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Healthcare and Disaster Supply Chain : Literature Review and Future Research

Irwan Syahrir^{a,b}, Suparno^b, Iwan Vanany^{b,*}^{a,b} Faculty of Technic, Muhammadiyah University of Surabaya, Surabaya 60113, Indonesia^b Department of Industrial Engineering, Sepuluh Nopember Institute of Technology, Surabaya 60111, Indonesia

Abstract

Healthcare and disaster supply chain have becoming a more important and popular research issues recently. However, only a few of paper is known about the current issues both healthcare and disaster supply chain especially in natural disaster case. This paper is a preliminary report of a research on healthcare and disaster supply chain. The paper intends to review and analyse several papers on above topic published during the last ten years. Published papers on healthcare and disaster supply chain research from 2005 and 2014 were classified into three main themes: (1) healthcare supply chain, (2) disaster supply chain and (3) healthcare supply chain in natural disaster. The topic issues in each main themes include operational management, information technology, inventory and control management, strategic management, and service management. Besides, the type of research methods contain empirical study, case study, modelling and simulation, literature review, and conceptual theory. Result of the review will provide the basis for the direction of future research in these three themes.

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* Corresponding author. Tel.: +628155100419; fax: +62313813096.
E-mail address: irwansyahrir@gmail.com

1. Introduction

Healthcare Supply Chain topic is a popular and many researchers are interested to investigate this area in the last ten years (e.g. [1], [2], [3], [4], [5], and others). According to Dobrzykowski et al [6], researches in healthcare area on the field of Operation Management (OM) and Supply Chain Management (SCM) are still relevant. Most of the researches on both fields still considering the supply chain operation [7] and technology [8] [9] in normal circumstances. There are still a few previous research that considering operation on abnormal conditions, for example when disasters occurred. There are many types of the natural disasters that frequently disrupt many countries such as earthquake, flood, epidemic/pandemic, landslides and others. Research healthcare supply chain that related with the natural disasters issues are relatively a few such as Jr [10], Balcik et al [11], Gatignon et al [12], Scarpin & Silva [13]. In the last ten years, the events of natural disaster in the world are increasing. So that they provide attraction and a challenge for many researchers to conduct study in this issues.

On disaster management topic, frameworks and logistics operations model for the humanitarian disaster operations has been generated by researchers, such as those conducted by Pujawan et al [14], Kumar and Havey [15], and Chakravarty [16]. The studies that addressed the issues of disaster has been done extensively in approximately 20 years ago. These researches focused on disaster management typically on the management of relief operations which include the planning and distribution of relief material needs of disaster victims, evacuation, coordination and collaboration among the parties involved in humanitarian operations. But still few have focused on the role of Healthcare Supply Chain (HSC) in natural disasters. Studies that consider the integration between the area of healthcare supply chain and supply chain disaster particularly natural disasters will become an important and interesting issue for academician and researchers. Several studies that take into consideration both these areas such as Dasaklis et al [17] who focus on the development of the role of management and logistic operations to control epidemic attack. Gupta et al [18] developed a new models to decide the best local health departments in implementing the vaccination program when faced catastrophic epidemic attacks, and Abbas and Routray [19] which builds a semi-quantitative models for risk assessment at the hospital in facing a flood disaster.

Studies on the healthcare supply chain related to natural disasters are still less. So this research area will be an interesting and challenging issues to be discussed. Therefore, in-depth and comprehensive study still need to be done further. This paper will discussed the research opportunities that can be done in the future on the area of healthcare supply chain, disaster supply chain and healthcare supply chain in natural disaster

2. Healthcare supply chain in natural disaster

Most of natural disasters could not be predicted when it happened, including the demand for goods to disaster victims are also unpredictable. Usually demand of the material needs (e.g. food, beverages, clothing, medicines, medical equipment, etc.) for disaster victims will increase sharply during the disaster is still ongoing. In humanitarian operations for disaster relief, nearly 60-80 percent of the costs associated with supply chain activities in the operational logistics of humanitarian aid [20]. So that the implementation of logistics operations should be run effectively and efficiently to reduce the impact of greater losses due to natural disasters. Therefore, logistic operations management in disaster relief have a very important role.

