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Prioritizing Factors Influencing the Logistics Performance of the Hospitals' Supply Chains in Transferring the Corona Patients

Abstract:

The present study aims at prioritizing the factors influencing the logistics performance of the hospitals' supply chains in transferring the corona patients using multi-criteria decision-making. The features are weighed and prioritized using the AHP method. The present study has been conducted on 30 corona patients in a pilot format. The results obtained from the aforesaid study would be applied to determining the complete and final study sample volume. Based on the literature review and study backgrounds, the factors influencing the logistics performance of the hospitals' supply chains in transferring the corona patients were extracted; two indices consisting of two aspects were figured out and, regarding these factors' domestication, 30 experts were asked within the format of a questionnaire to give each of the scores a value based on Likert's five-point scale. Delphi test results indicated that all of the study's indices have mean values above 3 so they have acquired the required scores and are confirmed. The pairwise comparisons of the scales and subscales were carried out and the experts (n=30) were provided with the results. After completing the pairwise comparison matrices, the inconsistency rate of each was calculated and it was found that these inconsistency rates are all below 0.1 indicating the stability and consistency of the matrices.Based thereon, amongst the 20 subscales, several transportation times were found in the first rank followed by the services' assurance and, then, the inventory to sales.

Keywords: *Factors, Performance, Logistics, Supply Chain, Hospital, Corona Patients, Multi-Criteria Decision Making*

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Introduction

The hospitals' internal supply chain is substantially specified by such properties as complexity, uniqueness, and operational challenges like very expensive products and the medical appliances used in the operation rooms, difficult tracking of the inventory due to the emergency nature of the treatments, and the unpredictable demand for medical equipment (Holsho et al, 2019).

There are various kinds of instruments and equipment stored in hospitals' warehouses and many of the hospital processes like clinical processes, procurement processes, and administrative processes are applied to help achieve a high quality of patient care (Chang et al, 2020). Therefore, it would be very useful to take advantage of the logistics methods in the hospitals for controlling and distributing the resources when they are being transferred to the healthcare wards of the hospital. In recent years, however, the cost of the logistics measures like maintenance, dislocation, and materials and tools processing has undergone a notable increase and they account for about 20% to 45% of the patients' total operational expenses. The primary reason for such a considerable cost is the wastage within the healthcare and treatment supply chain processes. For example, the supply and procurement of the operation rooms have become an important and primary source of the hospitals' spending of money, as documented, explaining about 40% to 60% of the hospitals' expenditures (Sway et al, 2014).

In sum, management of the hospitals' procurement costs has been turned into one the substantial challenges. The healthcare section features special properties directly influencing the quality of patients' care. Insufficient and untimely access to the required materials and facilities can end in delays in operating or, possibly, a disorder in the healthcare plans and, resultantly, in patients' exposure to health risks whereas the unmanaged and excessive inventories and resources in the hospitals cause immethodical miscellaneous costs and, on the other hand, the emergence of shortages and shortcomings in the supply of the things required for the patients' care and treatment (Ely et al, 2008).

In line with this, supply chain management becomes more important. Supply chain management (SCM) means "information, requirements, and assets related to purchasing and dislocation of the goods and services and they're transferring from the supplier to the final users for enhancing the clinical results meanwhile controlling the costs" and it is right here that the issue finds twice as much importance because it has to be noted that the companies, centers or hospitals who use supply chains for actualizing their logistics processes' objectives (for instance, supply, distribution, and warehousing) need inter-process interaction (Lin et al, 2014).

Indeed, the coordination and integration between the processes would influence the performance of the healthcare services supply chain. In line with this, industrial engineering (IE), operational research (OR), or operation management (OM)

fields offer analytical methods for supporting the supply chain of the hospitals' logistics operations. In line with this, operation management means "designing, managing and improving systems that create and offer healthcare services". However, the important point here is the creation of a balance between supplying the highest quality of providing services to the patients and limited financial and instrumental resources existing in the hospitals. It seems that the use of the logistics function of the hospitals' supply chains along with operation management enables the creation of a balance between the two abovementioned factors. Although this same effectiveness is per se influenced by various factors like those related to macro-level governmental decision-making, hospital management factors and even the other factors pertinent to the patients themselves, the identification and controlling of such factors are necessary and generally parallel to the optimization of the treatment services offered to the patients (Siara et al, 2016).

There is a need for a completely coordinated system that offers healthcare and treatment with supreme quality and efficiency and with reasonable costs in the form of healthcare resources in proportion to the existing facilities. Following the lethal Covid19 pandemic, the hygiene, healthcare, and treatment body of every involved country were subjected to a huge shock. Within a few time, the balance between the treatment costs and the supply of the materials and instruments required for the patients' management was disordered the supply chain and procurement of the instruments and equipment for admitting and hospitalizing the patients, particularly the corona patients, was found in an urgent need of the specific care services (Griffin et al, 2020).

This important issue was more evident in the developing countries and the shortage of the resources and facilities in these countries underwent a significant increase with the raid of the disease's second and third waves. It is in such a situation that the enjoyment of proper operation management in terms of the logistics function of the hospitals' supply chains can resolve part of the hospital requirements' supply problems and manage the treatment of the patients with Covid19. In line with this, in the first stage, the identification of the various relevant factors influencing the logistics performance of the supply chain and, then, assigning proper weights to them and prioritization of them could be the first measure for attaining properly functioning supply chains. These factors' identification and weight assignment using multi-criteria decision-making are considered one of the best methods still being currently extensively applied (Ibid).

In this method that was first offered by Van Houdenhoven and colleagues, the interactions between the various managerial factors (including the type of the services offered, resources' capacity, and financial factors) and the control's hierarchy (offline strategic, tactical, and operational control) are investigated and prioritized using the multifactor method.

