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The contribution of scientific productions at the beginning of the third millennium (2001 - 2014) for humanitarian logistics: a bibliometric analysis

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Abstract

The humanitarian logistics is a branch of logistics that aims to plan, schedule and control inventories of goods in an efficient and low cost way, beyond monitor the flow of goods from point of origin to point of consumption in order to meet and alleviate human suffering in vulnerable communities affected by natural disasters and complex emergencies. Humanitarian logistics plays a key role in any aid effort. Considering the importance of humanitarian logistics to the success of disaster response operations, this paper aims to capture the state of art in this field of knowledge using bibliometric methods and techniques of social network analysis. The paper presents a comprehensive analysis of the studies in the field of humanitarian logistics, between the beginning of the XXI century (2001) and the present day (2014). This study aims to develop a literature review on the subject of the Humanitarian Logistics, rising information, scientific and technological knowledge, capturing the state of the art in this field of knowledge. The research is carried out by analyzing the citation and co-citation of articles leadership in humanitarian logistics research and seeks to provide valuable information about the knowledge network among studies in this area. Through the application of this statistical analysis, relevant theories, concepts and the research methods used in the area were identified, as well as topics for future research. This will enhance understanding of the subject, serving as a guide to the growth, development and dissemination of this scientific knowledge to better respond to humanitarian problems

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1. Introduction

Due to urban sprawl and climate change, the world population is more susceptible to suffer the action of natural disasters (UN, 2012). The risk of human and material losses due to natural disasters have increased significantly worldwide. From 2002 to 2011, about 400 natural disasters occurred per year around the world, affecting 270 million people, causing numerous physical damages and leading to the death 110,000 individuals (Guha-Sapir et al., 2013). Only in 2012, there were over 9,655 casualties, as well as a material loss of U.S. \$ 157.3 billion, 9.7% higher than annual average observed upon 2011 (Guha-Sapir et al., 2013).

In this panorama, it becomes essential a well structured humanitarian aid, seeking flexibility in response and, consequently, minimizing human suffering. Thus, it becomes essential to search, in the field of humanitarian logistics, for an efficient procedure for planning, implementing and controlling inventories of goods as well as monitoring the information flow from point of origin to point of consumption with the purpose of meeting the requirements of the final beneficiary (Thomas & Mizushima, 2005).

Scientific knowledge about humanitarian logistics is still incipient when compared to the business logistics. Nonetheless, based on the high numbers of losses that accompany natural disasters, the scientific community is driven to contribute effectively to reducing human suffering. Therefore, it is extremely important to identify in which level the knowledge on humanitarian logistics really is, seeking to understand and guide the growth, development and dissemination of this scientific knowledge to better respond to humanitarian problems. Thus, this article aims to analyse the growth of knowledge and to identify trends in course of written communication in the field of humanitarian logistics, from the beginning of the 21st century (2001) to nowadays (2014). In addition, this paper presents a literature review on the subject and, through a bibliometric analysis, indicates the development of scientific publications in this field of research.

This article was structured as follows: section 2 presents an overview of the concept of humanitarian logistics, while the third section covers the main concepts of bibliometrics. Section 4 details the study methodology and section 5 analyses the results of the bibliometric research, presenting the evolution of knowledge about humanitarian logistics, from 2001 to 2014. Finally, section 6 presents the conclusion and final remarks.

2. An overview about humanitarian logistics

According to Apte (2009, p. 17 apud Çelik et al., 2012), humanitarian logistics is a "special branch of logistics that manages the supply of critical materials and services, with challenges such as demand peaks, uncertain supply responses, critical time gaps and vast scope of its operations". Thomas and Mizushima (2005, p. 60 apud Çelik et al., 2012) defines humanitarian logistics as "the process of planning, implementing and controlling the efficient flow and storage of low cost of goods and materials, as well related information from point of origin to point of consumption, in order to meet the needs of beneficiaries."

