Improving the Management Performance of the Military Medical Supply Chain for Mission Readiness

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Abstract

The paper discussion the issue of improving the performance of managing the military medical supply chain to fully achieve its main goal, to ensure mission readiness of the military forces. The concept of supply chain management is adopted by the military logistics as a modern approach better at solving the complexities of the logistic activities in the current period. The research method was quantitative. Hypotheses were formulated regarding the correlations between three major types of medical supply chain, specific types of needs influencing the improvement of the performance of the medical supply chain and the efficiency of the management of the supply networks for medical products. Results are discussed, conclusions and recommendations are presented.

KEYWORDS: *military medical supply chain, military logistics, supply chain, performance improvement*

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1. Literature review

There are several definitions of the concept of supply chain. A group of definitions focuses on the main stages of a process such as Pienaar (2009b) defines Supply Chain as "a general description of the process integration involving organizations to transform raw materials into finished goods and to transport them to the end-user". The second group of definitions are including the extended approach of a Supply Chain. According to the definition given by Little (1999) a supply chain is "the combined and coordinated flows of goods from origin to final destination, also the information flows that are linked with it". The definition of Chow &Heaver (2004) focuses on the entities which are involved in a value chain which "is the group of manufacturers, suppliers, distributors, retailers and transportation, information and other logistics management service providers that are engaged in providing goods to consumers". Consequently, the researcher

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opinion is that a supply chain is adding value to a product by transporting it from one location to another, including the possible transformation of the product.

There are number of supply chain models we have identified. First, there is the SCOM model (supply chain and operations management) (Ivanov et al., 2017), having as key components: sourcing, production, distribution and after sales. These key elements are kept aligned by the management at every planning level strategic, tactical planning level and operational and execution. Second model is the Supply Chain Operations Reference (SCOR model) which consists of the following processes: planning, acquisition, make, delivery, and return (APICS, 2017).

A different view is taken by the Global Supply Chain Forum model (GSCF). According to this model the supply chain consists of three essential parts: first, supply chain network structure; second, supply chain business processes; and third, supply chain management components.

The nine dimensions that make up the process performance requirements construct for any supply chain in the modern era are the following: "interoperability, collaboration, transparency, integration, flexibility, responsiveness, efficiency, making the supply chain leaner and performance measurement" (Frederico et al., 2020, p. 274).

The most frequent system for supplying and distributing medical items such as: medicines, medical materials, equipment to hospitals, is the so-called "multi-level inventory system". The first level consists of many diverse suppliers delivering the needed medical items to a central warehouse. The second level of this system consists of the distribution of medical items from this warehouse to the places where the medical care services are provided to patients using medicines and medical equipment, also called "point-of-use". There are also other two types of supply systems used in hospitals for distributing medical items: the first is the so-called semi-direct system which consists of suppliers delivering the needed medical items directly to the "points-of-use" in each hospital (Volland et al. 2017). The second type, called the direct delivery system, is similar to the semi-direct system with the exception that in this case, suppliers are responsible to maintain the supply of medical items at the "point-of-use" at a required level for the best delivery of patient care.

By definition, "a supply chain consists of physical, informational, financial, and knowledgeable flows whose purpose it is to satisfy end-user requirements with products and service from multiple, linked supplies" (Elmuti et al., 2013). "A supply chain consists of all stages involved, directly or indirectly, in fulfilling a customer request. The supply chain not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and customers themselves" (Chopra, & Meindl, 2007). Supply chain refers to "a set of organizations directly linked by one or more of the upstream and downstream flows of products, services, finances, and information from a source to a customer" (Lee et al., 2011, page 1196).

Another definition takes a business process perspective, supply chain (SC) often spans the entire globe and involves production, trade, and logistics organization around the world (Zijm and Klumpp 2016). From the perspective of an organization

function, supply chain concerns the management and synchronizing of three flows, namely the product flow from suppliers to final customers, the financial flow of money from customers to suppliers, and the information flow connecting suppliers and customers (Kochak and Sharma 2015; Li and Liu 2019). From the perspective of an organizational entity, the supply chain represents the whole system of products, people, resources, departments and even services (Stefanovic and Stefanovic 2009). Therefore, the management of a supply chain facilitates all the major flows among different departments, both within the organization and between enterprise organizations.

The supply chain for the military is composed by supplier organizations, by procurement activities, by manufacturing (in some specific cases), by order management, by transportation and warehousing activities, and by soldiers, who are its customers.

