

## **Applications of Structural Equation Modeling in Humanitarian Operations: A Systematic Literature Review**

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## **1. INTRODUCTION**

Disasters displace people, disrupt lives and cause human and economic losses (DUBEY *et al.*, 2019). In 2019, natural disasters affected more than 95 million people worldwide, causing losses of 130 billion dollars (CENTRE FOR RESEARCH ON THE EPIDEMIOLOGY OF DISASTERS – CRED, 2019). The risks caused by disasters cannot be eliminated but can be minimized through efficient and effective Humanitarian Logistics (HL) (KHAN *et al.*, 2019).

HL is the process of planning, implementing and controlling activities related to the preparation, planning, acquisition, transport, storage, tracking and customs clearance of available resources, from the point of origin to the point of consumption, to meet the needs of the beneficiaries (THOMAS and KOPCZAK, 2005). Behl and Dutta (2018) emphasize the importance of researches in the domain of HL since natural disasters (droughts, hurricanes, floods, earthquakes), and human-made disasters (conflicts between and within nations, refugee crises, wars, fires) have a significant impact on the society globally.

Díaz *et al.* (2018) report the growing interest in disaster management research, both in the academic and professional community, to develop measures that mitigate the impacts of disasters. The literature related to models, tools and techniques in the field of humanitarian operations is comprehensive, and the studies include different research methods, such as Structural Equation Modeling (SEM). SEM is a multivariate analysis technique with increasing application in Operations and Logistics due to its adherence to complex phenomena and rigorous methodology (SANTOS *et al.*, 2020). SEM is a technique used to analyze a group of variables simultaneously, testing previously established hypotheses based on a theoretical foundation (HAIR *et al.*, 2009).

In this context, based on a Systematic Literature Review (SLR), this paper aims to analyze the use of Structural Equation Modeling in studies related to humanitarian logistics to identify the main topics addressed, with their respective objectives and results. The justification for the development of the paper is given by the importance of studies that systematically investigate the advances in studies in humanitarian logistics, enabling new analyzes. Also, the study presents an integrated view of different topics covered in a humanitarian context.

This paper is organized as follows. Section 1 is dedicated to the introduction, justification and objectives of the study. Section 2 presents the theoretical background with concepts relevant to the research. Section 3 presents the research methodology used in this study. Next, Section 4 presents the results obtained through the analyzes. Section 5 offers a discussion of the study and its theoretical and practical implications. Finally, Section 6 presents the conclusions, limitations and future researches.

## **2. THEORETICAL BACKGROUND**

This section presents the bibliographic review of the main concepts related to humanitarian operations and structural equation modeling. The section is subdivided for better understanding: section 2.1 covers the general concepts of humanitarian operations. Section 2.2 covers the main SEM concepts.

### **2.1 Humanitarian Operations**

Humanitarian logistics is related to the processes and systems involved in the mobilization of resources, skills and knowledge to help people affected by disasters (VAN WASSENHOVE,

2006). The research line emerged after the tsunami occurred in Asia in 2004, and is the adaptation of commercial logistics activities to the humanitarian context (RUSSELL, 2005), characterizing it as an essential theme, which has grown in recent years. (LEIRAS *et al.*, 2014).

The humanitarian operations deal with a series of natural disasters, such as earthquakes, tsunamis, hurricanes, tornadoes, epidemics, droughts, floods, as well as anthropogenic disasters, such as terrorist acts, chemical attacks, refugee crises and nuclear accidents (KOVACS and SPENS, 2009). Besides, humanitarian operations are related to development programs aimed at improving existing problems (KOVÁCS and SPENS, 2009). Therefore, in addition to alleviating human suffering, the objective of humanitarian operations focuses on finding solutions, through development programs, to social problems such as, for example, poverty, hunger, inequality or illiteracy. Van Wassenhove (2006) states that for a humanitarian operation to be considered successful, it is necessary to meet the urgent needs of the population, to reduce the vulnerability of the victims in the shortest possible time. Assistance to the population involves the collection and distribution of basic items, such as food, clothing, shelters, as well as equipment for setting up camps to develop basic activities and medical care (VILLAR *et al.*, 2012).