For Ertem et al. (2010), business logistics is 15 years ahead of humanitarian logistics. According to Nogueira et al. (2008), conditions faced by firms are different from those faced by organizations or countries in a disaster, so there are specific characteristics of humanitarian logistics that differ from traditional business approach, such as issues relating to human life, unreliable or non-existent information systems and demand is generated by random and unpredictable effects.

Logistics is responsible for defining the success or failure of a humanitarian operation, so it becomes the main element in any aid effort. However, it is the most costly part, corresponding to approximately 80% of the total costs of a relief operation (Van Wassenhove, 2006). As humanitarian logistics is the most sensitive part of a relief operation, it is important to understand how this particular supply chain, which needs to be multiple, global, dynamic and temporary, works (Van Wassenhove, 2006).

There is a limited body of research on humanitarian logistics (Beamon & Kotleba, 2006), with a few articles devoted to the subject until 2005 (Kovacs & Spens, 2007). But since then, humanitarian logistics began to be debated in different platforms, being subject to special sessions in renowned conferences like IFORMS, POMS, LRN (Kovacs & Spens, 2009). Special editions were published on the topic in journals such as the POMS, *International Journal of Physical Distribution & Logistics Management*, *Transportation Research Part E* and *Journal*

of Production Economics. In 2011, it was published the first exclusive newsletter on humanitarian logistics, the Journal of humanitarian logistics and Supply Chain Management. Exclusive research centers were also created, such as: The Health & Humanitarian Logistics Center G & A Tech (USA), the Master's Program in Advanced Studies in Logistics MIT (USA); the Humanitarian Response Lab Institute of Technology Massachusetts: also centers of research on the topic, as Humanitarian and Management - MASHLM University of Lugano (Switzerland), the Humanitarian Logistics and Supply Chain Research Institute – HUMLOG; the Hanken School of Economics (Finland), and the Disaster Prevention Research Institute of Kyoto University (Japan). Therefore, it is observed that the discipline has been developed as a theoretical body.

3. General vision about bibliometrics

Bibliometrics is a quantitative technique of statistical measurement of the rates of production and dispersion of scientific knowledge. This tool was presented in the early twentieth century, due to the need for production and evaluation of scientific communication (Araújo, 2006). Bibliometry is developed through empirical laws, based on the behavior of literature, particularly by:

- Lotka's Law (1926), which measures the scientific productivity;
- Bradford's Law (1934), which measures the spread of scientific knowledge;
- Law of Zipf (1949), which measures the distribution and frequency of words in a text.

It is worth mentioning that the tool has, as its central point, a quantitative methodology in the search for objective evaluation of scientific literature (Araújo, 2006):

"Leaving aside the judgments of value, it seems clear the importance of having a distribution that tells us about the number of authors, papers, journals or countries that are in each category of productivity, utility or whatever else we want to know (Price, 1976, p. 39 *apud* Araújo, 2006)."

The term bibliometrics refers to the mathematical and statistical analysis of patterns that appear in the publication and use of documents. There are two techniques widely used in bibliometrics: Citation and co-citation. The analysis of the technique in question is based on the premise that authors cite articles that are important in the development of their research. Thus, studies often cited has probably the greatest influence on the area surveyed than those who are poorly cited.

Therefore, bibliometry is a quantitative tool, which allows minimizing the subjectivity arising from the indexing and retrieval of information, which provides some knowledge in the area studied. Finally, the tool contributes to decision making in the management of information and knowledge, as it assists the organization and systematization of scientific and technological information.

4. Procedure for bibliometric study:

Figure 1 illustrates the proposed procedure for evaluating the course of written production in humanitarian logistics using a statistical tool. This section describes the steps of the study, as presented in Figure 1.

