

Categorization of reliability performance indicators

by Agung Sutrisno 10

Submission date: 13-Jun-2022 07:23AM (UTC+0700)

Submission ID: 1855571025

File name: Categorization_of_reliability_performace_indicators.pdf (559.5K)

Word count: 2732

Character count: 16767

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To cite this article: A Sutrisno *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **722** 012007

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Categorization of Reliability Performance Indicators of Humanitarian Response Supply Chain

A Sutrisno¹, D Handayani², W Caesarendra³ and I Gunawan⁴

¹Department of Mechanical Engineering, Sam Ratulangi University, Indonesia

²Department of Industrial Engineering, Universitas Islam Indonesia, Indonesia

³Faculty of Integrated Technologies, Universiti Brunei Darussalam, Brunei Darussalam

⁴Center of Entrepreneurship and Innovation, The University of Adelaide, Australia

^{1,2,3,4}Email: agungsutrisno@unsrat.ac.id, dwihandayani@uii.ac.id, wahyu.caesarendra@ubd.edu.bd, indra.gunawan@adelaide.edu.au

Abstract. To minimize a number of disaster victims due to certain disaster, identifying performance indicators representing reliable disaster response operation are very necessary to drive success in humanitarian action. However, literature in disaster response managements that focused on reliability performance measures are very few. To fill in this gap, in this paper presents categorization of humanitarian supply chain reliability performance indicators. This method consists of both hard and soft indicators. Our classification enables humanitarian practitioners to possibly develop unified reliability estimation indices containing of both qualitative and quantitative reliability performance indicators. At the end, conclusions and new research directions from the preliminary study are presented.

1. Introduction

When disastrous event occurred, an immediate response operation is required to help the victims with necessary aids. From this point of view, the existence of reliable disaster response operation is necessary for ensuring all activities in response operation are working as intended. Nevertheless, as it is undertaken in an immediate, dynamic and uncertain situation, likelihood of successful response operation is heavily affected by its reliability. In this regard, reliability of humanitarian response operation is very important in endeavor to save disaster victims. Moreover, unreliable humanitarian response operation will cause increasing disaster victims, crisis escalation and increasing recovery cost. Therefore, improving understanding on what metric representing reliability dimension of disaster response operation is very important for decision makers to take any necessary action to improve it. In spite of its importance, references discussing on reliability performance indicator issues in the context of humanitarian supply chain are very limited in literature [1] as most of reliability performance metric is dedicated to profit-oriented operation [2]. In filling in the research gap, this paper presents a classification method of reliability performance indicators of humanitarian response operation from theoretical lens. The objective of this paper is to study classification of humanitarian supply chain reliability parameters and their performance indicators using hard and soft measures. The structure of the paper is as follows. In section 2, an overview and characteristics of humanitarian response supply chain and characteristics of humanitarian supply chain failure is presented. A brief description on structural model of disaster response supply chain reliability and followed by reliability parameters of supply chain is discussed in section 3. In section 4, a categorical model of reliability parameters of



disaster response supply chain is presented and discussed. In section 5 conclusions and potential research direction from this initial study are presented.

2. Failure Characteristics in Humanitarian Response Supply Chain

2.1. Humanitarian Response Supply Chain

In dealing with adverse impact of disaster, collaborative effort to tackle the occurrence of disaster is accomplished among humanitarian response organizations. The humanitarian supply-chain management (HSCM) involves managing the different factors in the system such as goods and materials, information, manpower, political authority, available infrastructure, etc. to reduce the impact of a disaster to the people. According to [3], humanitarian supply chain management can be defined as activities related to planning, executing, controlling and monitoring the flow of goods, service and information from the suppliers to the disaster victims in a cost effective and efficiently manner. Operated to fulfil the need of beneficiaries, humanitarian response supply chain is having similarities and differences with commercial supply chains [4]. Similarities of both supply chains are related on goals in delivery supplies to the beneficiaries, complexity of the operations and demand uncertainty. Meanwhile, difference between those supply chains are depends on involvement of parties, network configurations and demand predictability. Detailed comparative attributes between commercial and humanitarian response supply chain can referred to [5]. Different from commercial supply chain which is operated on basis to fulfill satisfaction of the customers, humanitarian supply chain operates on the basis of humanity and saving human life is becoming its priority. In similar with commercial supply chain, the applicability of the Supply Chain Operational Reference model (SCOR) as means to analyze the supply chain process is applicable to both types of supply chain.