Although studies have grown in recent years, it is still necessary to understand how the subject is approached considering systematic tools such as for example, structural equation modeling.

## **2.2 Structural Equation Modeling (SEM)**

SEM aims to explain the relationships between multiple variables (PILATI and LAROS, 2007; HAIR *et al.*, 2009). The technique analyzes a group of variables simultaneously, testing previously established hypotheses based on a theoretical foundation. The insertion of these conceptual variables occurs through the latent variables or constructs, which are elaborated from the use of measurable variables, as long as they have at least one characteristic in common and that function as indicators of the concepts worked in the theoretical sphere (OLIVEIRA, 2016).

The analyzed models represent the reality of a phenomenon and are divided into two: measurement model and the structural model (HAIR *et al.*, 2009). The measurement model represents the theory that shows how constructs are formed through measured variables; the structural model shows the association between the constructs (HAIR *et al.*, 2009).

SEM involves the four stages of the Confirmatory Factor Analysis process focused on the measurement model: (i) definition of individual constructs, (ii) development of the measurement model, (iii) study planning to produce empirical results, (iv) evaluation of the model validity. It also involves two specific stages aimed at the structural model: (v) specification of the structural model and, (vi) evaluation of the validity of the structural model (PILATI and LAROS, 2007). The SEM technique is a major step forward in dealing with multiple dependency relationships, where its value is linked to the benefits of the simultaneous use of structural models and measures, each containing different purposes in the global analysis of the complete model (SILVA *et al.*, 2007).

## **3. METHODS AND PROCEDURES**

The methodological procedures of this study consider the application of a Systematic Literature Review. SLR is a research method that reviews, updates, criticizes and improves knowledge on a specific topic, identifying strengths and weaknesses, as well as gaps and contradictions that exist (TORRACO, 2016). In the operations management area, Thomé *et al.* (2016) details the SLR method according to eight steps, which are:

- Planning and formulating the problem,

- Searching the literature,
- Data gathering,
- Quality evaluation,
- Data analysis and synthesis,
- Interpretation,
- Presenting the results, and
- Updating the review.

Considering the *first step*, the paper intends to answer the research question: how are studies of humanitarian operations approached from the perspective of structural modeling equations?

The *second step* considers the bibliographic search in the Scopus and Web of Science (WoS) databases. The choice is due to the capacity for complementarity between journals indexed in the two databases (THOMÉ *et al.*, 2016; MONGEON and PAUL-HUS, 2016). The set of keywords is defined by the combination of two groups that cover the topic broadly enough to avoid any artificial limitation of the documents obtained, at the same time providing limits to exclude undesirable results. The search string is: ("structural equation modeling" OR "SEM") AND ("disaster operation" OR "relief operation" OR "humanitarian logistic" OR "development program" OR "humanitarian operation" OR "humanitarian assistance" OR "humanitarian aid" OR "assistance logistic").

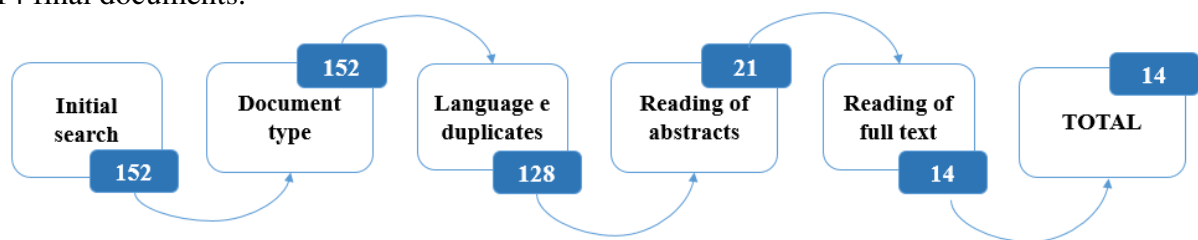
The search returns 152 documents on April 28 of 2020, and the documents are analyzed according to the following criteria to decide for the inclusion or exclusion in the present research:

- Inclusion criteria: address the structural equations modeling in the humanitarian context;
- Exclusion criteria: does not address the structural equations modeling in the humanitarian context; develops research outside the humanitarian context; deals with post-disaster medical assessments; duplicated documents; documents in other languages than English.

