Acta logistica - International Scientific Journal about Logistics
Volume: 9 2022 Issue: 2 Pages: 223-235 ISSN 1339-5629



doi:10.22306/al.v9i2.299 Received: 14 Feb. 2022; Revised: 12 Mar. 2022; Accepted: 10 Apr. 2022

# CAUSES AND EFFECTS OF SUPPLY CHAIN NERVOUSNESS: MENA CASE STUDY

**Ghazi M. Magableh**
Industrial Engineering Department -Yarmouk University, Irbid-Jordan, P.O. Box 21163,
ghazi.magableh@yu.edu.jo (corresponding author)
**Mahmoud Z. Mistarihi**
Industrial Engineering Department -Yarmouk University, Irbid-Jordan, P.O. Box 21163,
mahmoud.m@yu.edu.jo

***Keywords:*** supply chain, nervousness, MENA, AHP, framework.
***Abstract:*** As part of the global supply chain (SC), Middle East and North Africa (MENA) SC is subject to many disruptions and instability resulting in an unpredicted interference among decisions causing SC nervousness (SCN). Nervousness reduces the efficiency and negatively impact the overall SC performance. Nervousness greatly effect supply chain stability and resilience leading to an increase in costs and fluctuation of the relationships with suppliers as well as customers. This research explores the supply chain nervousness (SCN) in MENA region. An investigation of the existing literature and interviews with the experts used to identify factors related to nervousness in the SC. This study was prompted by a lack of research depth to identify and investigate the main causes, effects, and measures, of SCN. A survey is used to analyze and asses the SCN in the region. A comprehensive framework of SCN in MENA region is presented and analyzed. The results identify the major sources, causes, and impact of SCN, and then arrange causes based on their impact. Also, the relative criticality of nervousness factors was assessed using the Delphi based analytical hierarchy process (AHP). Furthermore it investigated the factors and response strategies to mitigate the nervousness sources. Finally, a list of measures is proposed to reduce the SCN and improve competitiveness, effectiveness, and responsiveness. Identification and assessment of nervousness factors enables professionals to take appropriate mitigation strategies, help companies decide plans to reduce nervousness in their SCs, and lead to better decisions on future resilient supply chains.

## 1 Introduction

The MENA region suffers from special conditions and exceptional circumstances, which have had a great impact on the supply chain and its performance, particularly, in light of the fact that the region is the center of attention by most countries of the world as consumers of their goods and products. There are several factors that affect the supply chain in the region, including political, social, economic conditions, and wars that almost never end in the region. As well as the supply chain of defense equipment, which is almost endless, and the region is one of the largest consumers of weapons and defense equipment as a result of the circumstances and surrounding crises. These conditions, in addition to the large number of partners, intense competition, sudden change in demand, lack of environment concerns, delay in response or delay in financial transactions, and the lack of interest of logistic companies in the region in exchanging information with their partners in the chain led to instability and SCN, which had negative repercussions on prices, times, and the level of services between consumers and suppliers. In general, MENA-SC is greatly affected by the SC nervousness.

Nervousness leads to a number of problems, including an increase in inventory, delays, costs, and the occurrence of mistrust between organizations and their suppliers on the one hand, and with customers on the other hand. It causes ineffectiveness of the supply chain in general, especially since most of the instability in this supply chain is caused by external events outside the company control. To the best of our knowledge, there is no previous study or research that considers nervousness in the MENA supply chain and analyzes it in terms of causes and their effect. Especially with the disruptions caused by Pandemics like COVID19 , which has special and exceptional impact that have led to a lot of instability in the supply chain and an increase in the costs of sustaining the supply chain and relationships with suppliers and customers. In this paper, an analytical study is presented showing the sources, causes of SC nervousness and their impact. Factors responsible for SCN are examined and prioritize using Delphi-AHP technique. Furthermore, response strategies to mitigate the nervousness sources are investigated. Because of the scarcity of research that deals with SCN, especially in MENA region, this study is unique and unprecedented in terms of analyzing the SCN in the region's supply chains. This research will help practitioners, executives, and managers understand and explore their SCN.

As shown in Figure 1, the methodology of this research includes a review of previous studies, data collection using a survey to identify the main reasons of nervousness and its impact on decision-making process, arranging the sources of SCN based on the expertise opinion, and identifying the characteristics and components including the main sources, causes that may lead to SCN and their expected impact. After that, a framework will be presented to describe the nervousness of the supply chain in the

region and analyze its impact on the effectiveness and efficiency of the supply chain. This is followed by the proposed list of measures to reduce the SCN and improve future efficiency and resilience. Furthermore, the criticality of nervousness factors is assessed using the Delphi based AHP method. Finally, an approach for dealing with nervousness and the findings and recommendations for future research is presented.

