses, religious and moral issues of the community Damaged and ultimately economic and social factors can disrupt the humanitarian supply chain.

2. Literature Review

2.1. Humanitarian supply chain

The humanitarian supply chain is a well-defined strategic and structured process that has four main phases: “Prevention”, “Preparation”, “Response” and “Reconstruction” (Schiffling and Piecyk, 2014). Humanitarian supply chain is a special type of supply chain with unique features that distinguishes it from commercial supply chains (Mohammadreza Sadeghi Moghadam, Hossein safari, Reza Barani Beyranvand, 1398). This supply chain is a special type of supply chain where task is to provide the basic needs for assistance in the right place and in the fastest possible time. Humanitarian supply chains consist of things beyond humanitarian organizations, so the subdivisions and links in this chain are unique (Da Costa at all 2012). Operational Environment of the humanitarian supply chain include: Water supply, Health improvement and promotion; Food and nutrition assistance, Food security; Shelter, housing and non-food items; Health services and medical care; Humanitarian access; Protection of individuals; Restore and reunite; Discharge; AIDS treatment; Psychological and behavioral help; Initial facilities; Initial support systems and Education.

Levy et al. define supply chain management as "a set of approaches used to effectively integrate suppliers, warehouses, and shopping malls. So that the goods are produced and distributed in the right volume and in the right place, in other words, the reduction of the extensive costs of the service system classifies the needs." This concept is called the Humanitarian Supply Chain when used for disaster relief operations (Iman Ghasemian Sahebi, Alireza Arab, Mohammadreza Sadeghi Moghadam, 2017). Flow (materials and information) in the humanitarian supply chain can be described as a multifaceted approach through international agencies and aid organizations, so that services and goods are provided by international and local agencies and delivered to recipients. Finally, Humanitarian Supply Chain management is essential to meeting and participating in multiple goals, often on a global scale, as fast as possible and capable in a short period of time (Cozzolino, A., 2012). Humanitarian supply chain in the academic literature refers to the process of planning, implementing and effectively controlling the flow of costs and information and storing the required goods and materials from the point of origin to consumption (Costa et all, 2012). The humanitarian chain requires a process to manage the flow of goods, information, and cash flow from suppliers to affected individuals (Cozzolino, A., 2012). The Humanitarian

Supply Chain can be described as a multifaceted approach through international agencies and aid organizations, so that services and goods are sourced from international and local agencies and delivered to recipients.

Table 1. A framework for the humanitarian aid supply chain (Chandra Prakaikul W., 2010)

Stages	Activities	Approach	Supply Chain Strategy	Key Factors
Before the Disaster	Prevention and preparedness	Strategic Planning	Pure	Collaboration, Coordination, Resource Planning and Knowledge Management
During the Disaster	Response	Short-term Project Management	Agile	Information Management, Demand Management, Supply Management, Project Implementation Management
After the Disaster	Reconstruction	Long-term Project Management and Completion	Pure	Collaboration, Coordination, Resource Planning, Knowledge Management, Continuous Improvement

2.2. Supplier Resilience

The common definition of supply chain resilience is the ability of supply chain adaptation to prepare for unexpected events, respond to disturbances and improve them while maintaining continuity of operations at the desired level of dependence, connection and control of structure and performance (Ponomarov & Holcomb, 2009). Resilience is defined as the organizational capacity to survive, adapt, and grow in the face of change and uncertainty (Pettit et al, 2013). Resilience is the ability of a system to return to its original state or move after turbulence to a new and more desirable state in which demand is a combination of flexibility and adaptability (Kristianto et al, 2014). Supply chain resilience is defined as the identification and analysis of supply chain vulnerabilities to potential disruptions and the effort to identify and strengthen resilience capabilities against vulnerabilities.