In fact, in such models, there are four primary factors, namely the engaged hospital's personnel, equipment and procurement managers, wards' supervisors and managers, and, finally, patients, that constitute the elements of multifactor or multi-criteria decision making. In the present study, the goal of the research is the prioritization of the factors influencing the logistics performance of the hospitals' supply chains in transferring the corona patients using multi-criteria decision-making.

Study Literature:

Supply chain management: is the corroboration of the companies for acquiring the needed materials for creating a product or offering a service to the customers (Bachlouse et al, 2008).

Multi-criteria decision-making: the complex multi-criteria decision-making models may, instead of using one scale of optimality assessment, use several assessment scales (Azimi et al, 2020).

Logistics performance: logistics is the process of planning, implementing, and supervising the services and information related to the maintenance of goods and their transportation from a source to a place of consumption with such an objective as meeting the customers' needs (Shafi'ei et al, 2019).

Corona: coronaviruses constitute a large family and they fall in the subcategory of coronaviruses ranging from the ordinary cold virus to the more severe disease agents like SARS, MERS, and Covid-19 (Griffin et al, 2020).

In a study by Mostaghimi et al in 2015 to identify and prioritize the indices of the services' supply chain performance, the results indicated that they possess the highest and the lowest priorities respectively go-to reliability and tangibility of the services' supply chain.

Nazari et al (2019) performed a study under the title of applying the discrete event simulation and data envelopment analysis (DEA) to find out how to improve the performance of the hospitals' emergency units. The rating of the DEA methods indicated that scenario 39 is the best choice in both of the methods. To determine the existence of a correlation between the results of the rating methods, as well, non-parametric Spearman's Rho test and Kendall's Tau test were utilized with the results being respectively 0.93 and 0.81. These results are expressive of the existence of a correlation between the DEA rating methods. Nikoukar et al (2019) performed a study named "offering a combined DEA and AHP method for evaluating the performance of the hospitals' managers. In the research process, the efficient managers were determined and the returns to scale were specified for each. Amongst the 29 managers, 15 were found efficient and others were found inefficient. The indices like the tasks' non-difficulty, number

of specialized workforces, and number of the treatment workforce were considered as the input, and indices such as the performance form's score, bed occupation coefficient, time of the last payments and ratio of income to cost were recounted as the outputs.

Shafi'ei et al (2019) carried out a research titled "evaluation of the hospitals' efficiency using the blended fuzzy SERVQUAL and fuzzy network DEA model. The study results signified that three aspects, namely sympathy, responsiveness, and guarantee, are most significant in the SERVQUAL section. Moreover, three out of the 26 service quality properties were categorized as interesting. Four service quality properties were recounted as necessary and 16 service quality properties were grouped in the unidimensional class. Azimi et al (2020) performed research called "prioritization of performance evaluation scales for patients' safety management in the healthcare centers. The study's findings resulted in the extraction of the patients' safety management scales with the healthcare and hygiene and infection control being pointed out in all of the evaluation methods. Many different scales have been offered regarding the patients' safety management in the studied evaluation methods and the compiling and examination of them sets a proper ground for creating a comprehensive evaluation method; therefore, this research's results can be utilized for self-evaluation, comparison of the various centers hence an improvement of the performances.

Khademlou et al (2020) performed a study under the title of "Evaluating the attitudes of the healthcare-treatment centers' staff in Amol County about the patients' safety culture indicators and patients' satisfaction indicators. The staff members were found to have positive attitudes and perspectives towards all the dimensions and aspects for a value of 82%. As for the clients' satisfaction, the strategy of the staff and the clients' participation, and the recognition of the clients' perceptions and expectations by the managers were found useful in improving the clients' satisfaction rate. Ghiathi et al (2020) performed research named "reallocation of the resources to the various sections and wards in Imam Reza (PBUH) Hospital, in Mashhad, based on their performances using the DEA method. The preliminary results of the allocation analyses indicated that there is a possibility of resources' reallocation in line with enhancing efficiency. Resources' reallocation enables enhancing the efficiency of the various wards by 36% on average. The optimal allocation of the resources is amongst the key factors for improving the performance of the hospital wards and, considering the direct effect it exerts on the quality of service-providing, it has to be seriously taken into account by the health sector's managers.

In 2020, Elahi performed a study named "evaluating the performance of the healthcare assistants in the course of Covid-19 pandemic's control in Tehran's hospitals". Various factors like the extent of the hygiene and sanitation principles' observance, the existence of work order amongst the healthcare assistants, method of coping with the patients, and coordination of the tasks with the nurses' activities were found to influence the nurses' perspectives towards the volunteers' performance ranking. Considering the nurses' high satisfaction with the volunteers' performances from their own and the volunteers' perspectives, the study findings were indicative of the positive effects of the volunteers' participation in containing the coronavirus pandemic.

Yadollahi et al (2020) conducted cross-sectional analytical research named "investigating the awareness and performance of emergency medical services (EMS) staff members in Shahr-e-Kurd County regarding observing the principles of infection control". The data were analyzed using SPSS software, version 15. The average age of the study participants was 30.21±8.34. 30% of the participants were found with needle-stick history. No significant relationship was evidenced between awareness and performance of the staff ($P>0.05$) but there was observed a significant relationship ($P<0.05$) between awareness and study field and education level. The mean score of the study participants' awareness of the principles of infection control was low (45.16±75.25) and the mean score of the study participants' performance was reportedly intermediate (51.48±41.97).

