

Review

A bibliometric analysis of humanitarian logistics

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Abstract: Recent years have seen a surge in interest in humanitarian logistics (HL) research. This study conducted a bibliometric analysis of 894 HL-related studies. The publications were chosen using a combination of keywords from their titles, abstracts and author-supplied keywords from the leading database Scopus. The publications were classified according to their publication year, country of origin, type of publication, most relevant journals, and most influential authors. The review's findings indicate that over a four-decade period, HL research progressed through three distinct stages. In terms of national contribution, the United States of America leads with the most studies published on HL. Additionally, the HL literature is advanced primarily through academic journal articles. The Journal of Humanitarian Logistics and Supply Chain Management is the leading journal in the field, with 148 articles published. The study makes a significant contribution by providing relevant analysis that may inform and guide scholars and researchers as they explore the evolution of HL research and foster networking and collaboration opportunities across multiple institutions.

Keywords: *humanitarian logistics; bibliometric analysis; review; disaster relief management*

I. INTRODUCTION

During emergencies, humanitarian logistics (HL) is an integral element for providing relief to vulnerable people in regions severely affected by hardship and disaster [1]. According to [2], HL is conceptualized as the "*process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials as well as related information from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people.*" The main goal of HL is to mitigate the negative impacts of a disaster and effectively respond to the requirements of beneficiaries [3]. Unlike commercial logistics, HL is

plagued by different uncertainties and unknowns since demands from disaster regions cannot be predicted [4]. Moreover, HL is more centred on effectiveness than efficiency, even though achieving cost efficiencies is becoming increasingly relevant [5]. The alignment of incentives and goals is essential among partners in HL networks because the effective partnership between the involved stakeholders (e.g., military and humanitarian organizations, local authorities, non-governmental organizations) is necessary for delivering relief [6]. While actors in business logistics operate in an uninterrupted environment and are driven by the profit motive, HL actors face several supply chain interruptions, which

require more concerted efforts to save lives and serve vulnerable victims in dire conditions. Therefore, there is a need to effectively manage the multiple distinctive features of HL, including the uncertainty of demand in terms of time, location, type, and size; the unexpectedly high demand volumes of a wide variety of supplies in very short lead times; the high stakes related to the timeliness of deliveries; and the shortage of financial, technological, human, and infrastructure resources [7]–[9].

Recently, HL has attracted significant attention from scholars [10]–[13]. However, a few studies have examined the intellectual structure of this field using bibliometrics. For example, [14] conducts a bibliometric analysis of the humanitarian supply chain using 1152 documents extracted from the Web of Science (WOS) database. The author concludes that HL logistics is a relatively new field and calls for expanding the findings of his study using other renowned databases such as Business Source Premier, Science Direct and Scopus. Similarly, [15] conduct a bibliometric analysis of HL-related studies using citation and co-citation articles in this field. While the authors seek to offer valuable information regarding the knowledge network among the article published in this area, several filters were applied during the literature selection, such as document type and year of publication. [16] carries out a systematic literature review and bibliometric analysis to understand the evolution of scholarly works published in the field of the humanitarian supply chain between 2009 and 2015. The key indicators analyzed by the author are the trends in humanitarian supply chain publications, number of influential papers, top productive authors, top productive institutions, most frequent keywords and citation measures. In another study, [17] perform a bibliometric mapping analysis using many scientific databases except Scopus and excluding non-peer-reviewed literature such as conference proceedings and book chapters. Lastly, [18] conduct a mapping of

humanitarian operations literature using bibliometric methods to provide major research topics and clusters covering this research field. Summarizing, the research gaps we revealed from these past studies were the following:

- Lack of studies using the Scopus database as an alternative source of citations to conduct a bibliometric analysis of HL
- Lack of bibliometric analyses considering all sources of literature, both peer-reviewed and non-peer-reviewed literature
- The need to update the HL field on what bibliometric data can be gathered in this research area to confirm or extend the findings of the previous studies and derive novel insights

Given the progress in the literature on HL and the topical richness of this field, this study examines and shows how research on HL has developed over time. Moreover, this study investigates the bibliometric profile of the literature pertaining to HL. The study adopts a bibliometric analysis using data from citations of articles, chapters, books, conference proceedings, and other materials available at the Scopus database to attain these objectives.

This research analyzes 894 documents on HL dating from 1978 to 2020, revealing how the number of publications on HL has evolved. The study considers all research published from 1978 onwards because the earliest research on HL in Scopus is carried out this year.