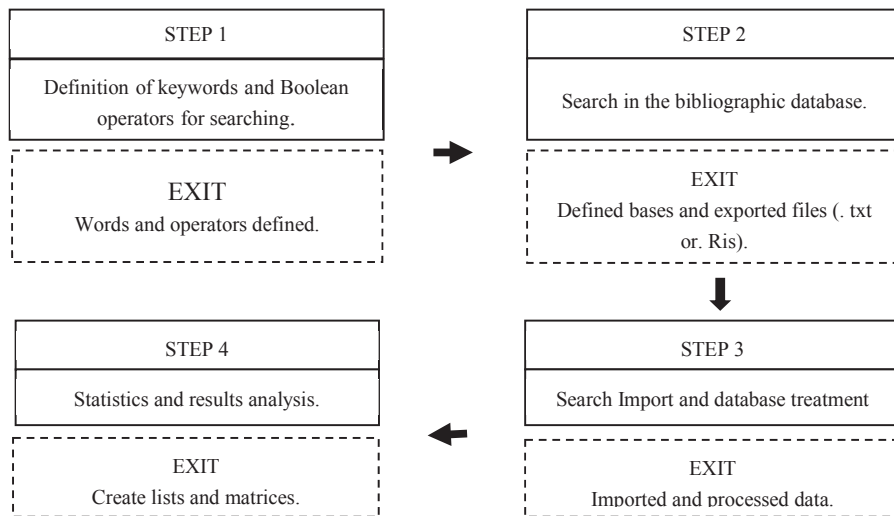


Fig. 1. Proposed procedure

4.1. Definition of keywords and Boolean operators (Step 1)

Initially, keywords were defined and selected based on the need to assess the state of the art in the field of humanitarian logistics. The authors have defined the following keywords: "Humanitarian", "Logistics", "Disaster" and "Supply Chain". The second step was to define the combination of words to cover the top works in the field of study concerned. For this study, the following combination of keywords was defined: ("Humanitarian" AND "Logistics") OR ("Disaster" AND "Logistics") OR ("Supply Chain" AND "Disaster").

4.2. Search in bibliographic database (Step 2)

The development of bibliometric study in the humanitarian field, specifically in the area of humanitarian logistics, was based on the analysis of scientific papers written from 2001 to 2014. The process of collection of published articles was then performed on three databases: ISI Web of Knowledge, Scopus and Science Direct, considering the last 14 years. As defined in Step 1, the logic judgment used for the search of articles was a the combination of the keywords – ("Humanitarian" \wedge "Logistics") \vee ("Disaster" \wedge "Logistics") \vee ("Supply Chain" \wedge "Disaster") – in the search field "topic" in the advanced search in the databases. For refinement of the results, filters were applied, as: "article document type" and "year 2001 to 2014".

A latter restriction was performed, by selecting the "categories" field in the databases. Only logistics-related categories were sought. Analysing this filter, it was essential for the elimination of the significant number of articles related to biomedical, anthropological and sociological areas. Table 1 represents the items selected to the study, totalling 690 papers.

Table 1. Search by database according to category filters

Search	("Humanitarian" \wedge "Logistics") \vee ("Disaster" \wedge "Logistics") \vee ("Supply Chain" \wedge "Disaster")
ISI Web of Knowledge	199
Scopus	213
Science Direct	278

4.3. Importing file to analysis software (Step 3)

The references of all databases were exported to the software VantagePoint, which enabled the organization and the elimination of duplicate articles (published in a journal and indexed in two or more bases), totalling 583 articles. The authors double checked the list of references and citations searching for possible duplications after completion of work.

4.4. Creation and analysis of lists, matrices and knowledge network (Step 4)

Step 4 of this research is the statistical analysis of quantitative data found in bibliometric study. This statistical analysis provides data which enables a better understanding of the state of art of humanitarian logistics. These results are presented and analysed in Section 5 of the article.

5. Analysis of results of the bibliometric study

In this section, we present and discuss the results of the quantitative data and bibliometric analysis. Initially, data was structured in lists and arrays, and then the knowledge networks of the field of humanitarian logistics were analysed.

5.1. Creation and analysis of lists and arrays

Figure 2 shows the distribution over time of 583 scientific articles identified in the data bases. Five of the articles analysed did not have its year of publication. Besides, based on Figure 2, it is possible to note the growing trend of studies in the field of humanitarian logistics. As previously pointed out by Kovacs and Spens (2007), it can be observed in Figure 2 that until 2005 very few articles on the topic were published. In December 2004 and on 2005, major natural disasters such as the Indian Ocean Tsunami (2004) and Hurricane Katrina (2005) draw attention to this research topic that has been growing since then. Academic publication showed a considerable increase in the years 2009 and 2012, doubling the amount published in the previous years.