Asandolou'ei et al (2014) dealt in a study on the efficiency of the healthcare systems in 30 European countries in 2010. The mean efficiency of the first model was 0.74 for constant returns to scale and it was 0.75 for variable returns to scale. The mean efficiency value of the second model was 0.81 for the constant returns to scale and 0.77 for the variable returns to scale. In general, the study results indicated that several developed and developing countries are on the borders of efficiency but a majority of the countries were found inefficient. Kitchanmay et al (2018) performed a study named "a strategy for improving the logistics performance of the healthcare services". The results indicated the mutual dependencies between the operational and national performances. The former was found to be influenced by the country's environment. In the end, a strategy has been proposed for improving the logistics performance of healthcare services. The mutual dependency between the operational and national performances has also been discussed. Gock et al (2015) used the DEA method in a study to evaluate the efficiency of the private and national hospitals in Turkey for the years between 2001 and 2008. It was shown in this research that the costs of the healthcare services and the efficiency of the private hospitals are negatively associated whereas the healthcare costs and efficiency of the state hospitals are positively correlated. Put differently, the increase in healthcare expenses can reduce the

efficiency in the private hospitals as compared to the state or public hospitals.

Dargan et al (2018) carried out research named "the perspectives of emergency wards' nurses towards patients' safety". The nurses' attitudes were compared regarding the patients' safety in terms of age, gender, marital status, education level, and ED experience but no significant difference was documented. However, a significant difference was found between the age groups and stress as the subscale of the patients' safety. There was found no significant difference in terms of the license status of ED nurses for emergency care, patients' safety training, quality training, hospitals' quality license status, or ED.

Moon et al (2019) performed research to measure the logistics performance of the hospitals' internal supply chains. The study aimed at offering related works about the measurement of the logistics performance of the hospitals' internal supply chains (for example, inventory management, distribution activities, and so forth) especially in the operation room because of being one of the most vital sections for a hospital. In operation rooms, the demanded items should be available at the right time and in the right place under proper conditions and with the lowest possible cost. Moreover, the study has also discussed the literature related to multi-criteria decision-making techniques.

Benzidia et al (2021) have stated that Meta (big)-data analysis techniques and artificial intelligence (BDA-AI) have drawn the attention of academicians and specialists in recent years. The results were indicative of the moderating role of green digital learning in the relationships between the BDA-AI and green supply chain cooperation. This is a substantial finding not highlighted in the extant works. This article provides valuable discretion to the procurements/supply chain managers and helps them in mobilizing the BDA-AI technologies in support of the green supply processes and enhancing the bioenvironmental performances.

Ramira et al (2021) worked on the way of displaying the practical problem-solving structure's implementation within the framework of definition, measurement, analysis, improvement, and control (DMAIC) in combination with the analytical power offered by the data-mining process's capabilities parallel to the improvement of the supply chain's quality in regard of a healthcare service provider. This study explains why the analysis of the data extracted from the core information systems features a notable value for the improvement innovations when it is completed by a traditional quality method. Blending the process-mining techniques with the lean six sigma tools, the researchers found out that 65% of the orders do not match the order time and that 200 extra purchases have been made with high operating costs.

In research aiming at the digitalization of the healthcare services' supply chains (a roadmap for creating benefits and effective support of the healthcare services offering), Biolo et al (2021) adopts the hospitals' perspectives as the points of centralized launching of the digitalization innovations. The roadmap that includes internal and external digitalization routes is drawn on a research method that combines the observations with a comprehensive review of the extant literature. The aforesaid method enables the displaying of the research challenges related to healthcare services' supply chain and showcases how the digitalization plans can take care of them. The offered digitalization plans are structured based on the priorities and focus on the hospitals. These suggestions can help the managers improve the supply chain as well as the clinical streams.

Study Method:

The present study is applied research in terms of the objectives for the reason that it deals with problem-solving in the real world. Furthermore, it is survey research in terms of the data collection method. Survey studies choose random samples symbolizing a larger population and deal with their responses to a set of questions through questionnaires, polling, and/or other methods to study the status quo regarding the attitudes, beliefs, and behaviors and, generally, tries extracting information about the hypotheses. In this research, the AHP method is applied to weight and prioritize the properties. A study population includes individuals or units possessing at least one common attribute as the feature shared by all the participants of the study population and distinguishing them from the members of the other populations. Or, in other words, the study population includes all the real or hypothetical members that we would like to generalize the study findings to them (Khaki, 2008). The study population incorporates all the elements to be investigated and it belongs to a well-defined group with the study sample volume being a part of the study population that is compiled in the course of research in practice (Sarmad et al, 2006). A research process can be realized as an effort for perceiving the behavior of a society based o the information collected from a sample. That is because compiling information for the whole study population entails spending a lot of time and cost. In addition, in some cases, collecting information from the whole population appears illogical hence the sample volumes should be consequently constructed (Khaki, 2008). The hospitals admitting the corona patients were the present study's population. The study uses a non-probabilistic sampling method in which the participants are selected with the aid of human judgment instead of relying on chance. Therefore, each of the study population's members has an unclear and uncertain chance of being selected for the study sample volume. So, in this regard, the present study applies the non-probabilistic purposive judgmental (intentional) sampling method. In purposive sampling, instead of gathering information from the readily available members,

it might be sometimes necessary to obtain information about certain individuals or groups meaning that a special type of individuals capable of offering the intended information would be chosen for they are the only participants capable of offering such information or they are the only subjects matching with scales codified by the researcher. In the non-randomized sampling method, since individuals are selected based on the researcher's wants and the special circumstances of every research, the determination of the study sample's volume does not make sense. To specify the study sample's volume, the present study was conducted on 30 corona patients in a pilot format because none of the studies performed in this regard was found exactly similar to this research and, also, because the parameters required for the determination of the sample's volume were missing. The results obtained from this pilot research would be utilized for the determination of the final and perfect study sample volume.