The *data collection* stage is performed by auxiliary tables to register bibliometric elements (title, authors, year of publication, publication channels, keywords, and main topics addressed). These elements are summarized and considered the descriptive results of this paper. The detailed description of the SLR ensured the *quality evaluation* stage.

The *fifth stage*, analysis, and synthesis are performed through full paper reading to identify essential aspects for the interpretation of the papers, as indicated by Seuring and Gold (2012). The next step consists in interpreting the results that include in discuss how the topics are being addressed by the studies analyzed. The *presentation of the results* is described in this paper, and the *updating of the revision* (the last step) is proposed as future research.

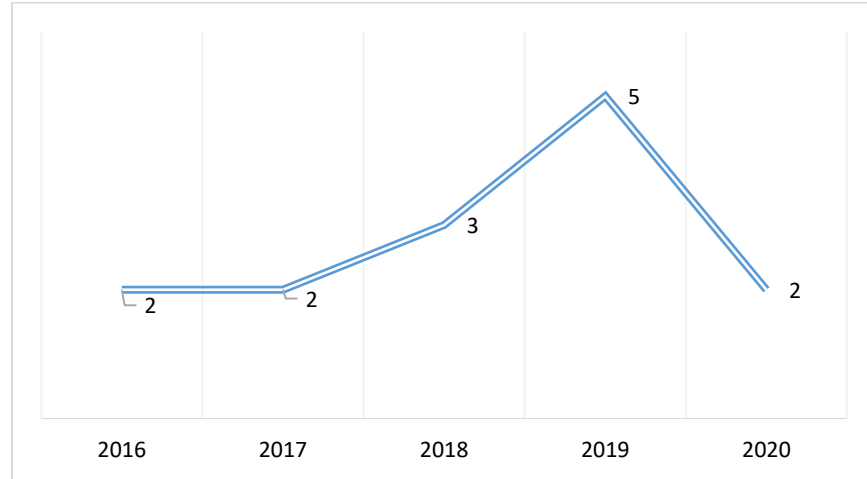
Figure 1 presents the results of the literature search, showing how the criteria resulted in 14 final documents.



**Figure 1** – Literature search. **Source:** Authors (2020)

#### 4. RESULTS

Figure 2 presents the evolution of the number of publications per year. Based on Figure 2, it is possible to notice that the first research related to the topic was published in 2016. After 2017 the number of studies increased and reached the most significant number of publications in 2019, with five publications. Also, it is observed that the topic is addressed as an object of study in at least 1 publication per year since 2016.



**Figure 2** – Evolution of publications per year. **Source:** Authors (2020)

Table 1 summarizes the 14 final documents selected, presenting the authors, year of publication, and periodic.

**Table 1** – Summary of papers

Authors	Source
Namagembe S. (2020)	Journal of Humanitarian Logistics and Supply Chain Management
Shafiq and Soratana (2020)	
Ahmed et al. (2019)	
Villa et al. (2017)	
Khan et al. (2019)	Sustainability (Switzerland)
Marcu et al. (2018)	
Dubey et al. (2019)	Annals of Operations Research
Behl and Dutta (2019)	Benchmarking
Sibirian (2019)	Applied Economics Letters
Berzin et al. (2018)	Child and Youth Services
Pazirandeh and Maghsoudi (2018)	Journal of the Operational Research Society
Kabra et al. (2017)	Telematics and Informatics
Bardhan and Dangi (2016)	Global Business Review
Maghsoudi and Pazirandeh (2016)	Supply Chain Management

**Source:** Authors (2020)

Table 1 shows that the Journal of Humanitarian Logistics and Supply Chain Management stands out with 4 publications. In addition to specific journals in the humanitarian logistics area, the topic is also addressed by journals from other areas, for example, supply chain management, business, economics and information technology, which can characterize the theme as multidisciplinary, seen from different perspectives.