Lenzini (2002) has analyzed the activity of military logistics and proposed several solutions to improve it in the future, such as "… evolving toward a holistic approach, much like business' supply chain management efforts, to improve its logistics capability" (Lenzini, 2002, p.13).

Another definition of military or defense logistics is given by the North Atlantic Treaty Organization which defines military logistics as" the science of planning and carrying out the movement and maintenance of forces. It is of vital importance for any military operation and, without it, operations could not be carried out and sustained. Logistics can be seen as the bridge between deployed forces and the industrial base, which produces the material and weapons deployed forces need to accomplish their mission." (NATO logistics, NATO - Topic: Logistics)

The core functions of NATO logistics are" supply, maintenance, movement and transportation, petroleum support, infrastructure engineering, and medical support". As we can see, medical support is included in the core functions indicating the high importance of the military medical logistics for the combat capacity and readiness of the military forces in the modern warfare.

However, there are differences mainly because external factors influencing military supply chain are specific, such as the fact that the soldier needs represent the number one factor. Soldiers who are fighting a war are dependent of the continuous support to accomplish their specific war mission. The smallest failure to do so is putting their lives, their health and also their fighting mission at high risk.

The basic goal of military supply chain is to attain a specific state of readiness at the lowest possible overall cost (Zsidin et al., 2020). The metric for military SC success is readiness for war, not profit gain (Burns et al., 2010 apud Sokri, 2014).

In the medical supply chain in the military, the stakeholders would be the suppliers, the warehouse staff, and the military inspectors, military clinic management personnel and the military medical staff, who would all be involved in some stage of the ordering and managing of medical inventory needed in the clinics and on the battlefield. In conclusion, in the medical supply chain for military there

are two major categories of stakeholders: military and non- military. Each one has its specific characteristics, while military must obey military discipline.

In the military, the goal of the supply chain is to satisfy the requirements of the military missions, by providing maximum supply support to ensure the maximum military field capability (Zanjirani et al., 2009). For the medical supply chains, the main goal is to achieve maximum effectiveness, that is to improve the quality of healthcare services provided to the military personnel (Kwon et al., 2016).

A medical supply chain has the mission to create and maintain the „capability to deliver efficiently the materials and information needed to ensure that patients receive quality health care" (Elmuti, et al., 2013). The specificity of the military healthcare supply chain management consists of the fact that its main aim is to provide constantly a high-level quality healthcare since patients in the military healthcare activities are soldiers and other military personnel, who are paramount to maintaining a high level readiness for executing their mission both in times of peace and war.Two hypotheses were formulated. The first hypothesis, H1, is the following: There are correlations between the type of medical supply chain and specific types of needs influencing the improvement of the performance of the medical supply chain. The second hypothesis H2 is the following: There are correlations between the efficiency of the management of the supply networks for medical products and the three types of medical supply chain.

The research method was quantitative. 100 participants completed a structured questionnaire which provided data used for the validation or rejection of the formulated hypothesis. The questionnaire consisted of 17 statements, assessed based on a Likert scale from 1 to 5. Of the 17 statements included in the questionnaire, 3 statements examine the distribution of medical equipment to the clinics, 4 statements relate to actions for improving the supply chain system, 3 statements relate to the management of supply chains for medical products, and 7 statements relate to changes occurring in the supply chains for medical products. The participants belonged to various stakeholders groups of the medical military supply chain of Israel Defense Forces.

2. Results and discussion

The first hypothesis, H1, is the following: There are correlations between the type of medical supply chain and three specific types of needs influencing the improvement of the performance of the medical supply chain.

Hypothesis H1A is the following: there is a correlation between the type of supply chain that transfers medical supplies directly from suppliers to military medical clinics and the needs to improve the relationships with the medical items suppliers.

Hypothesis H1B is the following: there is a correlation between the type of supply chain that transfers medical items from suppliers to a central warehouse followed by distributing them to secondary warehouses to be stored until they will

be required by military medical clinics and the need to reduce the number of medical items suppliers.

Hypothesis H1C is the following: there is a correlation between the type of supply chain that transfers medical items from suppliers to a central warehouse followed by distributing them directly to military clinics when they will be required and the need to reduce the medical inventory.

To examine hypotheses H1A, H1B and H1C we examined the correlation between the types of supply chain used for medical items in the military and the ways to improve the performance of the medical supply chain system, by Pearson correlation coefficient. The results are presented in the following Table 1.