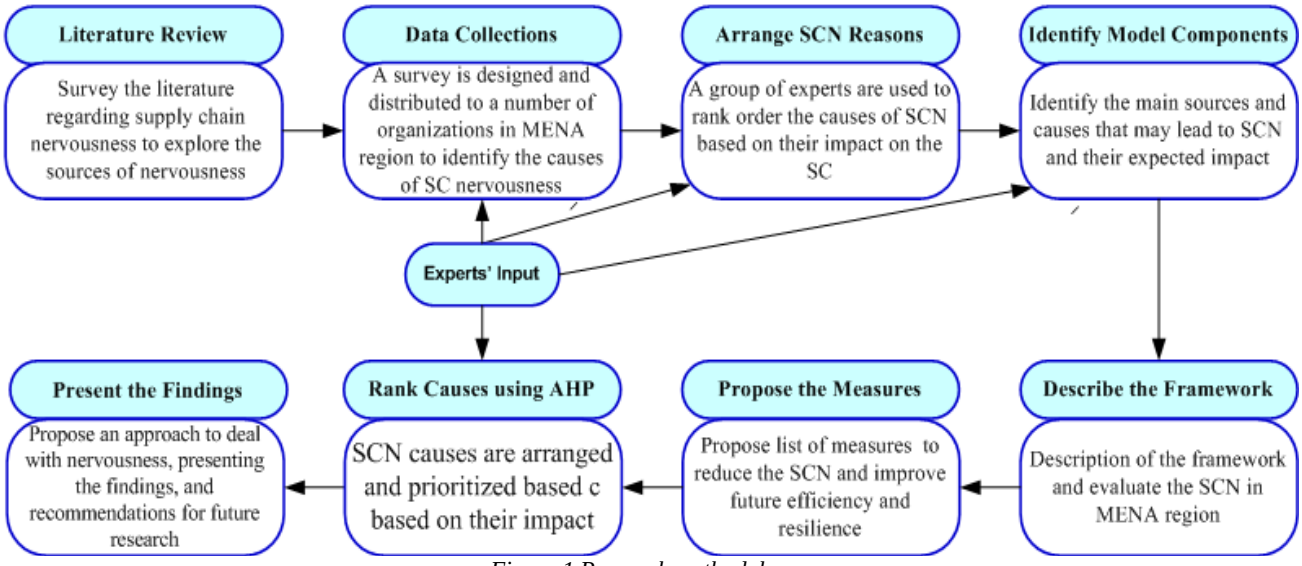


*Figure 1 Research methodology*

## 2 Literature review

Disruption in the supply chain cause post instability as a result of order delay and inventory accumulation. Shift of the residuals into post disruption cause a further delay and instability in the normal operations. To mitigate the instability effect there should be coordinated contingency procedure to prevent disruption [1]. Due to supply disruptions, demand instability, and government initiatives to combat the problem, the COVID19 pandemic had an impact on SC activities, operations, procedures, and management. The stress and panic caused by nervous decisions has an impact on SC operations and performance [2]. Political issue greatly effect supply chain management and it is implementation [3]. The change at one end of the supply chain greatly increases the shift from the steady state at the other end [4]. International crises taking into consideration financial instability effect the reaction of SC [5].

Nervousness results from time to time variability of orders given to the suppliers and resulted in a forecast error. Normal and proportional policy will reduce the bullwhip influence, SC inventory cost, and instability [5]. Systems nervousness results from the frequent review of the replenishment decisions because of the stochastic demand when coordinating the SC inventories [6]. Demand and supply are greatly affected by the rapid change in the market and the product variation. Demand planning accuracy vary among the SC partners and planning nervousness cause the bullwhip effect as the variation in demand amplified when sharing the information with the SC parties [7].

Globalization of the SC supporting the agglomeration and spreading and become healthier due efficient use of developing countries low cost labor but became less stable [8]. Currently with the growing of virtual SCs, companies not any more compete but the supply chains and the vertical integration is outdated. There is a need to visible the whole supply chain effectively to compete with others in the SC [9].

The integration of the dynamic SC functions can respond quickly and effectively to SC interruptions and changes and provides unique ability to current SC decision support systems [10]. The dynamic replenishment system can react successfully and efficiently to normal and disruptive supply chain operations [11]. Integration of supply chain segments with dynamic replenishments can improve partnerships, cost reduction and SCM efficiency [12,13].

SC nervousness associated with instability such as changes in task, source and SC uncertainties. These Uncertainties can be transformed into information processing which should be at the SC level. Sustainable SCM needs to turn into an organization's daily business to shape the SC of the future [14]. Supplier innovativeness and information sharing expedite collaborations in the global SC [15]. Sustainable SCM can improve economic, social, environment in global supply chains [16].

Performance of today SC relies on the accuracy, quality, and timing of the shared data between partners. Many companies used electronic data gathering systems, cloud computing based SC, and software applications to support collaboration among all SC segments to develop new innovative products [17]. Suppliers' innovation is

necessary for the process of development of new products and there is clear relationship between supplier integration and performance [18].

Nervousness can be understood of as "*a source of confusion or instability in the SC system caused by unexpected interference between decisions*" [19]. There is a connection between SC nervousness and demand planning and the bullwhip effect leading to a tangible difference in planning accuracy among SC partners [20]. The joint consideration of MRP nervousness and bullwhip effect in multi echelon SC reveals the system nervousness at various stages of SCs [21]. Planning nervousness should consider the relevant attributes of SC performance as there is a strong relationship between SCN planning and other SC segmentations [22].

While (23) discuss nervousness in the environment of current MRP strategy revisions, published research on nervousness in either modern GSC system or their impact framework are rarely exists. Nervousness is considered a major source of instability in the current and future SC resulting from unexpected interventions among decisions. Furthermore, there is no previous research investigates the supply chain nervousness in terms of causes and rank the SC nervousness sources based on their impact. This study was prompted by a lack of research depth to identify and investigate the main causes, effects, and measures, of supply chain nervousness. This research proposes an analytical framework for investigating nervous supply chains in MENA region, rank the causes using AHP method based on their criticality, and suggests a set of measures to mitigate SCN.

## 3 Causes of SCN

To identify the sources of SCN, a survey was developed and distributed to thirty leading organizations in MENA region. The survey consists of three major sections where each section aims to explore a side of the SCN causes: the first part ask about the SCN sources and causes and asked the respondent to rank order SCN causes based on their impact on their SCs, the second section concern about the impacts and effects of SCN sources and the sequences of the specified cause, the third part require the respondents to suggest measures to reduce the SCN. The survey consist of several questions including: the main sources of supply nervousness, causes of each type of source of nervousness, noise factors that are uncontrollable by SCs and contribute to the increase of the impact of nervousness, the risks associated with each cause of nervousness, the expected impact of nervousness on the supply chain operations and process, and the measures and metrics taken to reduce nervousness. Twenty four respondents answer the survey questions.

The literature review is utilized to list the available sources, causes, factors, and the impact of nervousness, as well as the measures mentioned in the reviewed articles. The data driven from the literature review, which represent the current nervousness factors worldwide, were made available to the experts to consider them in their decisions. A group of experts are used to identify the major sources and causes of SCN, study their impact, and cluster the causes in main and sub groups. It was also the role of the experts to rewrite and shorten the causes and effects, as they were given in different wordings and phrasing by the responses to the questionnaire.

Based on the literature, survey results, and the experts' opinion, Table 1 shows the main causes of SCN. The first column shows the sources of supply chain nervousness. The second column shows the causes of each source on the supply chain performance and operations. While the third/ frequency column indicates the number of respondents who included the reason specified in the cause column. For example, the first block in the frequency column specify that 23 respondent consider the "change in customers' need" as a source of SCN. The source reasons are arranged in descending order according to the number of times mentioned in the responses. Similarly, the causes for each source were arranged in descending order depending on the results of the questionnaire analysis.

All responses are summarized in ten main sources and their related causes. The largest number is for the variations in customer needs flowed by the crisis and disasters, while the smallest number is for the lack of integrations.