Since the supplier has an important role in the supply chain, if faced with risk and disruption, it will have detrimental and significant effects on the supply chain, so it seems necessary to study these conditions. The common definition of supply chain resilience is the ability of supply chain adaptation to prepare for unexpected events, respond to disturbances, and recover from them while maintaining continuity of operations at the desired level of dependence, connection, and control of structure and performance (Ponomarov & Holcomb, 2009). Resilience is a separate source of sustainable competitive advantage for suppliers. The ability of suppliers to manage risk, is the ability to respond better to disturbances than competitors, which shows the very nature of supplier resilience (Mohamad Hosein Kabgani And Hamid Shahbandarzadeh, 1398).

The selection of a supplier as one of the complex and multifaceted measures in the supply chain is vulnerable, therefore the importance of resilience in reducing vulnerability, determining the effective factors and explaining the structural relationships of these factors is essential for selecting a resilient supplier. Supply chain resilience emphasizes risk management throughout the chain and covers a wide range of issues such as troubleshooting, risk reduction, and supply chain recovery (Kleindorfer, Paul R., and Germaine H. Saad. 2005). Savik in 2013, using mixed integer programming

modeling, evaluated and selected suppliers in the presence of supply chain disruptions and assigned orders to selected suppliers. Research variables consist of number of parts purchased from each supplier, capacity of each supplier, cost of deficiency per unit, ordering cost, expected breakdown rate price, total demand, level of reliability, local disruption for the supplier and the probability of disruption It was a world for suppliers. It also aimed to minimize expected costs and research constraints, including capacity constraints and supplier selection policies, and risk constraints. To show the efficiency of the proposed model, he used a numerical example and the results showed that the probability of supply chain disruption is the most important factor for allocating orders to suppliers and a diverse supply base can reduce the consequences of disruption risks (Sawik,2013).

Supplier resilience assessment indicators include; "Visibility", "Collaboration", "Flexibility", "Agility", "Speed", "Vulnerability", "Project and Development", "Awareness of Technological Risks and Capabilities", "Risk Management Culture", "Safety", "Supply Chain Structure", "Adaptability", "Trust", "Risk Sharing and Income", "Sustainability", "Financial Strength", "Knowledge Management", "Information Sharing", "Redundancy", "Complexity", "Latency", "Distance", "Contingency Planning", "Demand Management" and "Human Resource Management" are the right supplier choices.

The selection of a resilient supplier in the supply chain is based on two main criteria: production-technical capability as well as response-support capability.

2.2.1. Production-technical capability

These factors include metrics that can help an organization gain more competitive advantage over its competitors. Flexibility in policy production is a relatively new policy used today by successful companies to develop and increase competition. Also, the ability of the organization to identify the types of risks in the supply chain, such as the risk of economic factors of an organization that is affected by macroeconomic variables in its operating environment, can have a significant impact on the performance of a firm.

2.2.2. Response-support capability

Intensified competition has increased the support of most organizations for R&D activities throughout their supply chain. Organizations must improve the quality and safety of products throughout their supply chain so that their customers are willing to buy goods. Therefore, planning and using environmentally friendly technology as well as the use of green raw materials in supply chain processes that cause less damage to the environment and the production of environmentally friendly products can increase the competitive advantage of the organization.

Table 2. Criteria and sub-criteria for selecting suppliers (Kabgani And Shahbandarzadeh, 1398)

Main criteria	Sub-Criteria
Production-technical Capability	Quality
	Price
	Flexibility
	Chain Risk Control
Response-support Capability	Chain Safety
	Transparency of Activities in the Chain
	Green Activities
	Research & Development

2.3. Risks and obstacles to implementation

2.3.1. Risks in the humanitarian supply chain

Risk in the sense of supply chain is related to the processes of production, transportation and delivery of goods on demand. Supply chain risk was generally divided into two categories: First, the internal risks that arise from the supply chain network and include supply risk, demand risk, and process risk. Second, the external risks that enter the supply chain network, such as international terrorism, natural diseases such as SARS, and everything that arises from the interactions between the supply chain network and the environment (GOH, M. 2007).

Risk management begins with the correct identification and assessment of risk and continues with the appropriate and timely response of disks. In fact, efficient risk management reduces network vulnerability by building a flexible supply chain against change (Bogataja, D. and Bogataj, M., 2007).