2.2. Failure Characteristics in Humanitarian Response Supply Chain

Failure is defined as the inability of an entity to perform operating function as intended. In relation to reliability terminology. It is likelihood to perform operation as intended. Failure is the cause of unreliable operational event occurrence. In this regard, it is inevitable to consider failure modes of supply chain in reliability evaluation of humanitarian response operation. Considering its locus of occurrences, failures in disaster response supply chain could occur at any point of operation. And also, it can be in the form of hard failures such the unavailability of response equipment and lack of supplies. The second mode of failure, the soft failure is in the form of dysfunctionalities such as bad accountability, poor planning and lack sense of crisis among humanitarian officers. Within humanitarian supply chain context, supply chain failure is related with incapability of a typical humanitarian response supply chain to deliver all needed supplies of goods, services and information to the beneficiaries [6]. In accordance with disaster relief cycle, failures are starting from failure in disaster hazard analysis, failure in emergency response and failure in disaster management itself. In connection with the role of disaster response supply chain which delivers supplies to the disaster victims, failure characteristics in disaster response supply chain can be manifested by the 7W terminology (the wrong product, the wrong quantity, wrong condition, wrong places, wrong time, wrong customers and at wrong cost). Those terminology can be used to propose method to calculate quantitative measure of delivery reliability indices.

3. Humanitarian Supply Chain Reliability

Supply chain reliability according to [7] is defined as the probability of a typical supply chain to deliver the amount of goods and services to the critical transfer points in the systems. In similar, [8] stated that supply chain reliability is defined as the likelihood of incoming materials and product flow will arrive at the transfer points under specified conditions. And within supply chain

context, [9] defined reliability as probability that a supply chain enables to deliver the amount of ordered goods or service to the end customer within due date and under specified condition.

Despite varying definitions on what supply chain reliability are existing in literature, the terminology of supply chain reliability having universal contents related to capability to fulfill logistical needs of the beneficiaries under specified conditions and at a certain time interval. Supply chain reliability as an aspect in undertaking humanitarian action must be taken into consideration since it affects to recovery costs and resource will be spent in emergency operation. With its goal to deliver supplies at transfer points, the structural model and characteristics of the supply chain affect to reliability of supply chain. Typically, there are five structural models describing reliability of supply chain [10]; Series, Parallel, Parallel-Series, Series-Parallel, and G-out of K. Different structure of reliability configuration is having different reliability formulation indices.

3.1. Factors Affecting Humanitarian Supply Chain Reliability

In performing intended function to deliver good and service to the disaster victims, many internal and external factors affect to the operational capability of disaster response supply chain. Those factors must be considered to create effective and efficient humanitarian response operation [11]. The internal factors are related to the disaster characteristics, demand uncertainty, availability of local suppliers, donation types, attitude of local government, law and access to the beneficiaries. The external factors affecting to successfulness in undertaking response operations are related to the mission of humanitarian response organizations and coordination among them.

4. Results and Discussion

In order to identify humanitarian supply chain reliability parameters, one dimensional approach is taken by using literature survey to bibliographical databases. The reference database consulted are Emerald, ScienceDirect and IEEExplore using keywords, “supply chain reliability”, “humanitarian supply chain reliability”, and “supply chain reliability performance indicators”. Then the content of papers found to the above subjects are analyzed and tabulated as in Table 1.

4.1. Reliability Performance Indicator of Humanitarian Response Supply Chain – A Categorical Model

Altogether with other performance indicators in humanitarian response operation such as delivery, flexibility, responsiveness, reliability performance indicator representing possibility a typical humanitarian supply chain will perform its function in delivering goods and services to the victims. Regarding that humanitarian supply chain is representation of a kind of socio-technical system, its performance indicators should consider both of technical and non-technical measures. The first category, the technical parameters represent quantitative measures of response reliability. It is called hard measures since its occurrence will totally terminating reliability and causing failure in the eyes of beneficiaries. The latter, non-technical parameters represent qualitative indicator affecting partially failure event occurrence in performing response operation. The soft measure shows qualitative attribute indicating how well a humanitarian response operation would be. The second parameters which is called soft factor represent some non-technical parameters in which their existential affecting to reliability of disaster response operation. Classification of both hard and soft supply chain reliability performance indicators from various references are presented in Table 1.