Based on the respondent answers to the third part of the questionnaire, the rank order of SCN sources based on their impact on their SCs are shown in Figure 2. The values were calculated using the following equation (1):

$$R_i = \frac{\sum_{j=1}^{n} r_{ij}}{n} \quad (1)$$

*Table 1 Causes of SCN*

| No. | Source | Cause | Frequency |
|---|---|---|---|
| 1 | Changes in customers' needs | Fluctuation in demand, change in production plan, change in inventory and stock policy, error in demand forecast, change in market place, change in products, competitor's advantages, and prices change | 23 |
| 2 | Disasters and crisis | Natural disasters such as earthquakes, dust storms, volcanos, storms, heat wave, diseases and its effect. Manmade disasters like ethnic and religious violence, Terror attacks, income equality, industrial accidents, refugees, migrations. Technological disasters like nuclear radiation, chemical accidents, biological propagation, power outages, climate change, natural gas explosions, and unplanned urbanizations. | 20 |
| 3 | Risk of supply continuity | Sporadic supply of raw material, unavailability of supply, instability in prices, shortage of resources, delivery conditions, political instability, fluctuation of quality and quantity, geographical instability, climate deviations, water shortages, and store nationalism | 19 |
| 4 | Safety and Security concerns | Security of the SC activities like transportation, shipping and handling, and all logistics practices, cyber security, risks, safety issues, the challenges of e-commerce, smuggling, piracy, cloud risk, devices interferences, poor quality hardware, local security on the facility itself, physical security to transportation for example, fraud, cargo theft, and virtual security. | 18 |
| 5 | Geopolitical instability | Change in state policies, regional conflicts, rapid changes of allies, crisis or wars, terrorism, UN resolutions, economic sanctions, and governmental lockdown. | 17 |
| 6 | Social unrest | Unemployment, inequality, financial crises, government failures, marginalized, disease epidemics, the anarchy of the sects, political instability, energy, food, discrimination, strikes, demonstration, objections to some products, high prices , and change in purchasing behavior and power. | 17 |
| 7 | Keeping pace with developments | Emerging trends, new technology, new product design, increased demand for quick responsiveness, low price, adopt new systems, new business trends, shorter products life cycle, and shorter product development cycle. | 15 |
| 8 | Environment concerns | Heat waves, flood, wildfire, and global warming, air pollution, toxics emissions, temperature changes, the seasons shifting, water shortage, oppressive land use, water pollution, energy usage, and contaminated waste, oil and chemical pills, and remediation and land reclamations. | 11 |
| 9 | Economic context | Risk of government decisions, tariffs, administrative and operations weaknesses, natural disasters, Bankruptcy, currency fluctuation, adequacy in SC infrastructure, outsourcing, redundancy systems, investment in wrong business, conflict of interests, global growth, international monetary system, shipping routes, sanctions, volatility in the international oil market, populism by country leader, trade competition between countries, political influences, socioeconomic causes, inflation, tariffs on trade, global financial system, and environmental considerations | 9 |
| 10 | Lack of integration | Objectives mismatch, difference in planning accuracy between partners, variance in decision-making process, overlapping interests, and lack of trust, commitment, transparency, IP protection, collaboration, partnerships, alliances, of information sharing, planning coordination, and operation flexibility. | 7 |

Where $r_{ij}$: rank of source $i$ by respondent $j$, $n$ represent the total number of respondent and $R_i$ represent the rank of nervousness source $i$.

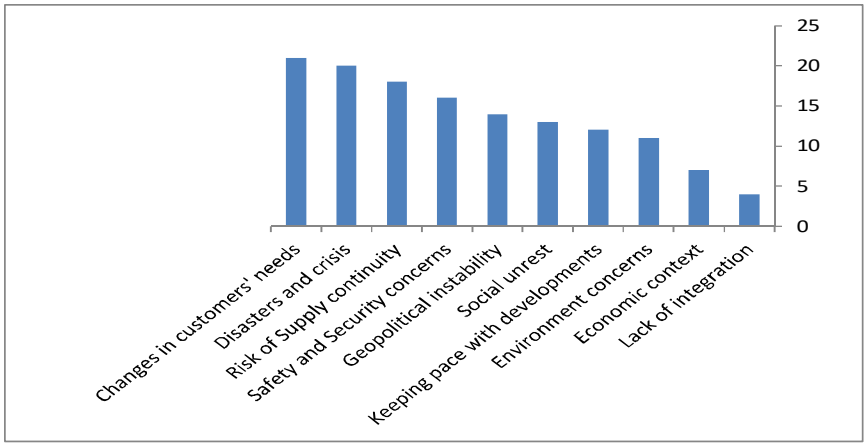


*Figure 2 Rank of SCN sources based on respondents' answers*

## 4 Framework for SCN in MENA region

In this section, a framework is developed to understand and analyze the supply chain nervousness in MENA region. MENA supply chain is part and strongly connected to the global SC. It effects and affected by the changes in the global supply chain like what happened during COVID19 pandemic crises. MENA SC chain has it is own conditions and is greatly affected by the never ended crisis in the region. The region is in the center of attention for many countries along with the political and social unrests which affect the SC performance and efficiency in the region. Therefore, MENA-SC is greatly affected by the SC nervousness. Nervousness in the MENA SC has some kind of unique characteristics due to the economic conditions, terrorists, piracy as well as the defense SC. The region is one of the largest consumers of weapons and defense equipment and the large weapon companies compete heavily in the Middle East market. In addition to the high number of partners, fierce competition, quick changes in demand, and a lack of environmental considerations, the lack of interest of logistic businesses in the region in sharing information with their chain partners, as well as delays in response and financial transactions, contributed to supply chain instability. This has a negative impact on costs, delivery times, and service quality between suppliers and consumers.

Figure 3 shows a framework of the nervousness in the supply chain of the MENA region. The framework consists of five major parts including nervousness sources and main causes, nervousness impact on the SC efficiency, and the noise factors that effect and affected by the SC nervousness, risk of uncertainty, and the suggested measures to deal with SC nervousness. The components of the framework are interconnected and interrelated, and are necessary to learn, explore, and understand the SC nervousness.

The sources of nervousness in the supply chain are classified into two main categories: the external sources of nervousness like natural disasters and manmade disasters and technological crisis, and the internal sources of nervousness like inside the organization and the global supply chain. Internal sources are considered the sources of nervousness within the global supply chain of the organization.