Information gathering is of the most important and most sensitive stages of the research. The information-gathering method is influenced by the nature of the subject and the studied variables. Library research is one of the ordinary methods for achieving the findings and one of the most essential stages in collecting information for research (Safa'ei and Akbarzadeh, 2010). In the present study, library research has been utilized for information gathering. The most essential methods and instruments of data gathering are comprised of documents and evidence, observations, interviews, and questionnaires (safari and Akbarzadeh, 2010). In the current research paper, a questionnaire would be also used for data gathering. A questionnaire is one of the means of acquiring information in survey research; in this method, data are directly collected. In this research, four questionnaire models will be utilized as explicated below:

The first questionnaire has been prepared for verification and screening of the indices and administered to the experts. The reliability and validity of this questionnaire will be investigated. The second questionnaire that contains pairwise comparisons of the supply chain's logistics performance indices will be used for the AHP method. in this study, content validity verification is the method of choice for investigating the validity of the questionnaires "lean agility" and "competencies" in this way that the questionnaires were administered to the university professors, specialists, and experts, and, then, they were subjected to content validity test after their confirmation. To affirm the reliability of the questionnaires, Cronbach's alpha coefficient will be used and values above 0.8 are usually acceptable for confirming the reliability of the questionnaire.

Analytic Hierarchy Process (AHP):

In decision-making science wherein the selection of a choice from amongst the great many of the existing solutions and/or prioritization of the solutions matters, it is now several years that the decision-making methods based on multiple indices (MADM) are being widely applied. Amongst these, AHP has been used in the science of management more than the other methods. AHP is one of the most well-known multipurpose decision-making techniques that was first invented by the originally Iraqi Thomas L. Saaty in the 1970s. AHP reflects human beings' natural behavior and thinking methods. This technique investigates the complicated issues based on their mutual effects and transforms them into simple forms to engage in solving them.

AHP can be used when confronting several rival options and several decision-making scales. The proposed scales can be qualitative or quantitative. This decision-making method is essentially laid on the foundation of pairwise comparisons. The decision-maker begins by preparing a hierarchy tree that shows the decision hierarchy, comparable factors, and rival options that are going to be evaluated. Then, a series of pairwise comparisons are made. These comparisons display the weight of each of the factors concerning the rival options that should be evaluated for reaching a proper decision. In the end, the logic of the AHP method enables the pooling of the matrices obtained from the pairwise comparisons for arriving at an optimum decision (Ata'ei, 2010). Thomas Saaty (the founder of this method) has expressed the following four principles as the AHP principles based on which all the calculations, rules, and regulations are made. These principles are:

On rank reversal condition: if element A is preferred to element B for a value of n, element B is also preferred to element A for a value of $\frac{1}{n}$.

Homogeneity Condition: element A should be homogenous and comparable to element B. In other words, element A to element B's preference cannot be infinite or zero.

Dependency condition: every element of the hierarchy can be dependent on another element at a higher level to it and this dependency can be continued to the highest level.

Expectation condition: whenever a change happens in the hierarchy's structure, the evaluation process should be resumed (Ghodsipour, 2002).

Analysis Method:

In this section, the study's data will be analyzed. The study aims at prioritizing the factors influencing the logistics performance of the hospitals' supply chains for transferring the corona patients. To accomplish this objective, the AHP method will be utilized. At first, the effective factors are identified and, then, the AHP method is applied to determine the weight and significance of each. All of the calculations will be conducted in ExpertChoice Software.

Respondents' Descriptive Statistics:

In this section, to determine the number of participants responding to the pairwise comparisons questionnaire, such

demographic characteristics as gender, age, work history, and education level will be dealt with.

Gender:

Table 1: gender-related frequency distribution

Gender	Frequency	Frequency percentage
Male	24	80
Female	6	20

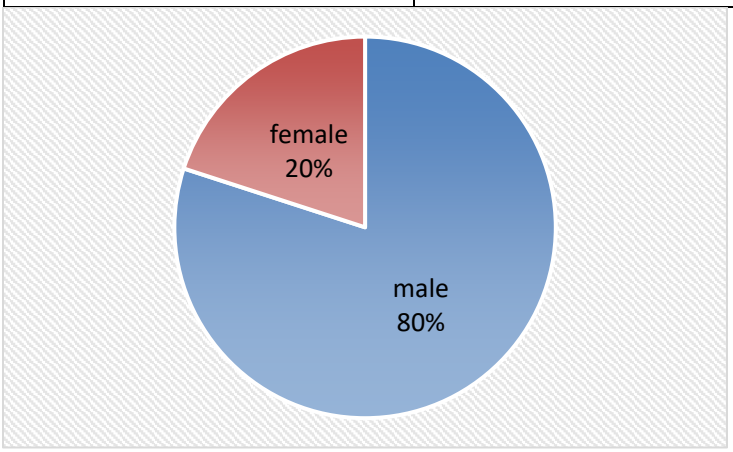

Figure (1): respondents' gender percentage

Considering table (1), 80% of the respondents are male and 20% are female.

Age:

Table 2: age-related frequency distribution

Age	Frequency	Frequency percentage
30-40	15	50
40-50	6	20
Above 50	9	30

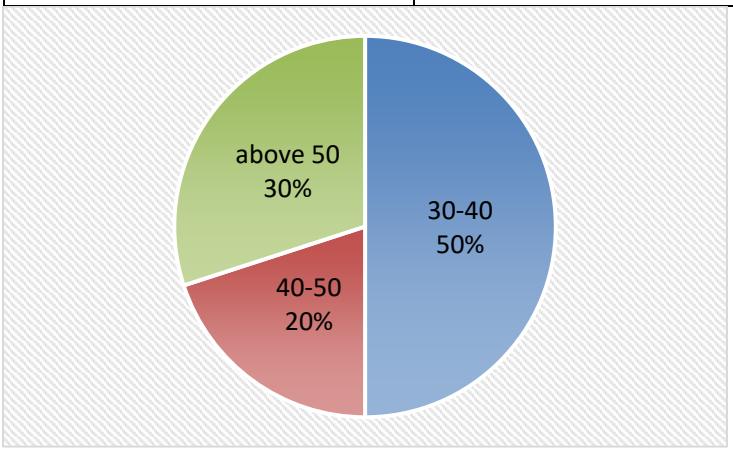

Figure (2): respondents' age

Considering table (2), 30-40 years of age is the highest frequency of the respondents and 40-50 years of age is the lowest frequency of the respondents accounting for only 20% of them.