Supportive and humanitarian activities face short-term uncertainties, such as demand for a product or set of goods. Risks in relation to the tactical level are very different from long-term plans, the tactical level and the costs imposed as a result can be calculated and predicted, while the risk at the level of long-term plans due to the phenomenon of uncertainty is much higher and even has There are different forms. From different perspectives, supply chain risk management can be considered from both operational and strategic perspectives. From an operational perspective, risk management is responsible for the risks associated with the procurement tasks that support production. From a strategic perspective, risk management requires strategies and methods. In order to identify the benefits of strategic risk management and the opportunities arising from timely response to risks and hazards (Yeo, K., 1995).

Among the types of risks in the humanitarian aid supply chain are “suppliers’ risks”, “producers' risks”, “distributors' risks” and “recipients' risks” (Kovacs, G. and Spens K., 2007).

2.3.2. Barriers to Humanitarian Supply Chain Implementation

Barriers to the implementation of the humanitarian supply chain are classified into five groups: manpower barriers, structural barriers, technological barriers, cultural barriers, and financial barriers.

Table 3. Criteria and sub-criteria for implementation barriers (Mohammadreza Fathi; Milad Aghaei; Mohammad Hassan Maleki; Zohreh Kermajani, 1398)

No.	Criteria	Sub-Criteria
1	Human Resource	Lack of logistics specialists
		Insufficient experience in the field of crisis management
		Lack of education and development of people
		Lack of efficient skills
		Lack of training feedback mechanism
2	Structural	Insufficient commitment of senior managers
		Insufficient governmental support
		Weaknesses in local infrastructure
		Delay in relief
		Lack of strategic planning
		Inefficient management of public aid
3	Technologically	Insufficient investment in IT
		Weak IT infrastructure
		Poor transportation facilities

		Lack of quick warning
		Incompatibility of information systems
		Poor coordination and information exchange
4	Cultural	Lack of recognition of the importance of logistics
		Misbehavior of Relief workers
		Lack of freedom to share and create knowledge
		Competition between aid agencies
5	Finance	Failure to meet needs
		Inaccuracy of needs assessment
		Lack of budget estimates
		Lack of estimated costs
		Ineffectiveness of financial estimation

2.4. Covid-19

This new disease is a disease that can be transmitted from animal to human, but the ways of transmission, animal reservoirs, ways of prevention, precise clinical considerations have not been determined yet and need further studies. Also, there is no suitable vaccine and treatment for it, so having high clinical suspicion and avoiding contact with fever patients and patients with respiratory symptoms has a very important role in the prevention and control of this disease. Covid-19 is a common disease between humans and animals. It is considered to be genotypically and serologically positive in four types of alpha, beta, and RNA and about 30 types of coronavirus are common in humans, mammals and birds. The human Corona viruses are alpha and beta viruses (Farshid danesh, Somayeh ghavidel, 2020).

The World Health Organization declared it as a global pandemic in March 2020, but the world is still confused about the aftermath of COVID-19. Originating in China, the disease has spread rapidly around the world, prompting tough action by world governments.

Coronavirus (Covid-19) is a causative agent of SARS COV2 and a potentially fatal disease of global public health concern. Due to the large number of infected people exposed to the aquatic market in Wuhan, China. It is possible that Covid-19 is common between humans and animals (Chen Zheng, Junru Zhang, 2021). Coronaviruses (from the order Nidovirals, the Cronaviridae family and the subfamily Orthochronovirinae) are spherical (0.036 nm in diameter) and coated with spherical appendages on their surface that give them the appearance of a solar corona (Candy Lim Chiu, Yicong Sha, 2020). COVID-19 is an acute respiratory syndrome that is the most important way to diagnose is PCR. In early December 2019, the Covid-19 first spread to China and then to the rest of the world. Identification, quarantine, and patient care began, and relationships were restricted to prevent human-to-human transmission of the virus (Yasmin A-MALIK, 2020).

3. Suggested Model

Factors influencing the success of the supply chain and humanitarian include the organizational environment and technology.

Choosing the resilient supplier affects the organization in terms of the risks involved in the environment as well as the implementation barriers, and ultimately the Covid 19 pandemic affects all six factors.