Nervousness causes could be internal like change in production plan, MRP system, change in requirements, BOM, inventory policy. The external causes of nervousness are out of the company control including the natural disasters or pandemic diseases. Based on the analytical study, the following summarize the main sources and causes of nervousness in the SC:

1. Changes in customers' needs and requirements. Customer demand is subject to change due to different reasons like change in market place, change in products, introduction of new technology, competitor's advantages (high quality, new tech, prices, advertisements), and prices change. This fluctuation in customer demand result in order deletion, decease or increase in order quantity. Customer demand change (new orders, order deletions, change in quantity, product return) make order decisions subjected to more frequent revisions affecting the systems throughout the SC. Also, error in demand forecast leads to frequent schedule change resulting in nervousness.
2. The necessity to cope up with emerging trends. Sometimes companies need to adopt new technology, software or hardware, to alter the product or add new features to stay competitive. Due to the introduction of new business trends, new technologies, shorter products life cycle, shorter product development cycle, environmental, and climate considerations, companies may need to respond quickly to survive which require change in their strategies, plans and decisions.
3. Supply continuity. The erratic and irregularity in the supply lead to decisions nervousness make it essential to ensure the continuity of supply and the availability of constituents/ components from suppliers. The sporadic supply of raw material, ingredients, components, parts, and subsystems from vendors interrupt the production schedule and require more frequent decisions. For example the supplies of agricultural crops are greatly affected by the season,

disease, international demand, and global prices. The majority of MENA countries rely on the imported wheat form different sources resulted in a fluctuation of quality, quantity, and prices. Any disruptions can greatly affect the SC especially in the current complex, interrelated, and global SC. One of the most problems in MENA-SC is to stable network of vendors and supplier to assure the continuous supply. Sometimes suppliers change their processes which negatively affect customers. Supplier selection and partnerships is one of the essential factors for supply chain stability.

4. Geopolitical instability. MENA-SC is greatly affected by the political issues between countries both regionally and internationally. The countries in the region have no chance but to change their supply chain relationships and allies rapidly and directly once there is contrast between their policies, regardless of the obstacles and consequences, as what happened between many of the Gulf countries and Qatar in 2017. In addition, the region almost has a continuous presence of conflicts so that it is hardly to have a year without crisis or wars. Examples include what happened since 2010 and beyond of what's known as "Arab Spring" and the consequence disruptions of the supply chain in the region, where the need to search for new supply chains and new partners emerged as a result of the interruption of production and import and export limitations and stoppage in many countries such as Syria. Syria was one of the main sources of many goods and agricultural products to the region. For example, 60% of the volume of Jordanian trade exchange comes from or through Syria [24]. In addition to the terrorism that has prevailed the region and the world for a long period of time which has led to great challenges in dealing with some countries, companies and people.
5. Social instability. Arab spring is an example of how social issues and instability affect the market and was resulted from the protest of unemployed youth. The demographic and population dispersion effect the distribution of the products to the end-users. Social instability directly affects state economies, which are directly reflected in the supply chain, causing changes in plans and decisions. The social impact can be triggered at any moment as a result of a situation, high prices, violation of social customs, religious abuse, economic matters, unemployment, or political changes which negatively affect the performance and efficacy of the supply chain.
6. Economic context. Unexpected economic uncertainty impact the business, so it vital to keep updated of economic situation globally. This is because the changes in one country impact other countries like currency deflation and debt concerns. This assures the globalism of the SC. Changes like the increase in production, prices, taxes, customs, trade tariffs between countries, and border control restrictions complicate the trade and travel between countries. Inadequacy in SC infrastructure, outsourcing, efforts duplications, redundancy systems, and investment in wrong business are also cause economic instability. Today economy control the politics of the countries resulted in what so called trade war. Like what is going on between USA and China.
7. Disasters and crises. Disasters and crises are a major cause of internal and external changes, and the cause can be over the power of people (out of control or even prediction), of their making, or of things that humans have made, but controlling them outpaces their capabilities or requires enormous potential. Whatever the type of emergency, crises and disasters, it ultimately leads to an impact on the supply chain locally and internationally, causing a state of instability and contraction. There are some disasters that do not happen in the region and others that occur more frequently, such as dust storms. However, the region is characterized by many crises resulting from wars, displacement, refugees, famines, diseases and epidemics, terrorism, and political, social and economic instability, which directly affecting the supply chain, causing nervousness to MENA-SC.
8. Environmental concerns. Climate changes affect supply chain operations and activities like costs, performance, speed, transportation, responsiveness, shipping and handling, and quality resulting in major interruptions. Weather and climate like disasters are unpredictable which increase the difficulty of SCM and its processes. Heat waves, flood, cyclones, storms, extra rainfall, weather change, drought, decreasing snowfall, wildfire, and worming are resulting from climate change. These changes cause damage to the SC infrastructure, warehouses, streets, bridges, power generation plants, crops, etc. climate change cause a damage to raw material and natural resources like wild fire which destroy the forests and agricultural crops caused by heat waves and drought. This requires a quick reaction from the supply chain to changes in environmental requirements just like a change in user requirements.