During a disaster occurs, usually the amount of demand for medical and health care needs will increase. In the disaster mitigation efforts, rapid response meeting the medical needs of disaster victims are emphasized to the rescue and recovery situation. Meeting the needs of medical and health services into the health care supply chain are very important. The success of disaster mitigation operations is influenced by how the healthcare system can run in disaster supply chain process. The efficiency and effectiveness of operational processes in the healthcare supply chain are expected to reduce the impact of greater losses, especially victims. Since it is very urgent issue of disaster, lately many researchers are paying attention to the study of supply chain management for disaster. One of them is Pujawan et al [14] who proposed the principles of supply chain for DROs (Disaster Relief Operations) and application framework model to evaluate the handling of logistic operations in relief disaster. In operating to tackle disaster, a decision maker role is very important. A frame work for the decision model in assessing risks for the relief disaster which are comprehensive required in order to reduce or avoid the greater impact of disasters [15].

Generally researchs in the area of disaster supply chain are still focus in disaster management field. But not specifically discuss the role of the healthcare supply chain in facing natural disasters.

In disaster relief operations, an availability of goods to meet disaster victim needs are an important issue that should be getting greater attention. Distribution timeliness and availability of goods must be fulfill by anyone that involved in the rescue operations of humanitarian disaster. According to Kumar & Havey [15], the mechanism of transport of goods and services, procurement of goods and supplies are an essential elements to handle disaster relief effectively. Supply chain flow of the materials needs for disaster victims will usually experience a disruption in the distribution and transportation. That's because the access roads and existing infrastructure damaged by natural disasters such as earthquakes or volcanic activity. Supply chain disruption which are caused damage the access road would affect distribution time and material procurement plan scenario in the disaster affected areas [21]. Urgent material needs during a disaster are food, beverages, clothing, temporary shelter, medicines, etc. The most important material needs are medicines to victims of natural disasters. One of the natural disasters that cause great loss of life was catastrophic epidemic outbreak. Fast response and meeting the needs of medicines during the epidemic progresses, it becomes a necessity. Dasaklis et al [17] has conducted research which focus on controlling an epidemic attack through logistic operation for drugs. At the time of the disaster, disruption problem of supply chain logistics for the availability of medical needs such as medicines in the health care facilities (hospitals, clinics, health centers, etc.) would be an interesting issue to be considered and discussed.

Healthcare SC in disaster management operations have a very important role that is not only to achieve a service quality, but also the safety of the patient [22]. At the time of the disaster, rescue operations be the main objective. Rescue efforts can be done by providing health services to the victims who suffer health problems due to the impact of disasters. Health services are usually performed at locations in the center of the disaster or health services such as hospitals, clinics, health centers, etc. Hospital role as a provider healthcare in serving of disaster victims would become very strategic. Performance of hospital services to disaster victims will determine the success rate of rescue operations. Good level and effective performance of healthcare services in hospitals will be able to save many people live that are affected by the disaster. Supply chain management issue in the health care system on the hospital have provide a challenge for many researchers in the world. As performed by Dobrzykowski et al [6], which has analyzed a number of papers which raised the issue of healthcare service industries in the field of operations management and supply chain management (OM and SCM). Most of paper analyzed still focuses on hospital services in normal conditions. There are still a few who do research with attention to abnormal conditions, for example in the event of emergency situations caused by disaster. Therefore, a frame work for disaster relief supply chain that is able to cope with the problems that arise in the event of extreme conditions and fraught with uncertainty remains a challenge. Especially with regard to the procurement and distribution of medical needs for disaster victims. An inventory models that can solve problems of supply chain in logistics operations on the hospital at the time of the disaster would be an interesting issue to be discussed.

3. Research method and paper classification

In this review, the paper obtained from science direct and emerald published from 2005 - 2014. The paper selection can be grouped based on research areas, namely healthcare and disaster supply chain. Keywords that were used in the search process are: healthcare supply chain, disaster supply chain and healthcare supply chain in natural disaster. Search results gained are 53 papers selected from numerous journal publications. Classification of the study area can be described as in Fig. 1.

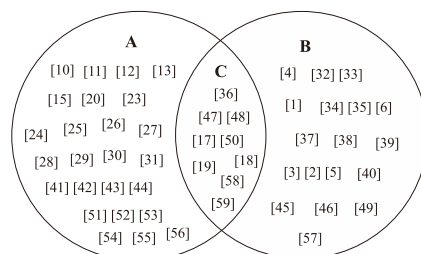


Fig. 1. Diagram of research area

- A = Disaster Supply Chain (DSC)
- B = Healthcare Supply Chain (HSC)
- C = Healthcare Supply Chain in Natural Disaster (Healthcare and Disaster Supply Chain/HDSC)

In Fig. 1, shown paper group that are classified according to the research area, namely the DSC, HSC and HDSC. The amount of paper generated based on the classification of the study area in order from the most are groups DSCR (26 papers), HSC (18 papers) and HDSC (9 papers) (Table 1). The amount of attention of researchers in both these areas indicate that this area are still attractive. Research area that integrates the two categories of areas are still lacking and less than disaster supply chain and healthcare supply chain area. Therefore, studies that integrate both still have a chance of more extensive research.