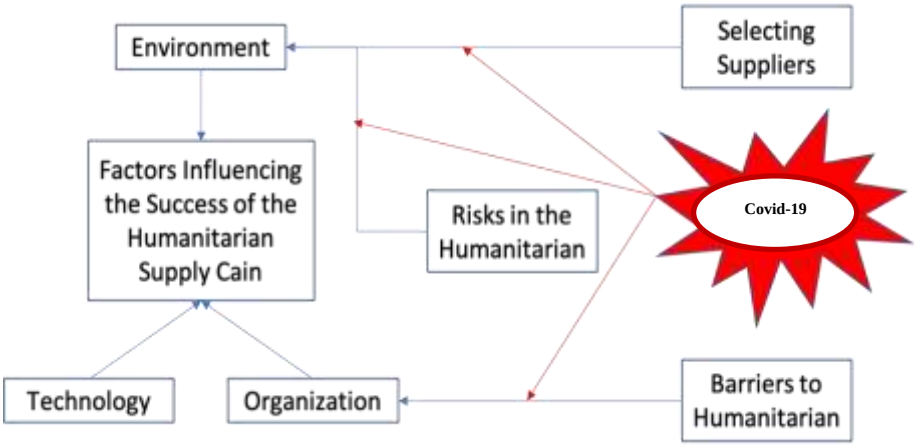

Figure 1. Conceptual model

4. Research Method

Since the purpose of this study is to "investigate the effect of resilient supplier selection on the success of the humanitarian supply chain in the COVID-19 pandemic", its results can be used in Red Cross, Rescue and Crisis Management to increase disaster preparedness and humanitarian logistics efficiency.

Therefore, it is a kind of applied research. The present study falls into the category of descriptive survey research because it examines and recognizes more the relationships between variables in the existing conditions. In this study, the statistical community of experts are familiar with the concepts of supply chain and new approaches, both theoretically and practically in the academic field and rescue and crisis management organizations.

The sampling method in this study is judgmental and purposeful. Due to the novelty of the humanitarian supply chain, six experts in this field have access. The issue of humanitarian supply chains is a new one and the number of experts available in this field is limited.

In this study, in order to collect data, two methods of interview and questionnaire were used. To write research literature, the method of scientific journals and articles and various scientific databases on the Internet has been used. In this research, three questionnaires have been used to collect information. The researcher has used three computational methods, SAVARA, DIMTEL and AHP.

5. Research findings (Results)

5.1. The affecting criteria on supplier selection, which in the first stage are prioritized according to the collective agreement of the opinions of experts. According to the experts, the production-technical criteria, as the first priority and response-support, as the second priority is taken in industrial units by the rate of supplier selection in resilient supply chain. In this section, the weight of these two criteria is calculated using the SWARA method.

Table 4. Criteria weights

	Sj	Kj	Q	W
Production-Technical	-	1	1	0.558
Response-Support	0.26	1.26	0.794	0.442

The calculations are as follows: in the first step, 6 research experts were asked to express the importance of the Response-Support criteria compared to the Production-Technical criteria in the questionnaire, then the average of the importance was calculated to be 0.26.

In the second step we have to calculate the value of Kj. To calculate the value of Kj, we have to add Sj to the number one.

$$Kj=Sj+1=0.26+1= 1.26$$

In the third step, the amount of raw weight (qj) is calculated. Which is obtained from the following relation:

$$q\_j=q\_(j-1)/K\_j =1/1.26=0.794$$

In the fourth step, the weight of each criteria is obtained by normalizing the values of raw weight, which in order to normalize, each raw weight must be divided by the total raw weights.

5.2. In the second stage, using the Dimethyl method, we evaluate the relationships between barriers to the implementation of the humanitarian supply chain form 0 to 4: (0= no effect, 1= low effective impact, 2= low impact, 3= high impact, 4= high effective impact) has been used.

In order to form a direct communication matrix, opinions from 6 experts have been used. The direct communication matrix consists of the arithmetic mean of the opinions of these 6 experts and is given in Table 5.