Table 1. Categorization of Humanitarian Supply Chain Performance Indicators

Reliability Performance Indicator		
Category	Performance Indicator	Reference
Hard Measure		
Delivery Reliability	Percentage of order delivered in full	[10] and
	Delivery performance commitment date	[12]
	Order fulfillment Rate	
	Accuracy on purchasing document	
	Percentage of perfect goods condition	
Disaster Response Transportation Reliability	Existential on risk mitigation plan	
	Fleet availability	[13]
	Travel Time Duration	
	Transportation Capacity	
Disaster Response Infrastructures reliability	Reliability of Transportation Connectivity	
	Communication and Information infrastructure Reliability	[14]
	Quality and adequacy of goods storage (warehouse)	[11]
Soft Measure	Availability of skilled humanitarian personnel	[15]
	Performance Indicator	
	Governmental /political factors	
Socio-Economic Factor	Regulation related to humanitarian organization	[14] and [11]
	Law	[11]
	Political Constraint	[14]
Situational	Availability of local suppliers	[15]
	Religion and local culture	[11]
	Security Issues	[11]
	Demand Uncertainty	[11]
Interorganizational factor	The existence of contingency planning of response operation	[11]
	Type of Donation availability	[11]
	Quality of coordination among agencies involved in humanitarian operation.	[11] and [16]
	Information Transparency and trust across humanitarian supply chain	[15]

4.2. Discussions

In the first category, hard reliability performance indicators of humanitarian supply chain are consisting of three reliability indicators; delivery, transportation and disaster response infrastructure reliability. Those three categories are having quantitative measures as depicted in Table 1. Delivery reliability relates to probability that the aids can be delivered in the correct amount, time and to the right beneficiaries. Furthermore, delivery reliability also relates to the existential of contingency planning considering the occurrence of delivery risks. The second reliability parameters, transportation reliability defined as the possibility that the owned fleet to deliver the aids can perform its function in the assigned time. The last parameter, infrastructure reliability represent possibility that the available infrastructure will be functioning as intended. The second reliability performance measures are consisting of some qualitative indicators ranging from the existence of contingency planning of

response operation until the interest of stakeholders. Different from the first category, the second reliability performance indicator, soft reliability measures are counted based on qualitative indicators consisting of governmental, socio-economic situational factors and the interorganizational factors. Governmental factors are factors related to the governmental regulations or politics adopted by a certain government which can accelerate or hinder the execution of humanitarian operations. Socio-economic situational factors relate to typical factors related to the culture of the people in affected disasters, the existential of suppliers' supply logistics to the victims and also the demand uncertainty and security in the affected disaster area. The interorganizational factors closely connected to the contingency planning in humanitarian response operation, typological of donation, coordination and transparency and trust among response operations. Inclusion on using soft reliability measures enable decision makers consider both of tangible (hard measure) and intangible (soft measure) attribute of reliable response operation commonly encountered by humanitarian practitioners. The new classification of reliability performance indicators as above enable decision makers to possibly build new holistic logistics reliability indices from earlier model as presented by [17].

5. Conclusion

Identifying performance indicators of reliable disaster response supply chain is very important factor for reducing the number of casualties when disastrous event occurred. However, it was rarely deeply discussed in disaster management discipline. In narrowing down this research gap, in this paper, factors affecting reliability of humanitarian supply chain and a categorical model of qualitative and quantitative performance indicators of humanitarian response supply chain reliability is presented. Inclusion of soft reliability performance indicators enables decision makers consider qualitative measures commonly encountered in practical situation. Stating as an initial effort toward a more comprehensive reliability calculation indices, future studies are opened in the following paths. At first, refining our conceptual reliability classification model by adding example metrics for empirical calculation testing. The second research focus relates to the development of unified humanitarian supply chain reliability indices consisting of both of hard and soft performance indicators which is still missing in literature.

Acknowledgement

This research is financially supported by Indonesian Ministry of Research, Technology and Higher Education under Basic Research Scheme 2019 under contract number 134 / UN12.13/LT/2019.

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