Table 1. Group of paper research area

Research Area	Number of Paper
DSC	26
HSC	18
HDSC	9
Total	53

Research topic in the area of HSC and HSC can be grouped into five areas, namely Operations Management (OM), Information Technology (IT), Inventory Management and Control (IMC), Service Management (Sv. M) and Strategic Management (St. M). OM is topic that focuses on the operational implementation of supply chain which includes the supervision and control of resources with the aim of achieving efficiency and effectiveness. IT focuses on using information technology in supply chain operational processes (information system management), for example, the use of computers and RFID (Radio Frequency Identification). ICM focuses on the management and control of operational logistics and inventory systems. Sv M focuses on the development and planning of services designed to achieve the satisfaction level of service. St M focus on the development of policies and planning management to achieve certain goals. Research topics which get most attention of researchers in the area of DSC and HSC in order are OM (20), St. M (11), ICM (10), IT (8) and Sv. M (4), see Table 2.

Table 2. Classification paper based on topic research

Topic	Research Area			Number of paper
	Disaster Supply Chain	Healthcare Supply Chain	Healthcare & Disaster Supply Chain (HDSC)	
Operations Management	[23] [24] [25] [11] [26] [27] [28] [29] [30] [16] [13] [10] [31]	[4] [32] [33] [34] [6] [35]	[36]	20

Information Technology		[37][38][1] [39][3] [2] [5] [40]		8
Inventory Management and Control	[20][41][42][43] [44]	[45] [46]	[47] [48] [17]	10
Service Management	[12]	[49]	[50] [19]	4
Strategy Management	[15][51][52][53] [54] [55] [56]	[57]	[18] [58] [59]	11

Table 3. Classification paper based on research method

Method	Research Area			Number of Paper
	Disaster Supply Chain (DSC)	Healthcare Supply Chain (HSC)	Healthcare & Disaster Supply Chain (HDSC)	
Math Modeling/ Simulation	[23] [26] [29] [43] [52]	[46]	[47][19] [18]	9
Case Study	[20] [12] [11] [42] [15] [28] [53] [30] [55] [56] [31] [54]	[37] [38] [1] [57] [39] [45] [49] [32]	[50] [58] [59] [36]	24
Literature Review	[24] [41] [44]	[4] [34] [6]	[17]	7
Empirical Study	[27] [13]	[35] [3] [2] [33] [5] [40]	[48]	9
Theory/ Conceptual	[25] [51] [16] [10]			4

From the journal selection obtained, we can be grouped based on the method of research into five categories, namely, empirical study, case study, mathematical modeling and simulation, review literature, and theory / conceptual (table 3). In Table 3 shows that the method most widely conducted research are case study (12) for disaster supply chain area. Research method which using approach theory / conceptual (0) is still less to do in healthcare supply chain and integration between the two (HSC and DSC). Overall the research methods used in all three areas in sequence is case study (24), mathematical modeling/ simulation (9), empirical study (9), literature review(7) and theory / conceptual (4).

In the area of healthcare supply chain in natural disaster in a sequence are case study (4), mathematical modeling / simulation (3), empirical study (1), literature review (1) and the theory / conceptual (0). It can be concluded that the research methods most widely performed for each area is case study.

4. Discussion

Based on the analysis of a number of paper options, we can classify the research areas into three, namely HSC, DSC and HDSC. Most papers in disaster supply chain area discuss about the issue of natural disaster operations. Research topics covered include areas of operations management and logistics operations. In disaster supply chain area, papers discussed about many issues that are related to the coordination of the humanitarian assistance operations [11] [51] [28] and logistics operations [20] [12] [60]. Problems that often arise in disaster relief operations are the lack of coordination and little knowledge of good logistics system. In [11] suggested that is necessary an innovation in the mechanisms of coordination among the participants involved in the humanitarian aid relief operations. According Wassenhove [20], operational challenges in humanitarian logistics are develop the science of better logistics and effective. Natural disasters have the characteristics of an emergency, uncertainty, complex and dynamic. That problems provide a large enough appeal for many researchers to develop a framework model for logistic operation that can be applied to tackle natural disasters. In [43] proposed a strategic planning on inventory capacity and coordination between storage networks in disaster relief efforts with using stochastic program approach. Strategies planning and cooperation among humanitarian aid teams must work effectively and efficiently in order to meet the needs of disaster victims. Manopiniwes & Irohara [44] proposed using optimization model for logistic features of humanitarian assistance when natural disaster occurred. Three aspects of logistics

feature in disaster relief are a placement facility, distribution models and inventory models. For the next study, it is necessary to consider the integration between the situation before and after the disaster which covers all three aspects of the logistics feature in each steps when dealing natural disasters.