Table 5. Direct communication matrix

	Human Resource	Structural	Technologically	Cultural	Finance
Human Resource	0	2.667	2.667	3.5	3.167
Structural	2.667	0	3	2.667	3.167
Technologically	2.5	2.667	0	2.333	2.833
Cultural	3	2.667	2.833	0	2.667
Finance	3.333	3.167	3.333	3.167	0

After the formation of the direct communication matrix, normalization must take place. In other words, to normalize the sum of rows and columns, the direct communication matrix is calculated and then the largest number is selected and the direct communication matrix elements are divided by the largest number that the normal matrix is given in Table 6.

Table 6. Normalized Matrix

	Human Resource	Structural	Technologically	Cultural	Finance
Human Resource	0	0.205	0.205	0.269	0.244
Structural	0.205	0	0.231	0.205	0.244
Technologically	0.192	0.205	0	0.179	0.218
Cultural	0.256	0.205	0.218	0	0.205
Finance	0.256	0.244	0.256	0.244	0

The total communication matrix is then calculated, which is given in Table 7.

Table 7. Total Communication Matrix (TC)

	Human Resource	Structural	Technologically	Cultural	Finance
Human Resource	1.547	1.679	1.753	1.778	1.776
Structural	1.663	1.457	1.715	1.679	1.722

Technologically	1.529	1.505	1.400	1.535	1.577
Cultural	1.642	1.589	1.667	1.471	1.657
Finance	1.850	1.802	1.889	1.860	1.683

Then, based on the values of D + R and D-R, the coordinate axis is formed, in which the X axis is the D + R and the Y axis is the D-R. Each index is specified on the coordinate axis, which is shown in the form of the causal diagram. Accordingly, the indices above the X-axis have a positive D-R that has a causal aspect, and the indices below the X-axis have a negative D-R that has a defective aspect.

Table 8. D & R Values

	D	R	D+R	D-R	Criteria Type
Human Resource	8.534	8.230	16.764	0.303	Cause
Structural	8.235	8.032	16.268	0.203	Cause
Technologically	7.546	8.424	15.969	-0.878	Effect
Cultural	8.025	8.323	16.348	-0.297	Effect
Finance	9.084	8.415	17.499	0.669	Cause

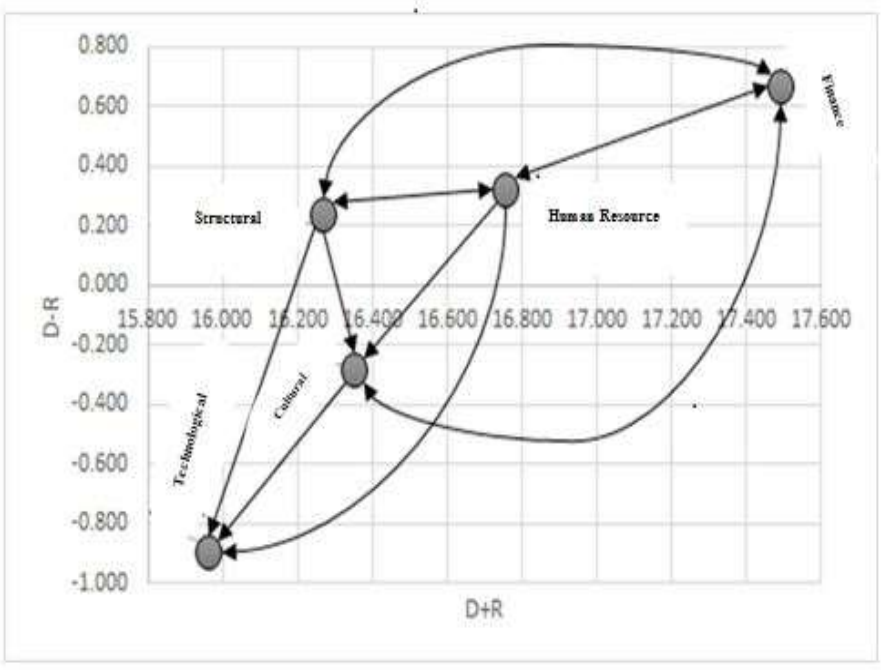

Figure 2. Effects Diagram

5.3. The third stage is to identify and prioritize the factors influencing the success of the humanitarian supply chain through the Analytic Hierarchy Process (AHP), where is applied one of the most comprehensive systems designed for multi-criteria decision making, introduced by Thomas L. (Saati, 1980). The purpose of using the hierarchical analysis process is to identify the preferred options and also to determine the ranking of the options by simultaneously considering all the decision criteria. Therefore, for any pairwise comparison, a number from 1 to 9 is assigned.