Work History:

Table 3: frequency distribution of the work history

Service history (years)	Frequency	Frequency percentage
5-10	9	30
10-15	15	50
Over 15	6	20

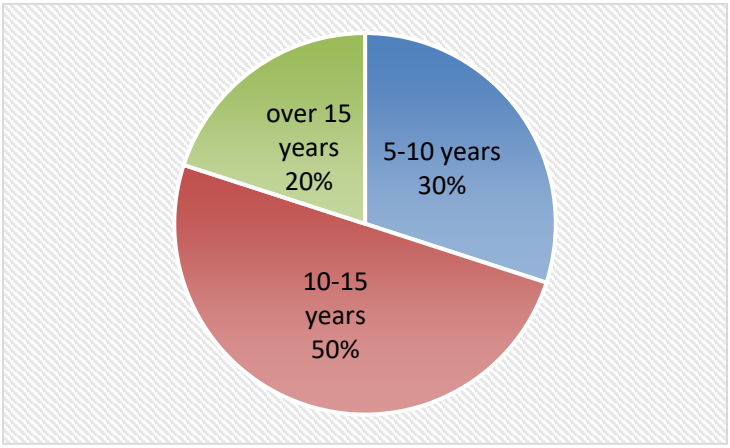

Figure (3): respondents' work history

Considering table (3): 10-15 years is the highest frequency of the respondents' service years and over 15 years is the lowest frequency (20%) of the respondents' service years.

Education Level:

Table 4: frequency distribution of the education levels

Education level	Frequency	Frequency percentage
BA	15	50
MA	12	40
PhD	3	10

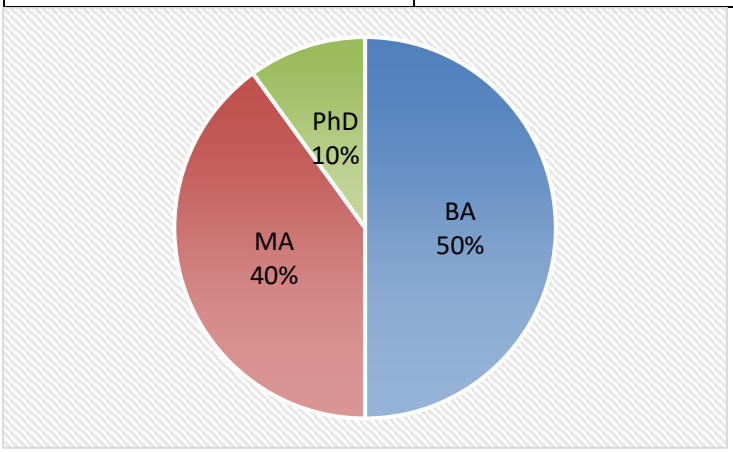

Figure (4): respondents' education levels

Considering table (4), BA is the highest frequency (50%) of the respondents' education levels and Ph.D. is the lowest frequency (10%) of the respondents' education levels.

Based on the review of the study literature and background, the factors influencing the logistics performance of the hospitals' supply chains were extracted for transferring the corona patients. These factors include 20 indices covering two aspects. For these factors' domestication, a questionnaire was administered to 30 experts who were asked to score each index based on Likert's five-point scale (1= very low importance; 2= low importance; 3= intermediate importance; 4= high importance; and, 5= very high importance). Then, the mean score of each index was computed. The index is discarded when its mean score is found below 3. Results indicated that all of the indices have been confirmed by the experts meaning that their mean values are above 3. Results have been presented in table (5).

Table 5: introducing the study factors

Scale	Subscale	Mean score
Services supply chain measurement	Services' reliability	3.600
	Services' responsiveness	3.100
	Services' flexibility	3.167
	Services' costs	3.300

	Services' assets	3.200
	Services' tangibility	3.233
	Services' assurance	3.967
	Services' uniformity	3.933
Logistics performance	Order time	3.533
	Order precision	3.367
	Delivery time	3.133
	Cost of order delivery	3.233
	Cost of warehousing	3.300
	Number of transportation times	4.200
	Accuracy in the inventory list	3.400
	Goods inventory turnover	3.500
	Inventory to sales ratio	3.933
	Use of information technology	3.533
	Proper planning	3.667
	Development of the staff's skill	3.633

Considering table (5), study indices have mean values larger than 3; so, they have acquired the required score hence confirmed. The verified indices have been given in table (6) in code forms. The hierarchy model, as well, has been demonstrated in figure (5).

