BIBLIOMETRIC MAPPING OF HUMANITARIAN LOGISTICS RESEARCH

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Introduction

Recently, an increasing number of natural and man-made disasters have occurred in many regions in the world, killing thousands of people and causing millions of indirect beneficiaries. Logistics has always been an important factor in humanitarian aid operations. Humanitarian logistics focuses on efficient management of flows of goods, information and services, to meet the urgent needs of affected people under emergency conditions (Kovács and Spens, 2007). Temporary Shelters provide immediate accommodation, medical care and food to affected people (Bayram et al., 2015). Its contribution towards overall relief operations is 80% (Trunick, 2005), which makes it a critical element for a successful relief operation (Sheu, 2007). Thus, a failure of the humanitarian and relief supply chain can result in catastrophic consequences for the affected populations.

The field of humanitarian logistics has been extensively studied so far, especially during the last 10 years. Many literature reviews have been published so far on this topic (Altay and Green, 2006; Kovács and Spens, 2007; Pettit and Beresford, 2009; Natarajarathinam et al., 2009; Overstreet et al., 2011; Kunz and Reiner, 2012). However, they all take a different perspective and approach for analysing the literature. In opposition to earlier work, this study use a bibliometric mapping approach which is data driven and relies heavily on computer algorithms and visualization techniques. The approach can be seen as complementary to the earlier studies. In this study, we present the results of the bibliometric analysis the humanitarian logistics field, and in particular the presentation of maps of the relationship between keywords, maps of clusters of research areas, as well as the maps of the density of keyword citations.

The term map is based on identifying pair of keywords, which occur together in large number of documents (Callon et al., 1991). The term map is used to visualize the structure of a scientific field by showing the relations between important terms in the field. The framework assumes that when two words appear together in titles or abstracts or in full text for a same document it indicates possible link between two distinct centres of interest designated by these words. Links like this when repeated in large number of documents can delineate are search sub-topic or intellectual sub-domain that may not have entered the mainstream of research delineation of that field. Recently, various studies have applied the bibliometric mapping approach for studying the structure and the dynamics of fields such as (Lee et al., 2014; Madani and Weber, 2016; Campos et al., 2017; Boudry et al., 2017; Hajduk, 2017; Mishra et al., 2017; Oraee et al., 2017; van Nunen et al., 2017; Zeng and Chini, 2017).

We analyse the broadest set of papers ever covered in previous literature reviews on humanitarian logistics. This paper is also the first in humanitarian logistics to use bibliometric mapping analysis as the main methodology to analyse literature in a structured way, which is of particular value to the academic community as well as practitioners.

The rest of this paper is organized as follows. The next section presents the process for constructing data set use in our analysis. Then explain how we performed our bibliometric mapping analysis. The last part of the study contains results and conclusions.

Methodology

Material collection

The first step in this study is the construction of a representative data set of humanitarian logistics literature. We conducted a search in June 2017 in following databases: Business Source Complete,

Science Direct, ABI/INFORM Global and Web of Science, and included all papers published or made available online until the end of 2016. The following keywords and Boolean operators were searched for in the fields "Title", "Abstract" or "Keywords": (Logistic* OR Supply Chain*) AND (Humanitarian OR Relief). These keywords were inspired by the keywords used in previous literature reviews (Kovács and Spens, 2007; Kunz and Reiner, 2012). The search was limited to peer-reviewed publications only, and book sections, conference proceedings, reports and practitioner journals were excluded from our selection. In total, 309 articles were collected from the search above. Titles abstracts and keywords are supposed to represent the full contents, including key concepts, of an article, and supposedly they are more focused than full texts and therefore more suitable for automated analysis.

The second step is data cleansing process. A sequence of strings is broken into pieces called tokens. This process is called tokenization. The aim of tokenization is to explore the words in a sentence and identify meaningful keywords. Punctuation was removed in the process of tokenization. Tokens can be made up of characters, numeric or alphanumeric. Following this, stop-words are removed from the data set. Stop-words are words from non-linguistic view that do not carry information. Prepositions (such as "from", "to", "after", etc.), articles (such as "a", "an" and "the") and pronouns (such as "I", "you", "she", "he", etc.) can be treated as stop-words. Eliminating stop-words helps to improve text processing performance. Next, word stemming is executed. Word stemming is a process of transforming words into their roots. Many words in English have different forms of the same words, for example "stemming", "stemmed" and "stems" have the same root word of "stem". Lastly, capital letters are converted into lower case.

Bibliometric mapping

We analysed the data set using a bibliometric mapping approach. Bibliometrics is the scientific field that is concerned with the *data-driven* quantitative analysis of books, articles, and other types of written communication.In the field of bibliometrics, a significant amount of attention is paid to bibliometric mapping.