Table 2 presents de number of citations extracted from Scopus database. The most cited paper is Maghsoudi and Pazirandeh (2016), which deals with key points for performance evaluation. One explanation for this may be that the topic of performance management is still a challenge for humanitarian organizations (DE FARIAS *et al.*, 2020).

**Table 2** – Number of citation

<b>Authors</b>	<b>Number of citation</b>	<b>Authors</b>	<b>Number of citation</b>
Maghsoudi and Pazirandeh (2016)	21	Ahmed et al. (2019)	2
Dubey et al. (2019)	20	Behl and Dutta (2019)	1
Kabra et al. (2017)	18	Marcu et al. (2018)	1
Villa et al. (2017)	7	Namagembe S. (2020)	0
Bardhan and Dangi (2016)	5	Shafiq and Soratana (2020)	0
Pazirandeh and Maghsoudi (2018)	3	Siburian (2019)	0
Khan et al. (2019)	2	Berzin et al. (2018)	0

**Source:** Authors (2020)

Table 3 presents a summary of the documents selected in the SLR. After full reading, documents were classified into 6 main topics: (1) coordination, (2) performance management, (3) communication, (4) social inequality, (5) readiness, and (6) integration. Each topic is presented in a synthesized below.

**Table 3 – Summary papers select by SLR**

#	Reference	Objective	Results	Sample size/ Country
1	Pazirandeh and Maghsoudi (2018)	Analyze the link between resource sharing, aspects that affect resource sharing and operational performance of organizations, including coordination	Resource sharing can improve organizational performance, and this complementarity of resources between organizations increases your willingness to share resources	101 humanitarian organizations Southeast Asia
	Dubey et al. (2019)	Understand the impact of information sharing and the formation of a network for coordination in humanitarian aid supply chains	Information sharing and behavioral uncertainty reduction act as facilitators for quick confidence	187 officers and manager India
	Ahmed et al. (2019)	Understand how coordinated effort effects Resources Management (RM).	Swift Trust helps to improve coordination and commitment from all stakeholders in order to manage resources to lead effective relief operations.	82 humanitarian workers Pakistan
	Namagembe (2020)	Examine the influence of relational capital on coordination between groups and the provision of services by humanitarian organizations	Relational capital influences inter-cluster coordination and service delivery in humanitarian relief chains	60 humanitarian organizations different countries
2	Maghsoudi e Pazirandeh (2016)	Investigate the association between visibility, resource sharing and performance in humanitarian supply chains	Supply chain visibility has a significant impact on organizational performance and will increase the improvement in cost efficiency and the flexibility in delivering aid to beneficiaries	101 humanitarian organizations Southeast Asia
	Bardhan e Dnagi (2016)	Establish a relationship between Critical Success Factors (CSFs) for relief logistics with the performance of the overall relief effort.	CFFs were classified as follows: level of coordination, behavioral factors, level of preparation, and needs assessment. The coordination level was considered to be the most significant	200 relief providers 100 affected population India
	Khan et al. (2019)	Understand how transparency can improve the performance, efficiency and effectiveness of humanitarian logistics	The relationship between predictor variables and the response variable is mediated by public confidence. Public confidence is essential in improving the performance, efficiency and effectiveness of humanitarian logistics	210 humanitarian workers Pakistan
3	Villa et al (2017)	Understand the impact of effective communication mechanisms on the performance of humanitarian organizations	The use of internal manuals and procedural guidelines, along with formal strategies is essential to promote dialogue with stakeholders and increase the perceived performance of humanitarian programs	107 humanitarian workers Somalia
	Kabra et al. (2017)	Examine how technology adoption can improve communication in humanitarian organizations	Of the four constructs analyzed (expected performance, expected effort, social influence and enabling conditions), expected performance and expected effort significantly affect the adoption of information technology	192 humanitarian practitioners India
	Behl and Dutta (2019)	Explore how information quality moderates the relationship of Corporate Social Responsibility (CSR) and crowdfunding to achieve financial and social stability	Corporate social responsibility can support the disaster relief operation, as there is a positive effect on corporate social responsibility activities in collective funding based on donations	232 respondents India
4	Siburian (2019)	Investigate the effects of fiscal decentralization on social income inequality	Decentralization allows for a balance in the distribution of resources to design a personalized development program that meets local needs	Database Indonesia
	Berzin et al. (2018)	Understand the relationship between a low-income youth entrepreneurship program and positive youth outcomes	Entrepreneurship and business creation can be important mechanisms to support marginalized youth	129 young different countries
5	Shafiq and Soratana (2020)	Present a Lean Readiness Assessment Model (LRAM) to assess the readiness of Humanitarian Organizations (HO) to adopt Lean Management (LM) practices	The critical factors accepted for LRAM are: process management, planning and control management, customer relationship management, human resource management and communication and coordination management	163 experts different countries
6	Marcu et al. (2018)	Identify possible ways of integrating immigrants and increase the performance of the labor market	Active labor market policies, the achievement of secondary education and advances in well-being, can generate a reduction in the unemployment rate of the foreign population	Database European Union countries