Table 6: study's scales and subscales

Scale	Scale's code	Subscale	Subscale's code
Services supply chain measurement	A	Services' reliability	A1
		Services' responsiveness	A2
		Services' flexibility	A3
		Services' costs	A4
		Services' assets	A5
		Services' tangibility	A6
		Services' assurance	A7
		Services' uniformity	A8
Logistics performance	B	Order time	B1
		Order precision	B2
		Delivery time	B3
		Cost of order delivery	B4
		Cost of warehousing	B5
		Number of transportation times	B6
		Accuracy in the inventory list	B7
		Goods inventory turnover	B8
		Inventory to sales ratio	B9
		Use of information technology	B10
		Proper planning	B11
		Development of the staff's skill	B12

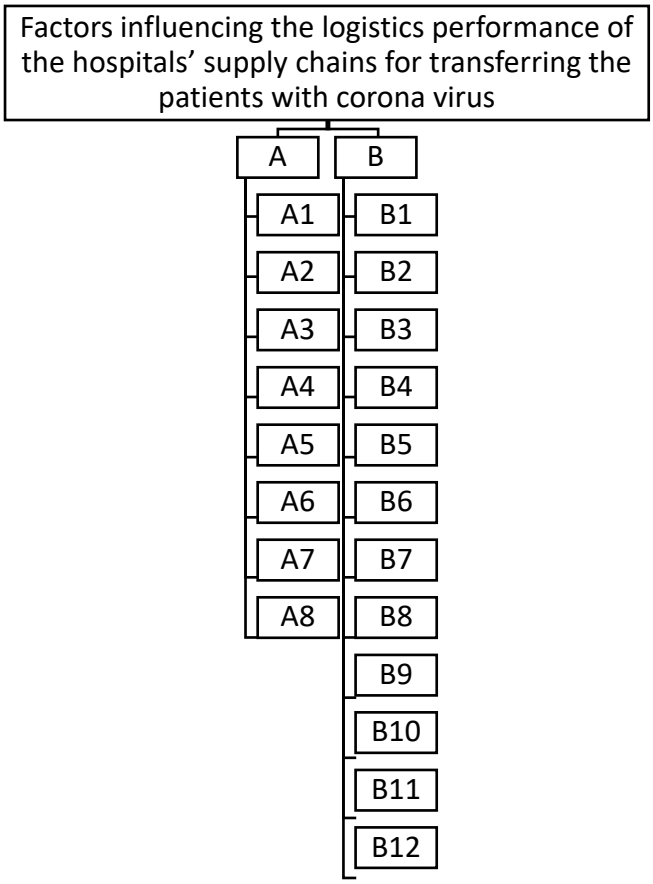

Figure (5): study's hierarchical model

AHP Method's Results:

In the previous stage, the study factors were introduced. In this step, as well, AHP is applied for determining the significance and weight rates of the factors. At first, based on tables (4-6), pairwise comparisons of the scales and subscales were undertaken and the experts (n=30) were provided with the results. Following the completion of the pairwise comparison matrices, the inconsistency rate of each was calculated and it was figured out that all of them fall below 0.1 indicating the matrices' stability and consistency. Then, experts' pairwise comparisons were blended using the geometrical mean method; next, to determine the weights, the mean values were inserted into ExpertChoice Software. The forthcoming part gives the pairwise and weight comparisons' results.

Primary Scales' Pairwise Comparisons:

In this section, table (7) presents the pairwise comparisons of the seven primary factors. This pairwise comparison's inconsistency rate is equal to 0.000 and, since it is below 0.1, it is reflective of the acceptable consistency.

Table 7: pairwise comparisons of the main factors

	A	B
A		0.561
B		

The pairwise comparisons' results given in table (7) are inserted in Expert Choice Software. Figure (6) displays the weights of the calculated scales.

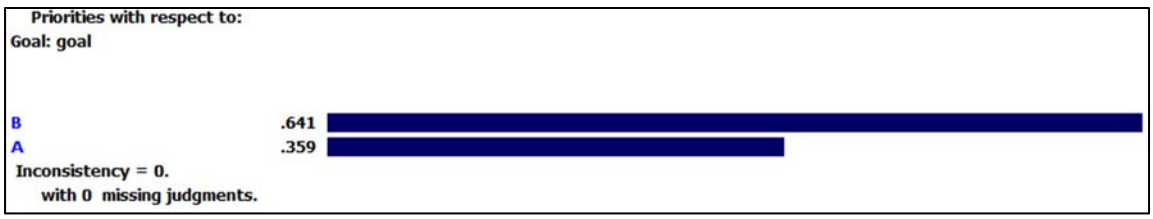

Figure (6): weights of the primary factors

Table 8: the weights and ranks of the primary scales

Scale's name	Code	Weight	Rank
Logistics performance	B	0.641	1
Services' supply chain measurement	A	0.359	2

Considering figure (6), logistics performance falls in the first rank with a weight of 0.641 and the services' supply chain measurement falls in the second rank with a weight of 0.359.

Pairwise Comparisons of the Subscales for Services' Supply Chain Measurement:

The scale "services' supply chain measurement" possesses eight subscales. Table (9) gives the pairwise comparisons of them. The inconsistency rate of this pairwise comparison is equal to 0.04.

Table 9: pairwise comparisons of the subscales of services' supply chain measurement

	A1	A2	A3	A4	A5	A6	A7	A8
A1		**1.041**	**0.647**	**0.983**	**1.093**	**1.005**	**1.041**	**0.647**
A2			**0.983**	**1.093**	**1.005**	**1.093**	**1.005**	**0.470**
A3				**0.539**	**1.041**	**0.470**	**0.539**	**1.093**
A4					**1.005**	**0.470**	**0.539**	**1.041**
A5						**0.470**	**0.539**	**1.041**
A6							**0.470**	**0.539**
A7								**1.041**
A8								

The pairwise comparison results given in table (9) are inserted into Expert Choice Software. Figure (7) demonstrates the calculated weights of the scales.