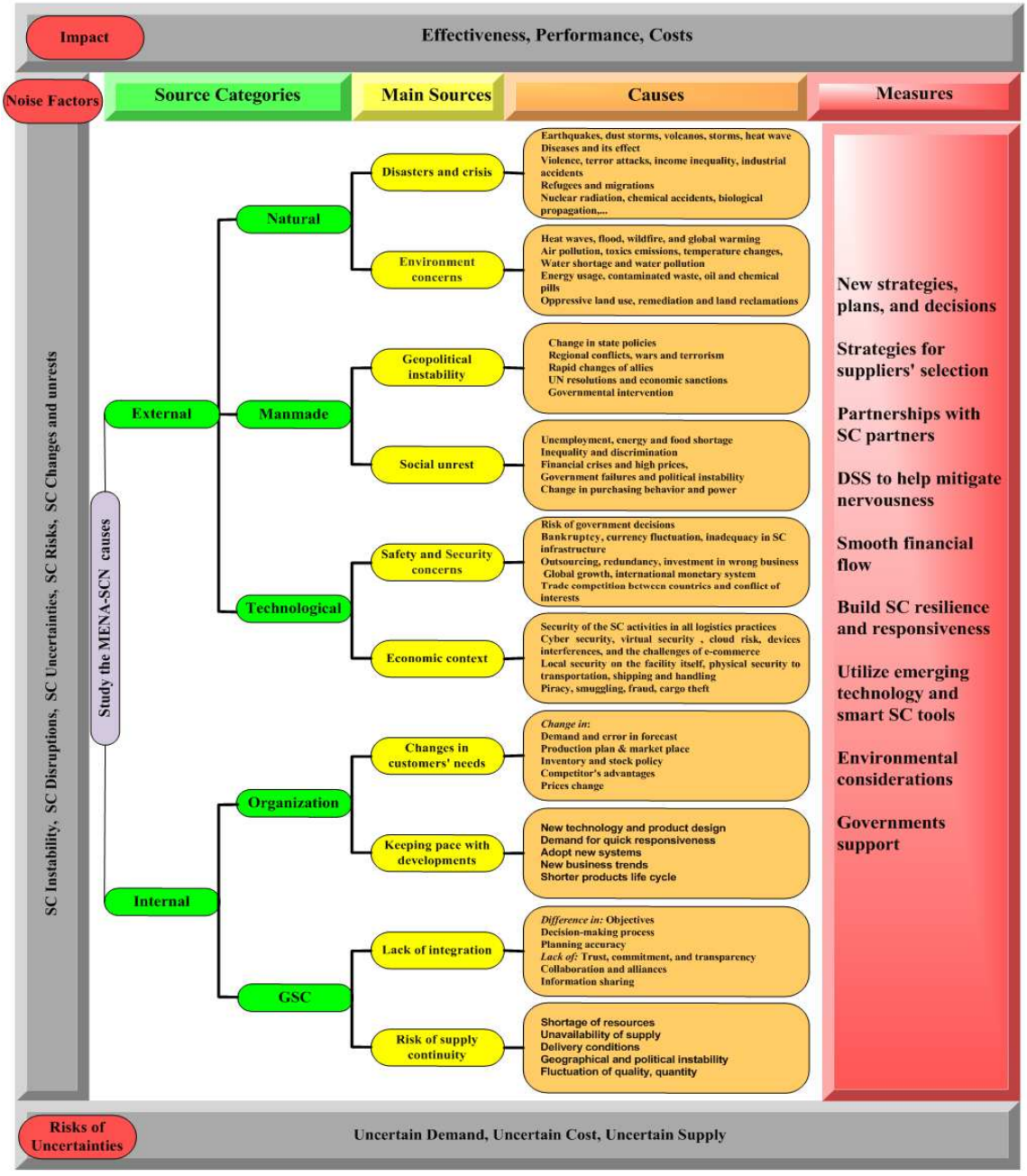


*Figure 3 MENA-SCN framework*

9. Lack of Integration. Partnerships and alliances are part of the SC competition; some make decisions regardless of their impact on others. The difference in planning accuracy between partners, decision-making process, lack of integration and overlapping interests, and how they handle risks lead to fluctuations and differences in plans and decisions. Lack of collaborations leads to lack of transparency in the SC decision-making system which adversely affect the trust among partners. Lack of desire to share data and knowledge leads to continuous change in partner plans and decisions causing the SC nervousness.
10. Security and safety concerns. The main threats include criminal statistics usage, production shrinkage, theft, terrorism, smuggling, piracy, IP loss, and intercepting of money transfer, competitor penetration, and goods imitating. Safety and security of the supply chain, including its physical and virtual risks affect all parts of the supply chain, including transportation, inventory, transported goods, common data, and the equipment used. Therefore, any security problem in the supply chain results in a change in the supply chain procedures, causing a kind of nervousness in the plans and decisions of the companies involved in the chain.

There are several noise factors that are effect the SC nervousness like SC instability, disruptions, uncertainties, risk, changes and unrest. These factors require regular rescheduling of orders in terms of setup and quantity to constantly respond to varying demand requests, where a necessary trade off among responsiveness, cost, and instability occurs. They results in change and frequent rescheduling of orders in terms of timing and quantity requiring frequent rescheduling activities. Instability is present even with stable demand. Undesirable effects of noise factors iclude ıncreased production and inventory costs, ıincreased in throughput times, reduced productivity, decrease in capacity utilization, lower customer service levels, confusion on the decision making system, loss of confidence to planning system, low morale, etc.

The risk of uncertainity is considered the one of the main root and sources of supply chain nevousness. The principal risk of SC uncertainity come from the uncertain demand, cost, supply. Therefore special attention should be paid to these factors in the SC strategies, policies, and planning.

SC managers should take several measures to reduce the impact of SCN. These measures may include new strategies, plans, and decisions, strategies for suppliers' selection, partnerships with SC partners, developed decision support systems to mitigate nervousness, smooth financial flow, build SC resilience and responsiveness, utilize emerging technology and smart SC techniques, consider environmental factors, and seek the governments support to minimize the impact of their decisions.

Organization should seek the continuity of their SC in case of crises such as the wake of COVID19 pandemic. It is important to know when and where the disruption will occur and how countries will react. The most important thing is the guarantee the continuity of the SC during and beyond crisis. Therefore, organizations and their SCs partners need to constantly reviewing the politics, regulations, and technological changes to avoid the risk of inability to supply products. SC partners are required to share information to increase visibility and resulted in unity SC decisions. For success business, enterprises need to integrate SC and business, technologies, employees, and the decision making systems.

SC-Security should be a high priority to firms and should cover all SC activities and functions like transportation, shipping and handling, and all logistics practices to eliminate any disrupt of the operations. The main objectives of SC security should be to recognize, evaluate, prioritize, and provide solutions to SC risks and nervousness. There should be a balance in relationship between human, environment, and industrial revolution to face the dramatic increase in the earth population, and the high rate of consumption and reduction in natural resources.

## 5 Delphi-AHP tool

The Delphi method is used to obtain data from a panel of experts sequentially through structured questionnaires. It is a very practical way to achieve a convergence of opinions. To obtain generally reliable results, studies have shown that at least ten experts are sufficient [24]. A total of eleven experts were used in this study to obtain reliable results. All experts have more than 15 years of experience in supply chain areas. To identify the most prominent SCN causes, a Delphi technique was performed in three rounds. The experts were asked to confirm the main source causes, sub- causes, and sub- causes at three levels in the hierarchy. The experts were asked to add or eliminate SCN causes in the model presented to them.

Once selecting the causes of SCN, AHP is used to prioritize the causes. AHP is a widely used and practical method of pairwise [25] and is suitable for ranking variables and modularizes a problem [26]. AHP approach was used to evaluate different variables [27], asses SC risk drivers [28], and to calculate the decisions of outsourcing location on SC resilience [29]. The AHP methodology used in this study include the following steps:

1. Outline the research objective. The research objective is to study the MENA region SCN factors including sources and causes.
2. Form the hierarchical structure. The hierarchical structure created was shown to and confirmed by experts using the Delphi method.
3. Develop the pairwise comparison matrices. Pairwise comparison matrices are built for all levels of causes. A questionnaire was formed using 1 to 9 scale to collect data from experts on paired comparison matrices for all SCN sources and causes.
4. Determine the priority weights. The eigenvalues and the eigenvector are calculated for the pairwise comparison matrices developed for SCN causes and sub-courses.
5. Examine the consistency ratio. Check the consistency of the pairwise comparison matrix using the following equations: $\lambda_{max} = average\ (AxX/X)$, where X is the priority vector and a pairwise comparison matrix, consistency index $CI = \lambda_{max} - n/n - 1$, the consistency ratio $CR = CI/RI$, RI is a random index based on matrix different sizes.

In this study, a framework for the SCN Assessment was proposed and SCs from the MENA region were selected to provide a case application of this tool. Thus, it is imperative to identify the SCN causes. The Delphi-based AHP approach has certain advantages over AHP-based interviews as it is free from prejudice and data acquisition through iterations improves data quality and stops when data saturation is reached. The hierarchical model of SCN causes is as described in Figure 3.