Table 1. Pearson correlation coefficients between the type of supply chain and the goals for improving the performance of the medical supply chain (N=100)

	Ways to improve the performance of the medical supply chain			
Type of medical supply chain	We need to reduce inventory	We need to reduce the number of suppliers	We need to improve relationships with our suppliers	We do not need to make any changes to our supply chain
The supply is delivered directly to medical clinics by the suppliers	.166	-.041	**.734****	-.085
The supply is transferred to a central warehouse and then distributed to secondary warehouses and stored until the need for medical clinics	.209*	**.792****	-.181	-.114
The supply is transferred to a central warehouse and distributed directly to medical clinics	**.646****	.011	.236*	.109
* p<0.05 ** p<0.01				

As shown in Table 1, there is a very strong positive relationship ($r = 0.734$, $p < 0.01$) between the statement "we need to improve relationships with medical items suppliers" and the statement "supply is transferred directly to medical clinics by providers", so hypothesis H1A is validated. It means that improvement of

relationships with providers will result when the medical items supplies are being transferred directly to medical clinics by the suppliers and less by other parties.

This means that the adoption of the supply chain type of transferring directly medical items from supplier to military medical clinics explains 53.9% of the increase of the improvement of relationships with medical items suppliers.

It also shows that there is a positive very strong relationship ($r = 0.792$, $p < 0.01$) between the statement "we must reduce the number of suppliers" and the statement "the supply is transferred to a central warehouse and then distributed to secondary warehouses and stored until medical clinics are needed", thus validating the hypothesis H1B. According to our hypothesis, the reduction of the number of suppliers will result when the medical items supplies are being transferred from suppliers to a central warehouse and from there distributed to secondary warehouses and stored until the need of military medical clinics is requesting them.

This means that the adoption of the supply chain type of transferring medical items from suppliers to a central warehouse and then distributed to secondary warehouses and delivered from there to military medical clinics explains 62,8%% of the reduction in the number of medical items suppliers.

It was also found that there is a positive very strong relationship ($r = 0.646$, $p < 0.01$) between the statement "we must reduce medical items inventory" and the statement "supply is transferred to a central warehouse and distributed directly to clinics", thus validating hypothesis H1C. According to our hypothesis H1C, the reduction of inventory will results when the supply of medical items will be transferred from medical items suppliers to a central warehouse and from there will be transferred directly to medical clinics when requested.

This means that the adoption of the supply chain type of transferring medical items from suppliers to a central warehouse and then distributed to military medical clinics explains 41.7% of the reduction in inventory of medical items.

Hypothesis H1a, H1B and H1c were validated. Subsequently, also the hypothesis 1 was validated.

The second hypothesis H2 is the following: There are correlations between the efficiency of the management of the supply networks for medical products and the three types of medical supply chain.

Hypothesis H2A is the following: there is a connection between the efficiency of the management of the supply networks for medical products and the type of the medical supply chain to through which medical equipment and medical items are distributed from suppliers directly to military clinics so that the efficiency of the management of the supply networks will increase.

Hypothesis H2B is the following: there is a correlation between the efficiency of the management of the supply networks for medical products and the type of supply chain that transfers medical items from suppliers to a central warehouse followed by distributing them to secondary warehouses to be stored until they will be required by military medical clinics so that the efficiency of the management of the supply chain will increase.

Hypothesis H2C is the following: there is a correlation between the efficiency of the management of the supply networks for medical products and the type of supply chain that transfers medical items from suppliers to a central warehouse followed by distributing them directly to military clinics when they will be required by military medical clinics so that the efficiency of the management of the supply chain will increase.

To examine hypotheses H2A, H2B and H2C we examined the correlation between the types of supply chain used for medical items in the military and the statements related to the efficiency of the management of the supply chains for medical products, by Pearson correlation coefficient. The results are presented in the following Table 2:

Table 2. Pearson correlation coefficients between types of supply chain and the efficiency of the medical supply chain (N= 100)

	Efficiency of the medical supply chain		
Type of medical supply chain	Supply chain management has become more efficient in the last two years	Implementation of supply chain management technology has improved the medical supply chain management	Further changes in the medical supply chain management are likely to occur in the next two years
The supplies are delivered directly to medical clinics by the suppliers	.562**	.570**	.578**
The supplies are transferred to a central warehouse and then distributed to secondary warehouses and stored until the need for medical clinics.	-.034	-.269**	-.253*
The supplies are transferred to a central warehouse and distributed directly to clinics	.207*	.197*	.137
* p<0.05 ** p<0.01			