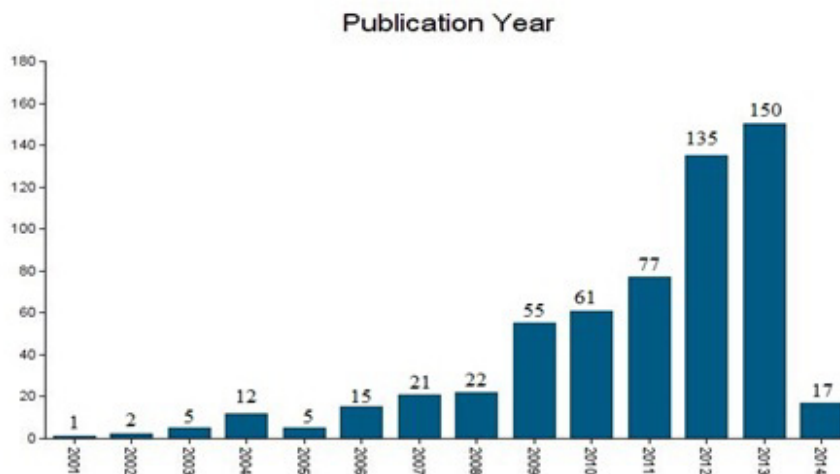


Fig. 2. Annual scientific production on humanitarian logistics published in international journals

By examining the number of countries that published researches on the subject, it was found that 250 articles did not have the availability of such data, so only 333 items of the total raised were reviewed. Table 2 presents the 10 countries that published the most of studies on the time period. These countries are responsible for 78% of publications, being the United States alone the source of about 33% of the published studies.

Table 2. Top ten countries in number of publications

Countries	USA	China	Taiwan	Turkey	United Kingdom	France	Finland	Japan	Spain	Germany
Records	109	46	17	17	16	14	11	11	10	9

A review about the articles published considering the degree of industrial and economic development of countries where the researches were held was also developed. The classification of developed, developing and underdeveloped countries adopted was based on that proposed by the International Monetary Fund (IMF), according to Nielsen (2011). Table 3 presents the found results.

Table 3. Distribution of publications per countries by level of development

Developed countries	Paper	Developing countries	Paper
Australia	5	Brazil	2
Austria	5	China	46
Belgium	2	Colombia	1
Canada	4	India	4
Finland	11	Indonesia	2
France	14	Iran	7
Germany	9	Kuwait	1
Greece	4	Peru	1
Ireland	1	Romania	1
Italy	2	Russia	2
Japan	11	South Africa	2
Netherlands	5	Taiwan	17
New Zealand	1	Thailand	4
Norway	2	Tunisia	3
Singapore	6	Turkey	17
Slovakia	1		
Spain	10		
Sweden	3		
Switzerland	2		
United Kingdom	16		
USA	109		

There was no publications for underdeveloped countries and the developed countries were responsible for about 67% of the published research, leading to 33% of the published research by developing countries. The United States

alone accounts for about 50% of the publications of the developed countries, while approximately 42% of publications from developing countries have originated in China. United States and China are the countries with the highest number of publications on the subject, and together accounted for 47% of the articles about humanitarian logistics. It is worth noting that, besides topping the list of publications, the United States also tops, in 2012, the list of countries that have suffered losses from natural disaster (Guha-Sapir et al., 2013). China itself also topped the list of countries with the largest number of victims due to natural disaster, which justifies the search for knowledge to alleviate the effects caused by disasters by both countries.

After this spatial analysis of articles, a review on the most important articles published was also conducted performed, with emphasis on the top ten cited articles within those selected (Table 4). From the top ten cited references, seven of them were published in the years 2006 and 2007, which can be explained by the challenges faced in natural disasters such as Indian Ocean Tsunami (2004) and Hurricane Katrina (2005). Lack of efficiency and effectiveness in the humanitarian operations in response to these disasters was a motivator for humanitarian logistics studies.