Bibliometric mapping is a powerful tool for studying the structure and the dynamics of scientific fields. Researchers can utilize bibliometric maps to obtain a better understanding of the field in which they are working (van Eck et al., 2010). Bibliometric mapping aims to produce visual representations of the relations between certain units of interest. Various types of bibliometric maps can be distinguished, which each visualize the structure of a scientific field from a different point of view. Some maps, for example, show relations between authors or journals based on co-citation data. Other maps show relations between words or keywords based on co-occurrence data (van Eck et al., 2010). In this paper, we focused on maps that show relations between terms. We refer to these maps as term maps. By a term we mean a word or a phrase that refers to a domain-specific concept.

We identified noun phrases in the titles abstracts and keywords of the 309 articles in our data set by using a computer program called "visualization of similarities" or VOS; freely available at http://www.vosviewer.com) (van Eck et al., 2010; van Eck and Waltman, 2010). The VOS uses two techniques which are mapping technique and clustering technique which can refer to (Waltman et al., 2010) for more detail.

Only noun phrases occurring at least 10 times in the titles abstracts and keywords were taken into consideration. The irrelevant noun phrases were excluded from further analysis such as Author, Abstract, Year or Published are not particularly informative about humanitarian logistics. This resulted in a set of 158 terms.

For each pair of terms, we counted the number of times the terms occur together in the same article. Co-occurrence frequencies of terms are a commonly used measure of the relatedness of terms. We used the co-occurrence frequencies of our terms as input for the VOSviewer software which provides a graphical representation of the bibliometric networks, and in particular, enables the mapping of the relationship between keywords, indication of the most common terms in the defined description of a bibliographic record, highlighting the cluster groups of the analysed concepts, mapping the intensity of the citations of the highlighted concepts (Moed, 2010; Zhu et al., 2009).

Results

The term map constructed using the methodology discussed in the previous section is shown in Figure 1 and 2. These figures display the so-called network visualization and density visualization of the map. The network visualization focuses on the details of the map, while the density visualization provides a general overview of the map by indicating the relative importance of the various areas in the map.

Network visualization

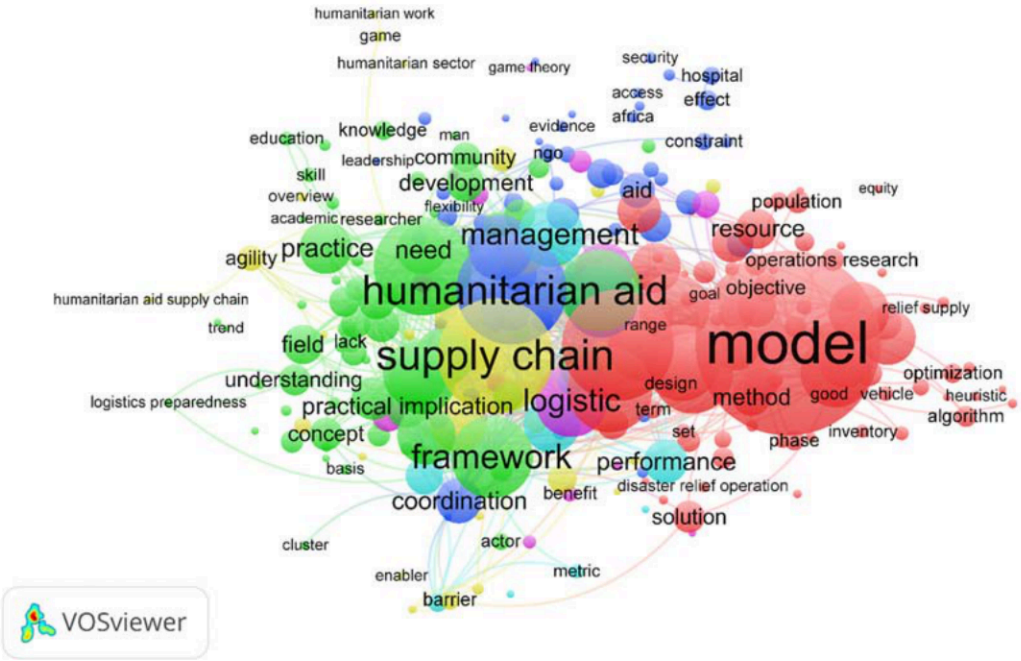

Figure 1: Network visualization. Colours indicate the clusters of research areas.