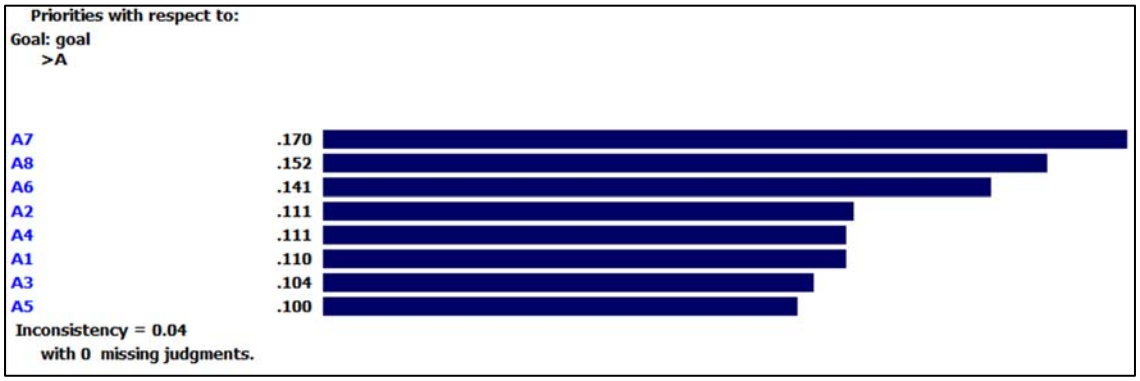

Figure (7): weights of the subscales calculated for the scale "services' supply chain measurement"

Table 10: weights and ranks of the subscales for "services' supply chain measurement"

Scale's name	Code	Weight	Rank
Services' assurance	A7	0.170	1
Services' uniformity	A8	0.152	2
Services' tangibility	A6	0.141	3
Services' responsiveness	A2	0.111	4
Services' cost	A4	0.111	5
Services' reliability	A1	0.110	6
Services' flexibility	A3	0.104	7
Services' assets	A5	0.100	8

Considering figure (7), amongst the subscales of services' supply chain measurement, services' assurance has been found in the first rank with a weight of 0.170; services' uniformity falls in the second rank with a weight of 0.152 and services' tangibility falls in the third rank with a weight of 0.141.

Pairwise Comparisons of the Logistics Performance Subscales:

The scale "logistics performance" has 12 subscales. Table (11) presents their pairwise comparisons. The inconsistency rate of this pairwise comparison is equal to 0.05.

Table 11: pairwise comparisons of the logistics performance's subscales

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12
B1		1.072	0.336	0.741	0.905	1.083	0.470	0.539	1.041	0.647	0.983	1.093
B2			1.005	0.985	1.068	1.041	0.647	0.983	1.093	1.072	0.291	0.741
B3				0.905	1.083	0.470	0.539	1.041	0.647	0.983	1.093	1.005
B4					0.985	1.068	1.041	0.647	0.983	1.093	1.093	1.005
B5						0.949	1.093	1.005	0.949	1.026	0.850	0.985
B6							1.068	1.041	0.647	0.983	2.125	3.555
B7								0.949	1.360	1.026	0.850	0.985
B8									1.068	1.041	0.647	0.983
B9										2.555	1.985	0.320
B10											1.093	1.005
B11												0.949
B12												

Pairwise comparison results are given in table (11) and will be inserted in Expert Choice Software. Figure (8) depicts the calculated scales' weights.

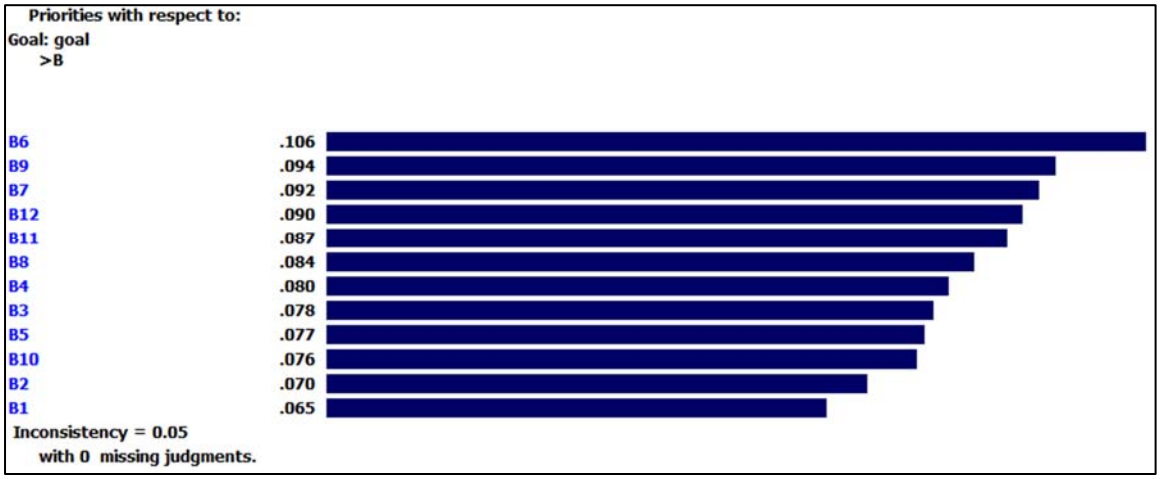

Figure (8): weights of the logistics performance's subscales

Table 12: weights and ranks of the subscales for logistics performance

Scale's name	Code	Weight	Rank
Number of transportation times	B6		1
Inventory to sales ratio	B9	0.094	2
Accuracy of the goods inventory	B7	0.092	3
Staff's skills development	B12	0.090	4

Proper planning	B11	0.087	5
Goods inventory turnover	B8	0.084	6
Cost of order delivery	B4	0.080	7
Delivery time	B3	0.078	8
Warehousing costs	B5	0.077	9
Application of information technology	B10	0.076	10
Order precision	B2	0.070	11
Order time	B1	0.065	12

Considering figure (8), amongst the subscales of logistics performance, the number of transportation times is ranked first with a weight of 0.106. The inventory to sales ratio is ranked second with a weight of 0.094 and the accuracy of the goods inventory is ranked third with a weight of 0.092.