Hypothesis H2A is validated since positive and significant correlations were found between the statement "the supply is delivered directly to medical clinics by suppliers" and the three statements of supply chain management for medical products, so that as supply had been delivered directly to suppliers the management of the medical supply chain has become more efficient in the last two years

($r = 0.562$, $p < 0.01$). Also, as the implementation of supply chain management technologies had improved the management of the supply chain type when medical supplies are transferred directly from suppliers to medical hospitals ($r = 0.570$, $p < 0.01$) and as further changes in supply chain management are likely to occur in the next two years for this type of supply chain ($r = 0.578$, $p < 0.01$).

Hypothesis H2B is rejected since the correlation coefficients between the type of system in which "the supply is delivered to a central warehouse and then distributed to secondary warehouses and stored until the need for medical clinics" and the efficiency of the supply chains for medical products and were found to be weak and negative in all three cases.

In this case, the fact that the implementation of the supply chain management technology has improved the medical supply chain is negatively correlated ($r = -.269$) indicates that the respondents considered that the new management technology (SAP system) has not performed at the positive expected level. This is explained by the fact that this type of supply system is the most complex system and is difficult to be used by people in the supply chain management. The same results were found during the qualitative research when several interviewed respondents stated that the system is cumbersome, difficult to use, needs to use several level for accessing its various parts. Therefore, before making additional changes to the management system of this type of supply chain, respondents considered that the simplification of the existing SAP management system should be first done. This explains also the negative correlation coefficients indicating that efficiency of this type of medical supply system has not improved ($r = -0.34$) and that further changes of the system should not occur in the next two years ($r = -0.254$).

Hypothesis H2C is validated since statistically significant positive relationships were also found between the supply chain in which suppliers deliver medical items to a central warehouse and delivered from this central warehouse directly to medical military clinics ($r = 0.207$, $p < 0.05$) and as the implementation of supply chain management technologies improves supply chain management to clinics ($r = 0.197$, $p < 0.05$), however at weaker intensity.

Findings from published literature has shown that there may be multiple options for the management of supply chains for medical equipment and supplies in the military, as demonstrated by the supply chain management systems in the US military and the Israel Defense Force. In this study, supply chain management in the Israel Defense Force was examined in-depth. The study focused on gaining an understanding of the way the medical equipment is distributed to the clinics in the military and the influence it has on the effectiveness of the supply chain system.

Based on the testing of the hypothesis H1, the confirmation of the hypothesis indicated that there is a link between the steps to be taken to improve the supply chain system and how medical equipment is distributed to clinics. One method of improving supply chain management in the Israeli military has been using an effective system of logistics to ensure that inventory stored in warehouses is available for use when needed in the end unit. To fulfill the need for transferring inventory, transportation systems are in place to move inventory from the logistic

centers to local warehouses. In addition, IT systems have been used to manage the transportation of equipment and supplies (Tachnai, 2017).

With the way the medical equipment is distributed to clinics shown in the study to strongly influence the effectiveness of the supply chain system, several factors involved in supply chain management were examined for their likely effect on medical supply distribution. From the responses of the military personnel and management of the warehouses to the statements in the questionnaire relating to actions for improving the supply chain system, the perception of the participants was that a positive relationship with the providers drives the supply of medical supplies directly to the clinics and is expected to lead to improvements in supply chain management, limiting the need for other agents to be involved in medical supply distribution.

In Israel, to maintain control over prices and costs, the Ministry of Defense signs a contract for medical supplies for the IDF with the selected supplier. The supplier is delivering the medical items to the IDF which is responsible for managing the medical supplies and equipment inventory.

Tachnai (2017) has identified in the Israeli military, that in special situations when relationships with the suppliers for medical items are strong and trust has been built between the supplier and the IDF, the supplies are being stored by the supplier. Each military unit is able to withdraw their supplies from the supplier only once they are needed at any time. This system allows the military to save some of the costs related to supply and storage while ensuring sufficient supplies as needed by the units.

In this study, the number of suppliers was perceived by the participants as an influencing factor, with a reduction in the number of suppliers leading to supplies being delivered to central warehouses, which then necessitated distribution to secondary warehouses and their storage until use. Furthermore, the participants perceived that reducing the inventory itself is likely to lead to the medical supplies to be received by a central warehouse, followed by distribution directly to the clinics.