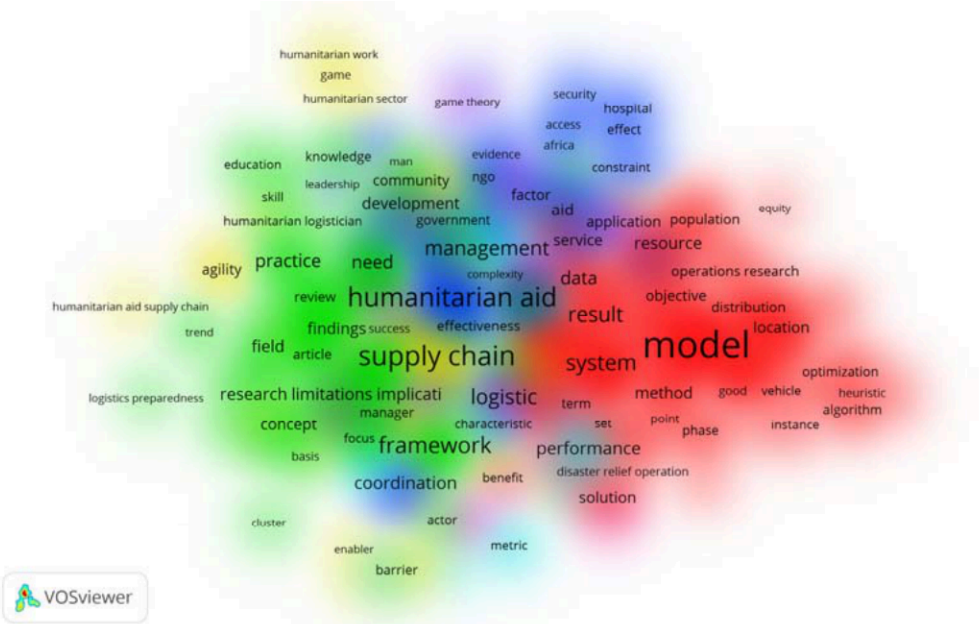

Figure 2: Network visualization. Colours indicate the clusters of research areas.

This is a map in which the 158 terms are located in such a way that the distance between any two terms reflects the relatedness of the terms as closely as possible. In general, the stronger the relation between two terms, the smaller the distance between the terms in the map. Each term in the term map also has a colour. Colours are used to indicate the grouping or clustering of the terms. Terms with the same colour belong to the same cluster and tend to be more closely related than terms with different colours. In other words, terms with the same colour tend to co-occur with each other more frequently than terms with different colours.

Figure 1 shows that each of the 6 clusters (research areas) has a more or less central term around which the other terms are positioned. The 6 central terms are model, humanitarian logistic, humanitarian aid, supply chain, logistic and management. The font size used to display a term and the size of a term's circle indicate the number of articles in which the term occurs. For each cluster, the 10 most occurring terms are listed in Table 1.

The first cluster combines studies relating to analytical models concerning logistics issues in disaster relief operations. The observation in the second cluster that humanitarian logistic is the most occurring terms in the field should not come as a surprise and needs no further explanation. The third cluster combines studies relating to humanitarian aid operations. The fourth and the fifth clusters combines studies relating to logistics and supply chain in context of humanitarian aid operations respectively. The final cluster represents the study of performance measurement in humanitarian logistics management.

Cluster 1 : Model	**Occurrences**	**Cluster 2 : Humanitarian logistic**	**Occurrences**
model	330	humanitarian logistic	176
disaster	199	framework	146
logistics	152	analysis	146
approach	144	design methodology approach	116
system	136	originality value	114
problem	127	finding	105
result	125	challenge	103
disaster relief	119	practice	93
time	107	need	88
demand	100	case study	77
Cluster 3 : Humanitarian aid	**Occurrences**	**Cluster 4 : Supply chain**	**Occurrences**
humanitarian aid	196	supply chain	206
operation	130	supply chain management	100
organization	117	issue	87
coordination	81	context	82
environment	64	impact	77
aid	63	activity	52
role	62	tool	47
service	60	agility	47
country	59	technology	43
relationship	54	state	37
Cluster 5 : Logistic	**Occurrences**	**Cluster 6 : Management**	**Occurrences**
logistic	128	management	117
area	104	process	101
humanitarian organization	58	performance	79
application	49	humanitarian supply chain	67
humanitarian operation	41	work	49
opportunity	37	performance measurement	34
partnership	34	metric	26

mechanism	34	studies	25
benefit	28	applicability	15
cooperation	24	performance evaluation	13

Table 1: The 10 most occurring terms in clusters

Density Visualization

In the density view (Figure 3), the colour of an area reflects the number of times the terms located in the area occur in the titles abstracts and keywords of the articles in our data set. The red areas in the density view can be regarded as the most important ones. The terms located in these areas together occur many times in the data set. The most occurring terms in density visualization is shown in Table 2.