## 6 Discussion of Case Application and results

Twenty four enterprises from MENA region were taken for this study. As a result, significant organizations from two different continents (Asia and Africa) expressed a strong desire to use the SCN tool. Consequently, eleven senior experts agreed to participate in the research study. The experts were selected based on their experience and knowledge. These eleven executives and managers provided decision-making hierarchy data to refine the SCN tool, and we then collected data in paired comparison matrices from these experts. The executives' above responses are then converted into sharp scores according to the AHP scale to calculate the weights per AHP [30].

A three-stage research methodology was used for data collection and analysis. In stage one, a list of SCN causes were identified and selected from the literature search and survey results; Stage two, determined the most relevant causes with the help of business experts. The experts refined the causes into a three-level hierarchical level model. This goal was achieved through a Delphi method. In Delphi, three iterations were enough to achieve the data stability in responses; Phase three, SCN causes were classified using the AHP method. In level one five main source causes of SCN in MENA region were identified, level two determine the ten secondary causes, and level three conclude the fifty causes at the lowest level. Figure 3 shows the hierarchical SCN model after three rounds of iteration.

After that, we calculate the priority vector for each level SCN causes using the AHP method. The pairwise comparison matrix for the main causes is shown in Table 2. The calculations of the consistency index and ration, $\lambda_{max}$ = 5.270; CI= 0.22; CR=0.06 <0.1, indicate the consistency of the matrix. The paired comparison matrix for causes was structured similarly. The priority vector was calculated for each matched comparison matrix and the consistency ration is acceptable as CR<0.1.

*Table 2 Pairwise Comparison matrix for main SCN sources*

| Goal | Natural | Manmade | Technological | Internal | Normalized principal eigenvector |
|---|---|---|---|---|---|
| Natural | 1 | 2 | 3 | 5 | 36.24% |
| Manmade | 1/2 | 1 | 2 | 4 | 25.16% |
| Technological | 1/3 | 1/2 | 1 | 1 | 9.03% |
| Organizational | 1/5 | 1/4 | 1 | 1 | 6.07% |
| GSC | 1/2 | 1/2 | 3 | 7 | 23.49% |

The overall weight of each subcauses was calculated as shown in Table 3. Diseases and its effect have the highest weight (0.081) when presenting the classification of the selected causes. Violence, terror attacks, income inequality, industrial accidents ranked the second highest with a weight of (0.065); refugees and migrations ranked third (0.055); Regional conflicts, wars and terrorism ranked fourth (0.054), and Governmental intervention and political instability ranked the fifth (0.054). This means that these subcauses are the major driving forces to the SCN in MENA regions. The first three with the highest ranks are part of the disasters and crises while the fourth and fifth subcauses are part of the geopolitical instability. Adopt new systems ranked the lowest (0.0008). This suggests that decision makers should pay more attention to SC external factors when assessing MENA-SCN systems.

The priority vector for the SCN causes at level 3 the relative importance of the SCN sub-causes was obtained. These partial drivers can be mitigated in practice using proper solutions. SCN measures are practical solutions that can be used directly to reduce the impact of partial SCN sources.

The results are helpful for supply chain professionals to get a well advice of the nervousness of their SC and provide information to understand which factor plays a larger role in nervousness. The results explore the factors increase risk if the unknown occurs, and how sensitively SCs react to such interruptions. Research results on the SCN business causes rankings show that most of external causes are in the top twenty in the SCN involvedness category.

The results of the analysis described above should be considered by both SC managers and executives in the current Covid-19 consequence to implement mitigation strategies and close the missing links in SCs. Identifying the root causes of the SC weakness would help strengthen the SC. Nervousness can be controlled by reducing the complexity of the supply chain. This could be achieved by improving the transparency and integration with new SC strategies, utilizing emerging technologies, government support and building new SC resilience.

*Table 3 Ranking of SCN sources in MENA-SCs*

| Level I | Weight | Level II | Weight | Level III | Weight | Global Weight | Global Ranking |
|---|---|---|---|---|---|---|---|
| Natural | 0.362 | Disasters and crisis | 0.72 | Earthquakes, storms, volcanos | 0.14 | 0.03652992 | 7 |
| | | | | Diseases | 0.31 | 0.08088768 | 1 |
| | | | | Violence, terror attacks, inequality | 0.25 | 0.065232 | 2 |
| | | | | Refugees and migrations | 0.21 | 0.05479488 | 3 |
| | | | | WMS propagation | 0.09 | 0.02348352 | 17 |
| | | Environment concerns | 0.28 | Heat waves, flood, wildfire | 0.24 | 0.02435328 | 14 |
| | | | | Water shortage and pollution | 0.27 | 0.02739744 | 11 |
| | | | | Air pollution, toxics emissions | 0.3 | 0.0304416 | 9 |
| | | | | Energy usage, contaminated waste | 0.15 | 0.0152208 | 24 |
| | | | | Oppressive land use | 0.04 | 0.00405888 | 44 |
| Manmade | 0.252 | Geopolitical instability | 0.67 | Change in state policies | 0.14 | 0.02360008 | 15 |
| | | | | Conflicts, wars and terrorism | 0.32 | 0.05394304 | 4 |
| | | | | Rapid changes of allies | 0.08 | 0.01348576 | 29 |
| | | | | UN resolutions and sanctions | 0.14 | 0.02360008 | 16 |
| | | | | Governmental intervention | 0.32 | 0.05394304 | 5 |
| | | Social unrest | 0.33 | Unemployment and food shortage | 0.27 | 0.02241756 | 18 |
| | | | | Inequality and discrimination | 0.17 | 0.01411476 | 28 |
| | | | | Financial crises and high prices, | 0.18 | 0.01494504 | 26 |
| | | | | Government failures and political instability | 0.12 | 0.00996336 | 35 |
| | | | | Change in purchasing behavior and power | 0.26 | 0.02158728 | 19 |
| Technology | 0.090 | Safety and Security concerns | 0.58 | Risk of government decisions | 0.29 | 0.01518846 | 25 |
| | | | | Bankruptcy and currency fluctuation | 0.09 | 0.00471366 | 42 |
| | | | | Outsourcing and redundancy | 0.27 | 0.01414098 | 27 |
| | | | | Global growth and system | 0.15 | 0.0078561 | 38 |
| | | | | Trade competition | 0.2 | 0.0104748 | 33 |
| | | Economic context | 0.42 | Security of the SC activities | 0.27 | 0.01024002 | 34 |
| | | | | Cyber and virtual security | 0.34 | 0.01289484 | 30 |
| | | | | Challenges of e-commerce | 0.08 | 0.00303408 | 46 |
| | | | | Local and physical security | 0.17 | 0.00644742 | 39 |
| | | | | Piracy, smuggling and cargo theft | 0.14 | 0.00530964 | 41 |
| Organization | 0.061 | Changes in customers' needs | 0.81 | Change in demand | 0.41 | 0.02015847 | 22 |
| | | | | Change in Production plan | 0.12 | 0.00590004 | 40 |
| | | | | Change in Inventory policy | 0.07 | 0.00344169 | 45 |
| | | | | Change in Competitor's advantages | 0.22 | 0.01081674 | 32 |
| | | | | Change in prices | 0.18 | 0.00885006 | 37 |
| | | Keeping pace with developments | 0.19 | New technology and product design | 0.37 | 0.00426721 | 43 |
| | | | | Demand for quick responsiveness | 0.25 | 0.00288325 | 47 |
| | | | | Adopt new systems | 0.07 | 0.00080731 | 50 |
| | | | | New business trends | 0.17 | 0.00196061 | 48 |
| | | | | Shorter products life cycle | 0.14 | 0.00161462 | 49 |
| GSC | 0.235 | Lack of integration | 0.62 | Difference in objectives | 0.22 | 0.03204036 | 8 |
| | | | | Difference in DM process | 0.26 | 0.03786588 | 6 |
| | | | | Difference in planning accuracy | 0.14 | 0.02038932 | 21 |
| | | | | Lack of trust and commitment | 0.2 | 0.0291276 | 10 |
| | | | | Lack of Collaboration and alliances | 0.18 | 0.02621484 | 12 |
| | | Risk of supply continuity | 0.38 | Shortage of resources | 0.22 | 0.01963764 | 23 |
| | | | | Unavailability of supply | 0.24 | 0.02142288 | 20 |
| | | | | Delivery conditions | 0.14 | 0.01249668 | 31 |
| | | | | Geographical and political instability | 0.29 | 0.02588598 | 13 |
| | | | | Fluctuation of quality, quantity | 0.11 | 0.00981882 | 36 |