After the introduction, we present a brief overview of HL literature. Section 3 provides the research method used. Section 4 presents the results of the bibliometric analysis. Finally, Section 5 concludes the paper highlighting the study's limitations and the future directions and opportunities arising from this research.

II. LITERATURE REVIEW

Over the last 20 years, the HL field has observed a lot of attention from scholars [19]. Several reasons explain the increasing focus on HL. For instance, HL is based on a combination of service and manufacturing to respond to emergencies at a given point in time [20]. Humanitarian emergencies are characterized by their unpredictable nature and uncertain demand patterns [21], thereby necessitating HL to optimize humanitarian aid and disaster relief efforts [22]. The main goal of HL is to alleviate the suffering of vulnerable people through planning, implementing and controlling the efficient and cost-effective flow of storage emergency supplies as well as related information from the point of origin to the point of consumption [23]. During a humanitarian crisis, several actors may be involved in HL and relief planning, such as citizens, governments, and non-governmental organizations (NGOs) [24]. The role of citizens is to ensure more preparedness for disasters to reduce property damage and save lives [25]. Preparedness is manifested in actions taken in advance of an emergency to build operational capabilities and facilitate effective responses when an emergency occurs [26]. The contribution made by citizens or communities can be a valuable source of economic support that can be harnessed to help victims suffering from a humanitarian disaster [12]. The efforts of citizens in HL cannot be undermined because they take a participatory approach in disaster relief operations and assume the role of first responders during a disaster with or without invitation [27]. [27] argue that local citizens are well-positioned to provide operational support to streamline emergency supplies flow to beneficiaries from local distribution points, working alongside volunteer organizations and official agencies.

The government is also one of the key players in HL. The intervention of government in HL can

impact the utility and performance of aid agencies because of its power and authority [28]. To reduce HL complexity and uncertainty, the government can play an influential role in humanitarian spaces by allocating the necessary funds to the relief operations and utilizing their services for capacity building and rehabilitation [29]. In their study, [30] note that the government is the second most crucial stakeholder in HL after the beneficiaries because it mobilizes the funds required, supports the military and paramilitary forces, delivers necessary infrastructure to humanitarian organizations, and facilitates relief missions. For example, in India, the government has made considerable efforts to control situations once disasters have occurred by managing humanitarian supplies, initiating rehabilitation plans for the disaster-affected regions [31], and minimizing the impact of natural disasters [29]. In China, the government has been involved in several disaster relief activities following the SARS infectious disease crisis. [32] posits that the government's role at that time was to speed up the transmission of disaster information. In the USA, the government provided assistance and aids to several nations hit by humanitarian catastrophes such as Haiti [33]. Therefore, governments can alleviate the suffering caused by disasters [34] as they are responsible for invoking protocols and reducing or mitigating the probability of disasters [35].

Several NGOs have dedicated technical support and developed human resources for HL response [36]. According to several studies (e.g. [37]), NGOs serve as vehicles for financial and health assistance for disaster-affected regions. In this context, [38] illustrate that some NGOs like the International Committee for the Red Cross have developed policies to support their field teams in providing care for patients inflicted by a disaster and not expected to survive. In some instances, NGOs have better access to global resources. They can

employ their connections to represent vulnerable communities' issues internationally, thereby improving the effectiveness of HL operations [39]. By working together, NGOs can manage disasters more efficiently, facilitate knowledge and resource sharing, and reduce the costs of HL operations [28].

The stakeholders of HL have conflicting interests; however, they are working on minimizing the suffering of vulnerable people. Also, humanitarian actors attribute significant value to HL due to its importance for the effectiveness and speed of response for major humanitarian programs, such as food, water, health, shelter and sanitation [21]. HL is also concerned with allocating scarce resources to complex relief operations in the most efficient manner [40], while serving victims quickly and minimizing the suffering [41]. HL shares some commonalities with business logistics since the basic principle of managing the flow of goods, information, funds remain valid for HL [8]. As such, HL comprises a set of stakeholders who operate in environments featured by irregular and uncertain demand. HL is necessary throughout the different disaster management stages, including mitigation, preparedness, response, and rehabilitation [42]. According to [43], mitigation is any activity aiming to prevent the likelihood of a disaster and reduce its impact during and after the disaster. Through HL, it is possible to apply different measures to prevent a disaster or reduce its impacts in case one occurs. For instance, humanitarian organizations can carry out risk mapping, identify communities' vulnerabilities and capacities for responding to potential hazards based on the available data, and develop plans that address likely scenarios. In the disaster preparedness phase, HL focuses on developing organizational structures, organizing supply chain resources, draft plans, and support training to ensure efficient response if preparedness is called for. Investing in HL for disaster preparedness is crucial because