Source: Authors (2020)

**Coordination** is the most discussed topic, being highlighted in four publications. One explanation can be a number of stakeholders involved (LEIRAS *et al.*, 2014; PAZIRANDEH and MAGHSOUDI, 2018; FONTAINHA *et al.*, 2017). Humanitarian operations have different stakeholders: military, government, legislative and regulator, private sector, direct supplier, media, international aid network, donors, local aid network and the beneficiary (FONTAINHA *et al.*, 2017). Pazirandeh and Maghsoudi (2018) explain that organizations are different, with different objectives, cultures and work procedures, which need to compete with each other for resources. One of the solutions to achieve coordination can be the sharing of resources to achieve better results. Corroborating this statement, Ahmed *et al.* (2019) indicate that sharing timely information among stakeholders is essential to boost rapid response logistics efficiently, as it reduces behavioral uncertainty and increases rapid confidence, which accelerates commitment through strong coordination. Dubey *et al.* (2019) claim that coordination between stakeholders defines the success of a humanitarian operation. One aspect that can influence coordination is relational capital, where coordination between groups partially mediates the relationship between relational capital and service delivery in humanitarian aid chains.

The **performance management** topic is still a challenge for humanitarian organizations (SHAFIQ and SORATANA, 2019; DE FARIAS *et al.*, 2020). Bardhan and Dnagi (2016) state that for proper management of operations, a performance measurement system is needed that identifies problem areas and provides guidance for improvement. Among the indicators considered to be crucial to the success of activities, the role of behavioral factors, especially leadership, is significant. Maghsoudi and Pazirandeh (2016) point out some difficulties for excellent performance, mainly related to information uncertainty (supply, demand, intensity and location) during disasters, which is considered a significant moderating factor for performance. Some factors influence the performance of operations: sharing resources, assessing needs, receiving feedback from specialists, regularly participating in coordination meetings and logistical infrastructure. Khan *et al.* (2019) affirm that it is vital that humanitarian service providers adjust, modify and reconfigure their activities, improving their performance, efficiency and effectiveness through transparency (disclosure, clarity and precision, and the components of transparency, such as corporate governance, decision making decision and responsibility).

Regarding the **communication** topic, Villa *et al.* (2017) claim that better communication strategies not only within organizations but also with other stakeholders is essential to result in more efficient programs. Kabra *et al.* (2017) indicate that the adoption of information technology in the humanitarian context is necessary to improve communication between those involved; therefore, organizations must initiate additional support and training programs emphasizing the benefits of using information technology to improve communication and, consequently, improve results. Behl and Dutta (2019) indicate that the quality of information positively affects the relationship between crowdfunding and social assistance, as well as the financial aid offered to victims of disasters and, therefore, timely and quality information helps to achieve resilience.

Regarding **social inequality**, Siburian (2019) states that fiscal decentralization better meets local demands for public goods, since local authorities have more knowledge than people need in their activities. The imbalanced regional distribution of natural resources, human capital and infrastructure can increase social inequality. On the experience of young people, Berzin *et al.* (2018) affirm that young people who participate in development programs have higher levels of financial literacy, project management, interactions with the community and leadership.