## 7 Conclusion

This research explore the nervousness of the supply chain in MENA region in terms the SCN sources, main causes, noise factors, risks of uncertainty, impact, and the measures to mitigate the SCN. To this end a survey is developed and distributed to companies in the region and a group of experts are utilized to identify the major causes of SCN, study their impact, analyze the measures, and group the causes in main and subcategories. Based on the analysis, a framework was introduced to understand and investigate the SCN in MENA regions. The results indicate the nervousness sources and causes and rank the cause based on their impact. Existence of SCN even in the most stable SCs necessitates the exploration of the required measures to reduce the effect of nervousness. A list of measures is proposed to decrease the SCN and improve competitiveness, effectiveness, and future SC resilience.

As part of the global supply chain, MENA-SC suffers from nervousness with special characteristics. Nervousness in SCM systems is thought to be a source of confusion, instability, or uncertainty in SC systems due to disruptions or unexpected decisions. Nervousness increase, potentially due to the frequent change in the decisions, more frequent change in decisions lead to a confusion for both workers and customers resulting in a reduction in trust, moral, and loyalty to the SC system. Nervousness increases the bullwhip effect, pushing SC to strengthen the buffer against frequent decision changes. When all of these elements are considered, anxiousness might result in a high level of discontent. As a result, system nervousness should be considered because it has a good or negative impact on the entire SC, typically at the same time for different SC partners and locations.

Supply chains have become more nervous in recent years. Understanding SCN has become essential for SC-managers in times of high uncertainty, as Covid 19 further explains this situation. Decision makers in MENA countries should rethink of the design of their SCs from a nervousness perspective. Therefore, this research adds to the literature on SCN by evaluating SCN factors such as causes, impact, and measures. This research identified five main categories and fifty operational causes. These SCN causes can be reduced and managers can take action to reduce the negative effects of disruption. Supply chain disasters and crises, geopolitical instability, and social unrest were found to be the most significant factor.

The results of the study help industrial managers, practitioners and decision-makers to focus on the SCN considerations during the planning stages, to increase sustainability in MENA supply chains, and further advance corporate and supply chain resilience development. The framework may also serve as a theoretical construct for a future empirical study on sustainable supply chain innovation in the manufacturing sector. Furthermore, the study introduce many policies and strategies to reduce nervousness in the SCs. Nervousness solutions may include integration, dealing with the problem from an external perspective, coordination's with partners, customers, and suppliers, and reduce instability in production environment.

This proposed SCN framework could be used to conduct surveys in different industries or consider the global supply chain (GSC) nervousness, and it would also provide interesting information and attention to GSC managers that require immediate attention. To capture the ambiguity of data collection by experts, advanced techniques such as Fuzzy-AHP technique can be used. This research can help companies decide strategies to reduce nervousness in the SCs, and would lead to a better assessment and decision on future resilient supply chains.

Future studies should examine the causes that lead to the occurrence of nervousness in the supply chain, methods of measuring it, and the appropriate solutions. Additional research may focus on evaluation of the nervousness solutions and use multi criteria decision making (MCDM) techniques to analyze and rank order the solutions based on their priority of implementation. Further research should deal with the nervousness in the global supply chain in terms of causes, sequences, measures, and solutions; so that decision makers can benefit from it in light of globalization, disruptions and instability in the supply chain, which ultimately leads to sustainable SC and increases the future resilience, responsiveness, and competitiveness of the SC.

**Acknowledgement**
This work was not funded by any agency.

## References

[1] IVANOV, D., ROZHKOV, M.: Disruption Tails and Post-Disruption Instability Mitigation in the Supply Chain, *IFAC-PapersOnLine*, Vol. 52, No. 13, pp. 343-348, 2019. https://doi.org/10.1016/J.IFACOL.2019.11.140

[2] MAGABLEH, G.M.: Supply Chains and the COVID-19 Pandemic: A Comprehensive Framework, *European Management Review*, Vol. 18, No. 3, pp. 363-382, 2021. https://doi.org/10.1111/emre.12449

[3] JADALLAH, N., BHATTI, F.: Political Instability and Sustainable Green Supply Chain Management, *Management Science Letters*, pp. 1169-1178, 2020. https://doi.org/10.5267/j.msl.2019.12.001

[4] NGUYEN, T.: Technical Note—Local Bargaining and Supply Chain Instability, *Operations Research*, Vol. 65, No. 6, pp. 1535-1545, 2017. https://doi.org/10.1287/opre.2017.1605

[5] LI, Q., DISNEY, S.M.: Revisiting Rescheduling: MRP Nervousness and the Bullwhip Effect, *International Journal of Production Research*, Vol. 55, No. 7, pp. 1992-2012, 2016. https://doi.org/10.1080/00207543.2016.1261196