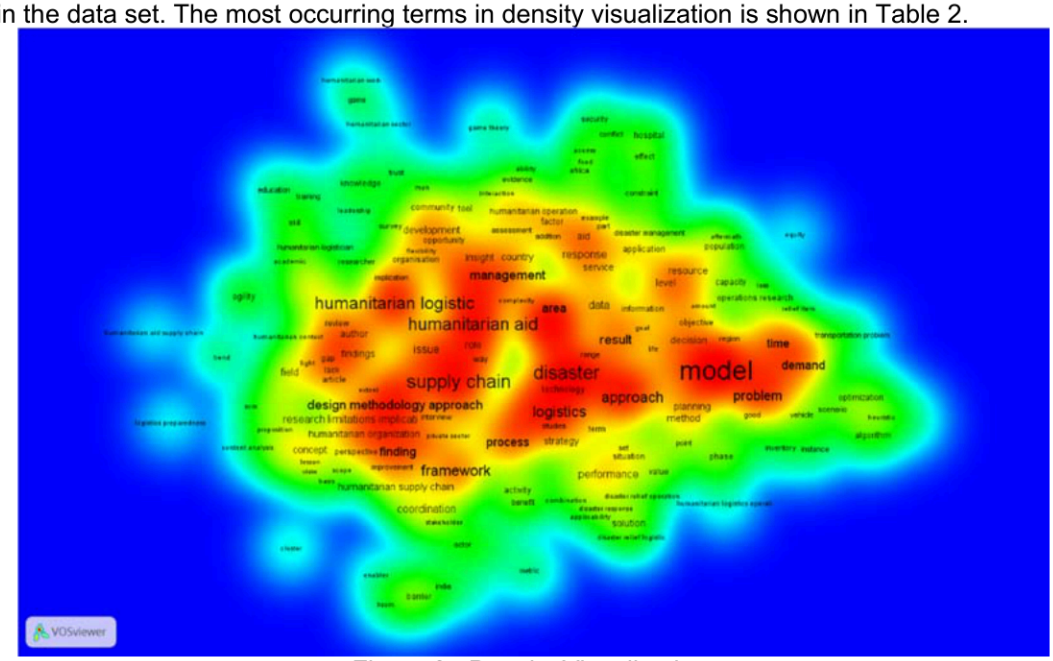

Figure 3: Density Visualization.

Term map of the field of humanitarian logistics field. Colors indicate the density of terms. The red areas in the density view can be regarded as the most important ones.

Terms	Occurrences	Terms	Occurrences
model	330	result	125
supply chain	206	disaster relief	119
disaster	199	organization	117
humanitarian aid	196	management	117
humanitarian logistic	176	design methodology approach	116
logistics	152	originality value	114
framework	146	time	107
analysis	146	finding	105
approach	144	area	104
system	136	challenge	103
operation	130	process	101
logistic	128	demand	100
problem	127	supply chain management	100

Table 2: The most occurring terms in Density Visualization

Conclusions

This paper is the first in humanitarian logistics to use bibliometric mapping analysis as the main methodology to analyse literature in a structured way, which is of particular value to the academic community as well as practitioners. A representative data set of titles abstracts and keyword of over 309 peer-reviewed articles published in leading journals in the humanitarian logistics field was constructed. With the help of various computer algorithms, key terms were identified and co-occurrence frequencies of these key terms were calculated. Based on the co-occurrence frequencies, the term map was constructed by using computer program called VOSviewer. The term map provides a visual representation of the humanitarian logistics field by showing the relations between 158 key terms in the field. The term map that was produced contains 6 clusters, namely model, humanitarian logistic, humanitarian aid, supply chain, logistic and management. The density visualization reveals the most important terms in the field of humanitarian logistics.

Furthermore, instead of term maps based on term co-occurrences, other types of bibliometric maps may be used. One may for example use maps of documents, authors, or journals. Instead of term co-occurrences, one may use co-citations or co-authorships to measure relations between items.

However, Interpretation of a bibliometric map is not entirely straightforward. Because bibliometric mapping has a number of limitations, the interpretation of a map should always be done in a very careful manner. Essentially, there are two types of limitations of bibliometric mapping, namely limitations imposed by the data and limitations imposed by the map. The availability of data will always be limited, and the data that is available will always contain a certain amount of noise. In our case, noise in the data may arise from the somewhat arbitrary decisions researchers make when choosing the terminology they use in the titles abstracts and keywords of their articles. Researchers may also use synonyms and homonyms. Our techniques do not recognize synonyms and homonyms, and this may also make the interpretation of our results somewhat ambiguous. A map provides a simplified representation of reality, and simplification generally implies some loss of information. In our case, there is a loss of information because terms are put in an Euclidean space and because this space has only 2-D. Given the limitations of both bibliometric maps and expert knowledge, a bibliometric map can best be seen as a tool that supports experts to improve their knowledge of a certain domain.

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