Table 4. Top ten cited articles list

References	Records
Özdamar, L., Ekinci, E. and Kucukyazici, B. (2004). Emergency logistics planning in natural disasters. <i>Annals of Operations Research</i> , 129 (1–4), pp. 217–245	33
Kovacs, G. and Spens, K. (2007). Humanitarian logistics in disaster relief operations. <i>International Journal of Physical Distribution & Logistics Management</i> , v. 37, n. 2, p. 99-114.	30
Yi, W. and Özdamar, L. (2007). A dynamic logistics coordination model for evacuation and support in disaster response activities. <i>European Journal of Operational Research</i> , 179 (3), pp. 1177–1193	24
Altay, N. and Green III, W.G. (2006). OR/MS research in disaster operations management. <i>European Journal of Operational Research</i> , 175 (1), pp. 475–493	24
Wassenhove, L.N.V. (2006). Humanitarian aid logistics: supply chain management in high gear. <i>The Journal of the Operational Research Society</i> , 57 (5), pp. 475–489	21
Oloruntoba, R. and Gray, R. (2006). Humanitarian aid: an agile supply chain?, <i>Supply Chain Management</i> , Vol. 11 No. 2, pp. 115-20.	19
Sheu, J.B. (2007) An emergency logistics distribution approach for quick response to urgent relief demand in disasters. <i>Transp. Res. E Logist. Transp. Rev.</i> ; 43(6): 687-709	17
Barbarosoglu, G. and Arda, Y. (2004). A two-stage stochastic programming framework for transportation planning in disaster response. <i>Journal of the Operational Research Society</i> 55, 43–53.	15
G Barbarosoglu, G., Ozdamar and L., Cevik, A. (2002). An interactive approach for hierarchical analysis of helicopter logistics in disaster relief operations. <i>European Journal of Operational Research</i> , Vol. 140, pp. 118–133	15
Van Wassenhove, L.N. (2006). Blackett memorial lecture. ‘Humanitarian aid logistics: supply chain management in high gear’, <i>Journal of the Operational Research Society</i> , Vol. 57, pp. 475-89.	15

Similarly, an evaluation of the authors who stood out in the field of humanitarian logistics was also performed, with emphasis on the top ten cited authors within those selected (Table 5).

Table 5. Top ten cited authors

References (Authors)	Van Wassenhove, L.N.	Beamon, B.M.	Spens, K.M	Balcik, B	Ekinci, E	Ozdamar, L.	Thomas, A.	Yi, W.	Altay, N.	Lee, H.L
Records	53	49	36	32	30	28	28	28	26	26

The analysis also identified the top five journals that have published articles on the subject humanitarian logistics. Based on quantitative analysis only, it was found that the top magazine in publications was Procedia - Social and Behavioral Sciences. It should be emphasized that Procedia publishes articles from scientific events and conferences, which explains the large amount of publications. However, as the focus of the article is a contribution to the growth

and generation of knowledge on humanitarian logistics, an analysis was made on top ten cited articles (Table 5), identifying the journals in which they were published and their impact factors. Table 6 presents the top five journals in number of publications and the journals that published the top ten cited articles. Only International Journal of Physical Distribution & Logistics Management appears in the list with the highest number of articles published on the topic and the list of journals that have published ten most cited articles on humanitarian logistics.

Table 6. Main magazines in humanitarian context

Search	Journal	Impact Factor (2012)
Top magazines in number of publications	Procedia - Social and Behavioral Sciences	0.000
	Procedia Engineering	0.000
	International Journal of Physical Distribution & Logistics Management	1.826
	International Journal of Production Economics	2.038
	Procedia Computer Science	0.000
Magazines that published the top 10 cited articles	Operations Research & Management Science	1.029
	International Journal of Physical Distribution & Logistics Management	1.826
	European Journal of Operational Research	2.038
	Journal of Operational Research Society	0.989
	Supply Chain Management: an International Journal	1.684
	Transportation Research Parte E: Logistics & Transportation Review	2.272

Table 7 presents the top five research areas within the proposed study, and articles published. Table 7 listed the five areas of research that had a greater emphasis on search. Since the numbers published are still low, much can still be studied and developed on these areas. The five areas identified require great attention in the field of humanitarian logistics.