effective preparedness enables to save lives, prevent injuries, reduce property losses and minimizes disruptions [25]. Furthermore, the primary goals of HL in disaster response are to shorten lead times [44], coordinate relief efforts [45], and ensure fast delivery of emergency supplies. Studies anchored in the disaster rehabilitation stage emphasized HL's primitive position as a critical enabler for successful humanitarian interventions and disaster management [25]. HL actions protect against the devastating impacts that a disaster can cause on a country, safeguarding development goals and maintaining the disaster-affected nation [46]. Therefore, HL research is broad in scope, covering multiple stakeholders, diverse themes, and topics that have differing dynamics. It is an emerging field informed by various disciplines and still lacks a holistic assessment and general overview of HL research's status quo. The upcoming sections discuss the research method used and the results obtained from the analysis.

III. RESEARCH METHOD

The term bibliometric was first used in 1969 in the *Journal of Documentation* [47]. Bibliometric is a broad term that refers to the statistical analysis of publication metadata [48], and it is typically used to evaluate publications and citations that are related to a particular phenomenon. To gain a better understanding of how a scientific domain develops and grows, bibliometric analysis examines the scholarly output and productivity over time. The premise at the heart of bibliometric analysis is that citations are a valid indicator of the impact of publications or academics in a given field of study [49]. In comparison to conventional and systematic literature reviews, bibliometric analysis are objective and free of subjective biases introduced by the researchers as they choose publications [50]. Similarly, it assists in overcoming the inapplicability of traditional review methods for large-scale

literature studies. However, bibliometric analysis alone does not capture all of the complexities of scientific impact and research quality [51]. Bibliometric results should be interpreted with caution, as they are not a review of the literature, a qualitative examination of the content, or an assessment of how the knowledge contained in publications is applied in real practice. In conducting the current bibliometric analysis of HL research, this study analyzes the most productive authors, the most relevant journals, the most common type of publication, and the most active countries in the HL field.

Our bibliometric analysis consists of six steps: 1) define the topic under study, 2) select the database, 3) apply the search criteria, 4) retrieve bibliometric data, 5) codify the retrieved data, and lastly, 6) analyze results.

We first identified the database for collecting information based on research gaps found in the HL literature. The study considered Scopus as the adequate scientific database that best met the objectives of the review. Scopus seems to be the most relevant because it is the largest abstract and citation database covering over 20000 peer-reviewed journals, including those published by Elsevier, EmeraldInsight, Springer, Taylor and Francis and Inderscience [52]. The reason for choosing Scopus instead of alternatives such as the WOS is its comprehensive coverage and indexing of logistics and supply chain-related peer-reviewed articles [53]. Scopus is also more accurate than Google Scholar [54] because it maintains better control over the referred publications and the controlled indexing [55].

The first scientific publication on HL appeared in 1978, and this research explored publications up to 2020. Related to the indicators used, quantity refers to the number of documents published on HL. However, quality is reflected in the impact of

publication and the number of citations that a publication receives. The final indicator serves to measure the relationships between the reviewed publications in the sample. For this study, we only considered the quality and quantity indicators since our goal was to reveal and measure how HL's scholarly interest has evolved in recent years. During the search for the literature, the following search query was used in Scopus:

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TITLE-ABS-KEY ( "humanitarian logistic*"
OR "humanitarian supply chain*" OR "humanitarian
operation*" OR "disaster relief*" OR "humanitarian
supply network*" ) AND ( LIMIT-TO (
SUBJAREA,"BUSI" ) ) AND ( LIMIT-TO (
LANGUAGE,"English" ) )
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The search keywords were used in the fields of title, abstract and keywords. Only English publications were retrieved, and the subject areas were limited to business and management. As a result, the search query returned 894 publications, which were retrieved for codification. We encoded the 894 publications using different variables: year of publication, country of publication, type of publication, leading journals, and most influential authors. Analyzing these bibliometric data enables us to observe the scholarly productivity in the field of HL. To conduct the analysis, the codification process took place in September 2020.