In the healthcare supply chain area , mostly discussing the issues in the field of operations management and supply chain management on the healthcare system [6]. such as: Beliën & Forcé [4], Duan & Liao [46]. The use of information technology in healthcare supply chain systems includes topics are pretty much covered [1] [40] [3]. The use of RFID technology in the health care system becomes research trend which rapidly expanding. As performed Engin et al. [38] which discusses the effect of the implementation of RFID in the pharmaceutical inventory management. Reyes et al [2] who conducted a study to see the effect of using RFID technology on relationship between healthcare organization's network. For future research, the wider use of RFID in the healthcare system can still be done further. According Dobrzykowski et al [6] many chance of research on the topic of healthcare system in the future, namely the use of information technology; operational strategies; service design and capacity planning, scheduling and control service. Most of the research in the field of healthcare supply chain still focus on normal operating conditions. Research which discussing healthcare supply chain issues in an abnormal situation such as disruptions in the supply chain due to natural disasters is still less. Therefore, other research in the area of healthcare supply chain which consider abnormal situation still needs to be done in the future.

From the collection of paper selection, use of information technology in the healthcare supply chain for the case of a natural disaster is still little who perform. In the field of healthcare supply chain which consider on disaster relief efforts are more less when compared to the disaster supply chain and healthcare supply chain area. Topics which discussed in HDSC area are operation management [36], inventory management and control [47] [48] [17], service management [50] [19], strategic management [18] [58] [59]. In disaster relief operation, healthcare supply chain has an important role in the effort to rescue victims of natural disasters. Healthcare supply chain include the availability of medical needs such as medical equipment, medicines, anti-virus, vaccine etc. The availability of medical needs like drugs for disaster victims have to be fulfilled. When a natural disaster occurs, usually the amount of demand for medical needs will increase sharply. So that a crucial problem which often found are shortages of medicines. Mohanty [48] has found an imbalance between the amount of the availability of medicines in hospitals and the number of patients in the event of catastrophic like epidemic outbreak. Supply chain in healthcare systems for disaster operation relief became an important part in the process of disaster mitigation. Healthcare supply chain management should be work by effectively and efficiently in disaster mitigation operations. So that, It will be able to reduce and prevent the impact of greater losses, e.g. death a great number of disaster victims. Disaster management requires a response speed and effectiveness in the implementation. Researchers who conducted a study on the response to catastrophic events is Aitken et al. [50], which discusses preparedness deployment of a medical team in providing health care at the time before and after the disaster occurred. Mete & Zabinsky [47] conducted a stochastic model optimization approach in addressing the problems of storage and distribution of medical needs for disaster management. Research in the field of healthcare supply chain in disaster relief operations are still a few who do. So that research can be done in the future is still wide open. According Dasaklis et al [17], further research that can be done are research that would be consider coordination and collaboration all of the parties involved, inventory replenishment policies , capacity planning and availability of medical needs (eg. medical equipment, drugs, anti-virus, vaccines, etc.), distribution time and transportation. Problem formulation alternative that can be used to overcome disaster event are stochastic approach.

5. Conclusion

In this paper, we have reviewed the literature on the healthcare and disaster supply chain. From the analysis of the papers selected, it can be concluded that several research opportunities in the future. The first, HSC and DSC are still an area of research that are interesting and challenging. Research that integrates both HSC and DSC is a relevant issue to develop a model of HSC framework in order to have the capability in handling humanitarian relief operations during natural disasters. Issues of research topics that could be considered are operations management and logistical operations in the HSC system in response to the supply chain disorders caused by catastrophic events. Second, research has focused on inventory management and controls for medical needs in the event of a natural disaster (eg earthquakes, floods, epidemic disease outbreaks, landslides, etc.). To develop a model inventory availability and capacity planning for medical needs that can be applied in response to natural disasters. Use

information technology more widely in the HSC system in responding to the problem of interference supply chain at the time of the disaster. Third, catastrophic events characterize with the emergency, uncertain and dynamic. On the other hand, the system HSC has unique characteristics, namely complexity in the system of distribution channels. Therefore a combination of those characteristics would be an interesting and challenging problems for further research. So the research that considers the problem of stochastic with optimization approach, mathematical modeling and simulations on the HSC system for handling a natural disaster may also be the direction of future research.

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