Final Weights of the Subscales:

The final weights of the subscales are calculated by multiplying the weight of each aspect by the weight of the scale and, then, multiplying the result by the relative weight of the subscale; these calculations are done in ExpertChoice Software. The results have been given in table (13). Based thereon, amongst the 20 subscales, the number of transportation times is ranked first followed by the services' assurance in the second rank and, then, the inventory to sales ratio in the third rank

Table 13: the subscales' final weights and rank

Scale	Scale's weight	Subscale	The relative weight of the subscale	The final weight of the subscale	The final rank of the subscale
Services' supply chain measurement	0.359	Services' reliability	0.11	0.0395	18
		Services' responsiveness	0.111	0.0398	16
		Services' flexibility	0.104	0.0373	19
		Services' costs	0.111	0.0398	16
		Services' assets	0.1	0.0359	20
		Services' tangibility	0.141	0.0506	10
		Services' assurance	0.17	0.0610	2
		Services' uniformity	0.152	0.0546	7
Logistics performance	0.641	Order time	0.065	0.0417	15
		Order precision	0.7	0.0449	14
		Delivery time	0.078	0.0500	11
		Cost of order delivery	0.08	0.0513	9
		Cost of warehousing	0.077	0.0494	12
		Number of transportation times	0.106	0.0679	1
		Accuracy in inventory list	0.092	0.0590	4
		Goods inventory turnover	0.084	0.0538	8
		Inventory to sales ratio	0.094	0.0603	3
		Use of information technology	0.076	0.0487	13
		Proper planning	0.087	0.0558	6
		Development of the staff's skill	0.09	0.0577	5

Conclusions and Suggestions:

The present study aimed at prioritizing the factors influencing the logistics performance of the hospitals' supply chains in transferring the corona patients using multi-criteria decision making. The present study is applied research in terms of the study objectives for the reason that it deals with solving a real-world's problem. Moreover, in terms of information gathering, this article is survey research. The survey is research that chooses indicative and random samples from the study population and extracts their responses to a set of questions using questionnaires, polling, and other methods thereby identifying the status quo of the attitudes, beliefs, behaviors, and, generally, gathering information about the hypotheses. In this research, the AHP method was seminally applied for weighing and prioritizing the properties and features. The study takes advantage of a non-probabilistic sampling method which, instead of relying on chance, tries selecting several respondents based on human judgment. Therefore, each respondent has an uncertain and unclear chance of being selected. Thus, the present study's sampling method is non-probabilistic purposive, and judgmental (intentional). Since no study was found similar to this one and there was the unavailability of the parameters required for the determination of the study's sample volume, 30 corona patients were selected for a pilot study the results of which were used for determining the final and complete study sample's volume. Based on the study review and background, factors influencing the logistics performance of the hospitals' supply chains were extracted about transferring the patients. Twenty indices covering two aspects were eventually found. Regarding these factors' domestication, experts were asked within a questionnaire to give a score to each of the indices based on Likert's five-point scale (1= very low importance; 2= low importance; 3= intermediate importance; 4= high importance; and, 5= very high importance). Then, the mean score of each index was calculated; the index was discarded in case the mean score was found smaller than 3. The results indicated that all of the indices have been confirmed by the experts meaning that their mean scores were all above 3. The results of the Delphi test indicated that all of the study's indices have mean scores larger than 3, so they have acquired the required score hence confirmed. AHP method, as well, was utilized for determining the weight and importance of each. At first, based on tables (4-6), pairwise comparisons were made between the scales and subscales, and the experts (n=30) were provided with the results. After completion of the pairwise comparisons' matrices, the inconsistency rate of each was calculated and it was figured that it is equal for all of them to 0.1 indicating the good stability and consistency of the matrices. Then, the experts' pairwise comparisons were blended using the geometrical mean method, and, then, the results were inserted into ExpertChoice for determining the weights. Based thereon, several transportation times were found to rank first amongst all the 20 subscales. Services' assurance was found in the second rank and the inventory to sales ratio was ranked third.

Therefore, considering the above results, the following suggestions are offered:

Enhancement of the company workforce's flexibility in terms of skills and knowledge

Elevation of the staff's recognition of the company's equipment and processes for removing the bottlenecks and better responding to the demand fluctuations in the market

Enabling the timely production in the company

Making the production planning more flexible in line with responding to the market

Investigation of the costs related to the cessations resulting from the production line changes

Enabling the possibility of production line changes within less than ten minutes

Providing the equipment for production line changes within less than three minutes in necessary cases

Automation of the unpleasant and unsafe processes

Enhancing the equipment's competencies for flawless production with no need for error control to ensure the adherence to the standards

Companies can speed up the processes by concentrating on the following factors to improve the index of new products' introduction:

1) Discovery of new chances in the market
2) Doing market research
3) Researching the competitors
4) Innovation
5) Introduction of new products to the market

Companies can use the following cases in their supply chains to improve the integrated mechanism devising and application index:

1) Electronic data exchange links: the orders' information created by the company along the supply chain are sent directly from a computer to the suppliers' computers
2) Comprehensive business systems: information integration in religious and faithfulness level and smooth flowing of the information between the various sectors
3) Integration of the information technology with all the customers and suppliers

Sensitivity to the changes encompasses the discovery, analysis, and recognition of the changes. Companies can improve their supply chain competencies and focus on the following factors thereby upgrading their index of sensitivity to changes:

1) Discovery of the changes in the market (structure, market, demand, and taste along with the state-of-the-art productions)
2) Discovery of the changes in the competitors' activities and situations
3) Discovery of the changes in the customers' needs and demands
4) Discovery of changes in the technologies
5) Discovery of changes in the economic, political, and social factors
6) Discovery of changes in the suppliers' interventions and situations
7) Discovery of changes in the amounts of demand for customized products
8) Guiding the market's needs towards the company's products and services and paying attention to the strategic planning at the higher company levels

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Conflict of interest

None.

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Ethics statement

None

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