In this section, using the AHP method, the weight of the criteria and then the sub-criteria of Table 9 are calculated.

Table 9. Introduction of criteria and sub-criteria

Sub-Criteria Code	Sub-Criteria	Criteria Code	Criteria
A1	Resource management	A	Environment
A2	Senior Management		
A3	Strategy and planning		
A4	Organizational Culture		
A5	Evaluation		
A6	Support		
B1	Cultural	B	Organization
B2	Economy		
B3	Geographical		
B4	Technologically		
B5	Legal-political		
C1	Information Systems	C	Technology
C2	Technology Education		

then to determine the weight of the factors, first the pairwise comparisons of the criteria and then the pairwise comparison of the sub-criteria are formed.

Table 10. Parallel Comparison of Criteria

	A	B	C
A		0.283	0.430
B			3.072
C			

To extract the weight from the pairwise comparison matrix of Table10, first the model was drawn in Expert Choice software and then the pairwise comparisons were entered into the software, the final result of the weight of the main criteria is shown in Figure 3. The results show that organization (B) with a weight of 0.612 is ranked first, technology (C) with a weight of 0.252 is ranked second and environmental attention (A) with a weight of 0.180 is ranked third.

Figure 3. Relative Weight of Criteria

The final weight of the sub-criterion is obtained by multiplying the weight of the main criterion by the weight of their sub-criteria and they entered the expert software to calculate the weight. The results are shown in Figure 4.

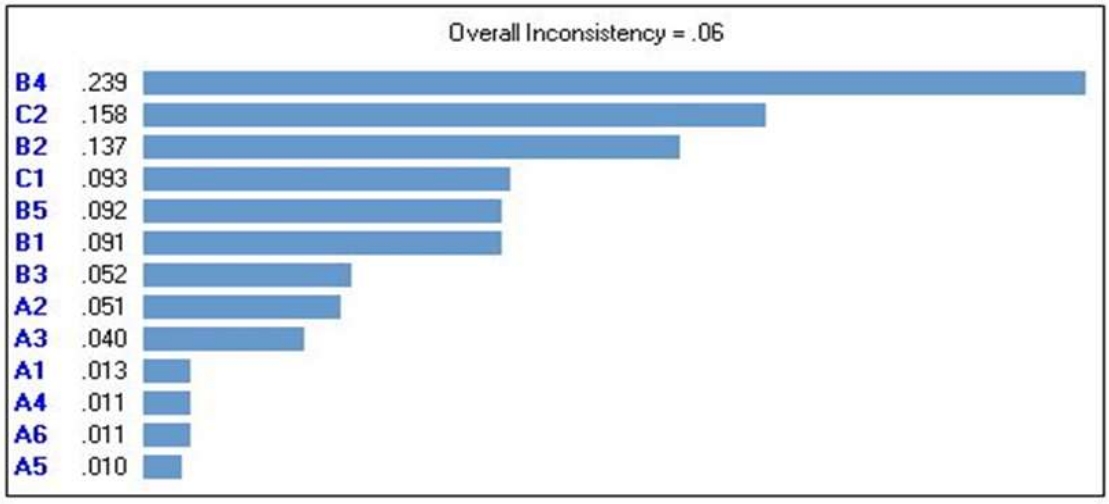

Figure 4. The Final Weight

Results show that, among 13 sub - criteria, technological (B4) is ranked first with 0.239 weight Has earned. Technology education (C2) with a weight of 0.158 is ranked second and economic (B2) with a weight of 0.137 is ranked third.

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