Table 7. Main researches areas according to Web of Science

Research Area	Operations Research & Management Science	Business & Economics	Engineering	Computer Science	Transportation
Records	95	88	83	42	34

The most cited keywords used in the analyzed articles – not considering the words used at the beginning of the research, which formed the basis for the study, and their combinations – were also identified and presented on Table 8. The keyword management risk arises with the highest recurrence. However, other words also deserve mentioning, such as vehicle routing, facility location and multi-objective optimization. As shown in Table 7 and Table 8, both research areas and keywords with the highest incidence rates demand a great deal of attention in the field of logistics for the relief of human suffering.

In order to understand the focus given to the five main research areas, Figure 3 shows the 5x15 matrix, which presents the records of the areas of research with the highest number of studies developed in the field of humanitarian logistics and the fifteen keywords most used.

Table 8. Main keywords raised by research

Main Keywords	Records
Risk management	26
Mathematical models	18
Optimization	18
Emergency management	17
Emergency response	17
Simulation	11
Vehicle routing	11
facility location	10
Multi-objective optimization	9
Stochastic programming	9
Decision making	8
Decision support systems	8
Relief operations	8
strategic planning	8
Crisis management	7

Reset		Research Area:5 Research area	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		# Records	26	18	18	17	17	11	11	10	9	9	8	8	8	8	7
		▼ ▲ Show Values >= 1 and <= 10															
		Cooccurrence # of Records															
		▼ ▲															
	# Records		Risk management	Mathematical models	Optimization	Emergency management	Emergency response	Simulation	Vehicle routing	facility location	Multi-objective optimization	Stochastic programming	Decision making	Decision support systems	Relief operations	strategic planning	Crisis management
1	95	Operations Research & Management Scie	10	4	8	7	4	1	5	3	5	6	5	2	3	2	3
2	88	Business & Economics	6	3	3	3	6	2	3	1	1	2	2	3		3	
3	83	Engineering	10	4	6	5	3	1	2	1	3	3	3	1	2	2	3
4	42	Computer Science	5	1	7	4	1		1	3	1	1	1	2	1		2
5	34	Transportation	2	3		1	1		4	1	1					2	

Fig. 3. Crossing Matrix (search area vs keywords) based in the records

6. Conclusion

In this study, 583 papers published in international journals related to humanitarian logistics were identified. The list of articles was filtered and analysed according to several criteria in order to identify a profile of the study in humanitarian logistics. Although the results presented in this study indicate that there is a growing trend of studies in the field of humanitarian logistics at an international level, the national field studies are still quite rare.

Based on the results, bibliometric analysis directs researchers to gain a better understanding of the major themes, concepts and relationships associated with the humanitarian aid. Through this study, it may provide a useful channel for accessing the publications in this area and identify the direction of studies of humanitarian logistics. The proposed methodology can also be applied to other areas of logistics as well.

Considering the presented results, it can be concluded that research in the field of humanitarian logistics, with a global focus, has a profile with occasional outbreaks of publication. Furthermore, the field of study is widely exploitable, challenging and promising application in humanitarian relief in whatever stage of disaster. Thus, by what was known at present, research should be continued.

This study is relevant about the aspect of contribution to the increase of knowledge in humanitarian logistics and contribution of the methodology applied. The presentation of the evolution of knowledge about humanitarian logistics, from 2001 to 2014, will assist researchers as a statistical tool towards new themes. As humanitarian logistics emerged as an important and fundamental area of management for humanitarian relief in disaster operations, the importance of the study is given due to the analysis of the patterns of cooperation and productivity of researchers in this field of knowledge, seeking to understand the dynamics of the structure of collaboration among researchers working in universities, research centers and the private sector.

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