IV. RESULTS

The scope of our analysis includes all English publications and countries involved in HL research. The study analyzed all documents published from 1978 to 2020. As there is no temporal restriction, the pool of analyzed literature is significant, given HL's incipient nature.

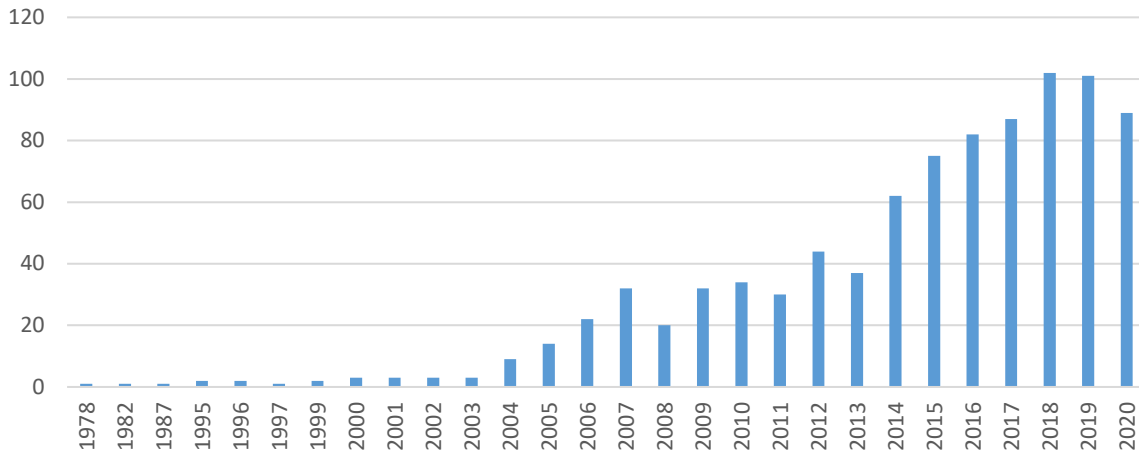


Figure 1. The number of publications per year

1. Publications per year

The topic of HL appears in academic research between 1978 and 2020. As can be seen in Fig.1, three phases marked the evolution of HL research. The first phase corresponds to the period 1978-2003, which forms the starting point of the HL research. From 2004 to 2013, HL research increased moderately.

However, during the final phase, 2014-2020, the number of HL publications grows considerably and consistently. This exponential increase in the total number of publications from 2014 may owe to the critical role of HL throughout all the stages of the disaster management cycle and its contributions to successful disaster relief missions.

2. The most productive countries in HL research

Table 1 presents the countries where researchers produce the most research output in the HL field. This bibliometric analysis considered different metrics that reflect both the quantity and quality of research output. These include the total number of publications, the number of citations received, the average citations per publication, and the h-index.

As can be observed from the table, the USA leads the race with the most quantity of publications, citations, and the highest h-index. During the period 1978-2020, researchers from the USA published 284 papers with 8011 total citations, 28.21 citations per publication, and an h-index of 47. Frequently, US researchers published their works in US journals (e.g., *Production and Operations Management*), enjoying greater access and opportunity than researchers in other nations. This suggests that the quality of publications should be improved, and further co-authorship cooperation should be promoted.

The next most productive countries are France and the United Kingdom, with 68 publications each. HL research has also gained traction in some developing countries. For example, according to the number of publications, India and China hold the fifth and sixth positions, respectively. At the same time, Iran and Turkey are ranked with 35 and 29 publications at the eleventh and fourteenth position, respectively. Even though developing countries have a considerable research output, their h-index is lower than developed countries on the list. This finding indicates that researchers should focus on the quantity and guarantee and ensure the high quality of HL research output. It is observed that Finland and The Netherlands have been remarkably involved in

Table 1. Top 15 most productive countries in HL research

| | Country | Number of publications | Number of citations | Average citations per publication | h-index |
|----|-----------------|------------------------|---------------------|-----------------------------------|---------|
| 1 | USA | 284 | 8011 | 28.21 | 47 |
| 2 | France | 68 | 3039 | 44.69 | 25 |
| 3 | United Kingdom | 68 | 2147 | 31.57 | 25 |
| 4 | Australia | 64 | 1647 | 25.73 | 19 |
| 5 | India | 60 | 639 | 10.65 | 12 |
| 6 | China | 55 | 551 | 10.02 | 13 |
| 7 | Finland | 49 | 1723 | 35.16 | 18 |
| 8 | Canada | 39 | 768 | 19.69 | 15 |
| 9 | Germany | 38 | 878 | 23.11 | 16 |
| 10 | The Netherlands | 37 | 1105 | 29.86 | 16 |
| 11 | Iran | 35 | 809 | 23.11 | 10 |
| 12 | Sweden | 29 | 497 | 17.14 | 16 |
| 13 | Turkey | 29 | 807 | 27.83 | 13 |
| 14 | Italy | 24 | 265 | 11.04 | 10 |
| 15 | Ireland | 21 | 446 | 21.24 | 10 |