Efficiency of the management of supply networks is another major factor affecting the process of distribution of medical products in the military, being in accordance with the findings of Duque-Uribe et al., (2019) who have identified high costs, negative impacts on the natural environment and high social problems as the most important deficiencies of the medical supply chains. Current plans for the distribution of equipment and supplies in the Israeli military have been designed with the three supply centers planned for construction serving as central warehouses for the distribution of supplies.

The questionnaire was used to examine the respondents' perceptions of the efficiency of the management of medical supply chains in the military using the three possible options for the distribution of medical supplies to the medical clinics. When the examination of supplies being directly delivered to the medical clinics by the suppliers was conducted, the correlation with observed efficiency was significant. Not only was efficiency improved, but in addition the introduction of supply chain management technologies had the potential to improve the management of supply

chains where the medical supplies were distributed directly to the medical clinics by the suppliers. For the second option of medical supply distribution, whereby the medical supplies are transferred to the central warehouse and then directly distributed to the clinics, efficiency is perceived to be improved but to a lesser extent. Introduction of supply chain management technologies was also found to positively influence the supply chain management process. However, indications of efficiency of supply chain management when the option of transferring the medical supplies to a central warehouse, from where they would be distributed to secondary warehouses and stored until needed by the medical clinics were examined and were not found to be significant.

Brubakken et al. (2020) have explored the subject of effective supply chain principles, to improve current shortages of medical items in the United States of America Air Force Medical Service (AFMS). Their findings validate our findings that using centralized purchasing for medical items, thus consolidating demand, has increased the 12%–17% availability of medical materials and medicines by a rate of 12-17%.

A further examination of changes that occur in the supply chains for medical products and the way in which they are affected by the manner of distribution of medical supplies to the clinics in the military has shown that an increase in the number of suppliers drove the distribution of medical supplies from the suppliers directly to the medical clinics. Furthermore, shortages in inventory also seemed to lead to an increase in the distribution of medical supplies directly to the clinics by the suppliers. Another aspect influencing inventory distribution and shortages is having accurate information available about inventory status, which can assist in ensuring efficient distribution of inventory and prevent shortages and out-of-stock events (Tachnai, 2017).

Insight of the military personnel about the importance of several criteria, like cost, quality, readiness, and accessibility of medical care on different aspects of the management of the medical supply chains in the military highlight some of the challenges that the clinics face in providing adequate care. While the personnel perceived that treatment in the clinics is adequate and supplies are available, when treatment is required for the forces in the field and the supply centers are not located nearby, the availability and accessibility of supplies may be limited, potentially delaying treatment. Furthermore, the participants in the study indicated that when the supplies are not delivered directly from the supplier to the unit, there may be delays in receiving the medical supplies.

Thus, although accessibility to supplies was considered necessary for medical therapy performance, the participants in the study indicated the great importance of readiness of the medical clinics to provide prompt treatment. Readiness was considered to partly be associated with adequate amounts of medical supplies and equipment.

Another conclusion is that there are available different options for purchasing and delivery of medical supplies, being possible to choose one of the three types of medical supply chain. The first is the direct type when medical supplies

are directly delivered to medical clinics by the suppliers. The second type is when medical supplies are delivered to a central warehouse and then distributed to secondary storages and stored until needed by the medical clinics. And the third type is when medical supplies are delivered to a central warehouse and then distributed directly to medical clinics.

The researcher opinion is that all the three major types of supply chain should be used for medical items. The decision about which one is the most appropriate should be based on various criteria each one having allocated a coefficient of importance correlated with the fulfillment of the medical supply chain to ensure the maintenance of the combat capacity and combat readiness of each military unit of the IDF.

3. Recommendations

The first recommendation is the introduction of independent delivery methods, where the medical units work directly with the manufacturer of the medical supplies to manage and monitor their supplies. Under these conditions, to be able to maintain readiness for all types of emergency situations that may arise in the military, the General Staff would need to maintain an inventory of medical equipment and medicines that could provide a response in an emergency, like a war or national disaster. Also, is needed to improve warehousing and management of inventory, and to optimize the transportation and distribution of medical items.

Another recommendation is to introduce independent procurement of medical equipment for the special units by allowing them to work directly with the medical suppliers.

The third recommendation is to undertake the adjustment of the work processes in the medical supply chain because it represents an integral part of getting the best performance from using these technologies in the daily work of personnel involved in the supply chain.

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