[6] TUNC, H., KILIC, O.A., TARIM, S.A., EKSIOGLU, B.: A simple approach for assessing the cost of system nervousness, *International Journal of Production*

*Economics*, Vol. 141, No. 2, pp. 619-625, 2013. https://doi.org/10.1016/j.ijpe.2012.09.022

[7] KAIPIA, R., KORHONEN, H., HARTIALA, H.: Planning nervousness in a demand supply network: an empirical study, *The International Journal of Logistics Management*, Vol. 17, No. 1, pp. 95-113, 2006. https://doi.org/10.1108/09574090610663455

[8] FUJITA, M., HAMAGUCHI, N.: Supply chain internationalization in East Asia: Inclusiveness and risks, *Papers in Regional Science*, Vol. 95, No. 1, pp. 81-100, 2015. https://doi.org/10.1111/pirs.12183

[9] ARCHIBALD, G., KARABAKAL, N., KARLSSON, P.: Supply chain vs. supply chain: Using simulation to compete beyond the four walls, In: *Proceedings of the 31st conference on Winter simulation: Simulation---a bridge to the future*, Vol. 2, pp. 1207-1214, 1999. https://doi.org/10.1145/324898.325039

[10] MAGABLEH, G.M., MASON, S.J.: An integrated supply chain model with dynamic flow and replenishment requirements, *Journal of Simulation*, Vol. 3, No. 2, pp. 84-94, 2009. https://doi.org/10.1057/jos.2008.22

[11] MAGABLEH, G.M.: A Dynamic Replenishment System for Integrating Supply Chain functions, *Maritime Economics & Logistics*, Vol. 9, No. 1, pp. 52-66, 2007. https://doi.org/10.1057/palgrave.mel.9100171

[12] MAGABLEH, G., MASON, S.J. Increased supply chain efficiencies through integration, In: *IIE Annual Conference, Proceedings*, pp. 1, Institute of Industrial and Systems Engineers (IISE), Portland, Oregon – USA, 2003.

[13] MAGABLEH, G.: Integration of Supply Chain Warehousing and Transportation Functions: A Dynamic Replenishment System (DRS), 3rd, *Annual Tech Summit Conference (TSC)*, University of Arkansas, Fayetteville, Arkansas – USA, 2003.

[14] BUSSE, C., MEINLSCHMIDT, J., FOERSTL, K.: Managing Information Processing Needs in Global Supply Chains: A Prerequisite to Sustainable Supply Chain Management, *Journal of Supply Chain Management*, Vol. 53, No. 1, pp. 87-113, 2016. https://doi.org/10.1111/jscm.12129

[15] KIM, M., CHAI, S.: The impact of supplier innovativeness, information sharing and strategic sourcing on improving supply chain agility: Global supply chain perspective, *International Journal of Production Economics*, Vol. 187, pp. 42-52, 2017. https://doi.org/10.1016/j.ijpe.2017.02.007

[16] KOBERG, E., LONGONI, A.: A systematic review of sustainable supply chain management in global supply chains, *Journal of Cleaner Production*, Vol. 207, pp. 1084-1098, 2019. https://doi.org/10.1016/j.jclepro.2018.10.033

[17] HUGOS, M.H.: *Essentials of Supply Chain Management, 4th ed.*, John Wiley & Sons, 2018. https://doi.org/10.1002/9781119464495

[18] WAGNER, S.M.: Tapping Supplier Innovation, *Journal of Supply Chain Management*, Vol. 48, No. 2, pp. 37-52, 2012. https://doi.org/10.1111/j.1745-493x.2011.03258.x

[19] MAGABLEH, G.M.: *A dynamic replenishment system for integrating supply chain warehousing and transportation functions*, Doctorate dissertation, University of Arkansas, 2004.

[20] KAIPIA, R., KORHONEN, H., HARTIALA, H.: Planning nervousness in a demand supply network: an empirical study, *The International Journal of Logistics Management*, Vol. 17, No. 1, pp. 95-113, 2006. https://doi.org/10.1108/09574090610663455

[21] LI, Q., DISNEY, S.M.: Revisiting rescheduling: MRP nervousness and the bullwhip effect, *International Journal of Production Research*, Vol. 55, No. 7, pp. 1992-2012, 2017. https://doi.org/10.1080/00207543.2016.1261196

[22] ANDERSEN, A.L., PRÆSTHOLM, N., NIELSEN, K., BRUNØ, T.D.: Planning Nervousness in Product Segmentation: Literature Review and Research Agenda, In: *IFIP International Conference on Advances in Production Management Systems*, pp. 403-410, Springer, Berlin, Heidelberg, 2014. https://doi.org/10.1007/978-3-662-44739-0_49

[23] ASSAF, O.: Sanctions on Syria increase Jordan's suffering, *Ammonnews*, Retrieved 25/7/2021, [Online], Available: https://www.ammonnews.net/article/103979 [05 Feb 2022], 2021.

[24] OKOLI, C., PAWLOWSKI, S.D.: The Delphi method as a research tool: an example, design considerations and applications, *Information & Management*, Vol. 42, No. 1, pp. 15-29, 2004. https://doi.org/10.1016/j.im.2003.11.002

[25] SAATY, T.L.: Decision making with the analytic hierarchy process, *International Journal of Services Sciences*, Vol. 1, No. 1, pp. 83-98, 2008. https://doi.org/10.1504/ijssci.2008.017590

[26] ISHIZAKA, A., LABIB, A.: Review of the main developments in the analytic hierarchy process, *Expert Systems with Applications*, Vol. 38, No. 11, pp. 14336-14345, 2011. https://doi.org/10.1016/j.eswa.2011.04.143

[27] PAMUČAR, D., STEVIĆ, Ž., ZAVADSKAS, E.K.: Integration of interval rough AHP and interval rough MABAC methods for evaluating university web pages, *Applied Soft Computing*, Vol. 67, pp. 141-163, 2018. https://doi.org/10.1016/j.asoc.2018.02.057

[28] SHARMA, S.K., BHAT, A.: Supply chain risk management dimensions in Indian automobile industry, *Benchmarking: An International Journal*, Vol. 21, No. 6, pp. 1023-1040, 2014. https://doi.org/10.1108/bij-02-2013-0023

[29] LÓPEZ, C., ISHIZAKA, A.: A hybrid FCM-AHP approach to predict impacts of offshore outsourcing location decisions on supply chain resilience, *Journal*

*of Business Research*, Vol. 103, pp. 495-507, 2019. https://doi.org/10.1016/j.jbusres.2017.09.050

[30] SAATY, T.L.: *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*, McGraw-Hill. New York, 1980. https://doi.org/10.1016/0377-2217(82)90022-4

**Review process**
Single-blind peer review process.