Concerning **readiness**, Shafiq and Soratana (2020) state that the adoption of Lean Management is a valuable tool for humanitarian organizations since it is a proven philosophy that encompasses the continuous improvement of supply chain management. In this case, the crucial factors are process management, planning and control management, customer



relationship management, human resource management and communication and coordination management.

About **integration**, Marcu et al. (2018) state that there is a great need to develop specific and distinct policies for migrant workers and asylum seekers/refugees, to contribute to their performance in the labor market. Local authorities have a key role to play in integrating migrants into their new communities; therefore, there is a need to obtain better evidence for the development of new policies for the integration of migrants.

## **5. DISCUSSION**

The results presented in this paper contribute to the theoretical foundation of the main topics of LH analyzed with the application of SEM: coordination, performance management, communication, social inequality, readiness, and integration. Among the papers analysed, most are related to the difficulty of coordination during disaster response actions. This result reinforces that actions to improve coordination between organizations are essential to minimize the negative impacts for the vulnerable population.

The results also indicate the prevalence of research carried out on the Asian continent; therefore, there is a need for further studies and analysis, considering other regions such as, for example, Latin America. According to the 2018 Social Panorama of Latin America, more than 60 million people live in extreme poverty in these countries (ECONOMIC COMMISSION FOR LATIN AMERICA AND THE CARIBBEAN – ECLAC, 2019), resulting in a large population vulnerable to disasters.

The research is developed to generate knowledge for researchers and society in general and motivate reflections on possible improvements that are necessary for the success of humanitarian operations. The studies that address SEM in the humanitarian context help to understand the causal relationships, explaining how the variables are related to producing a specific outcome.

In addition to these broad contributions, both for academics and practitioners, the research also offers additional and specific contributions to each group, and these are detailed in the following sections.

### **5.1 Theoretical implications**

This study contributes to the academic literature with a structured review of the application of SEM in humanitarian operations, which includes an analysis of the main objectives and results of the analyzed studies. In this way, it is possible to observe which are the most approached themes and to identify the research gaps that can be worked on in new practical applications.

The developed literature review allows us to identify where the state of knowledge on the subject is. In this way, it is possible to observe the models, analyzes and results already established; in addition to understanding the issues that have not yet been investigated. Therefore, this work contributes to the literature with relevant results on the topic, in addition to contributing to researchers, assisting in define the most appropriate research strategy to investigate that problem and the most pertinent data analysis to be adopted. It is, therefore, an essential step, by which the researcher can start his work.

### **5.2 Practical implications**

Regarding the practical implications, the development of the study allows humanitarian workers, directors and managers to identify the main variables that contribute to the success of operations. The results presented in the study as, for example, resource sharing can improve organizational performance (PAZIRANDEH and MAGHSOUDI, 2018) provide support for organizations in adapting their processes and activities to improve the operation as a whole.

Besides, this study can support the design and implementation of systems that meet the main needs for improving humanitarian activities, based on the identification of some variables that are fundamental to the provision of services. Thus, this study represents an opportunity to improve the services offered and, consequently, stakeholder satisfaction.

## 6. CONCLUSIONS

This aim of this paper is achieved by the identification of the current state of the art related to the application of structural equation modeling in the humanitarian context. Based on the SLR procedures, we analyze 14 documents obtained in the Scopus and Web of Science databases, according to descriptive aspects regarding the year, journals, papers more cited, and content analysis.

Although the SEM technique has several benefits for decision making, the results reveal that the topic is still little addressed in the academic literature of the humanitarian context. The results also show that the application of SEM covers six main research topics: coordination, performance management, communication, social inequality, readiness, and integration. The coordination topic is the most addressed by the studies due to the difficulties that humanitarian operations impose, mainly due to the number of actors involved in response actions. For this reason, the dissemination of collaboration mechanisms between organizations is essential to improve results.

Future research is suggested considering the need to address other topics in the area, for example, supplier selection, inventory management and location of facilities. It is also necessary that the studies are applied in different countries to understand the particularities of each region.

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