HL research, especially in terms of the average citations per publication. Although these two countries produced fewer papers than some countries on the list, the overall quality of research is very high since Finland and the Netherlands receive higher average citations per publication than many publications from other countries.

3. Publications per type

Table 2 depicts the distribution of HL research according to the type of publications. The sample of records comprises 678 journal articles, 89 conference papers, 54 book chapters, and 43 reviews. This finding suggests that journal articles are the most important source of knowledge dissemination in the HL literature, and they are vital carriers of research results. Through journal articles, researchers would observe the flows of knowledge

in the HL field and acquire more validated knowledge.

Surprisingly, the total number of conference papers is meager compared to the total number of journal articles.

This is somewhat contradicting since HL is an emerging field, and conference papers are often dedicated to reflecting the emerging topics and themes, while journal articles take a longer time to publish [56].

It is also more likely that some conference papers are reworked and submitted as journal articles.

4. Most relevant journals

This review identifies 678 articles published in various academic journals. **Table 3** lists all journals publishing at least ten articles. *The International*

Table 2. Distribution of publications according to type

| Rank | Type of publication | Total number of publications |
|------|---------------------|------------------------------|
| 1 | Article | 678 |
| 2 | Conference Paper | 89 |
| 3 | Book Chapter | 54 |
| 4 | Review | 43 |
| 5 | Editorial | 8 |
| 6 | Short Survey | 8 |
| 7 | Book | 7 |
| 8 | Note | 3 |
| 9 | Conference Review | 2 |
| 10 | Erratum | 1 |
| 11 | Letter | 1 |

Journal of Humanitarian Logistics and Supply Chain Management is the most influential outlet for HL contributions. Three academic journals are active devoting more space to HL related studies; *Production and Operations Management* with 48 articles, *Jane's Defence Weekly* with 46 articles, and *Socio-Economic Planning Sciences* with 37 articles. Overall, **Table 3** shows the dominance of *The International Journal of Humanitarian Logistics and Supply Chain Management* and its significant influence and leading position in scientific output. The wide variety of journals in **Table 3** reinforces the fact that HL is a multidisciplinary field attracting scholars from operations management, supply chain management and logistics, production economics, and social sciences.

5. Most productive authors

Finally, the review analyzes the influence of the most productive scholars in the HL field. **Table 4** shows that three authors are very active in HL research: van Wassenhove L.N, Tatham P., and Kovacs G. These authors published 33, 31, and 26 papers, respectively.

Table 3. Most relevant journals

| Journal | Number of publications |
|---|------------------------|
| Journal of Humanitarian Logistics and Supply Chain Management | 144 |
| Production and Operations Management | 48 |
| Jane's Defence Weekly | 46 |
| Socio-Economic Planning Sciences | 37 |
| Transportation Research Part E: Logistics and Transportation Review | 28 |
| International Journal of Production Economics | 23 |
| International Journal of Production Research | 21 |
| Journal of Operations Management | 17 |
| International Journal of Physical Distribution and Logistics Management | 13 |
| Journal of the Operational Research Society | 10 |
| Lecture Notes in Business Information Processing | 10 |
| Supply Chain Management | 10 |

Table 4. Most productive authors

| Name of author | Number of publications | Number of citations | Average citations per publication | h-index |
|-----------------------|------------------------|---------------------|-----------------------------------|---------|
| van Wassenhove L.N. | 33 | 2288 | 69.33 | 18 |
| Tatham P. | 31 | 849 | 27.39 | 15 |
| Kovacs G. | 26 | 1457 | 56.04 | 13 |
| Heaslip G. | 14 | 170 | 12.14 | 5 |
| Dubey R. | 11 | 501 | 45.55 | 9 |
| De Souza R. | 10 | 72 | 7.20 | 4 |
| Pedraza-Martinez A.J. | 10 | 408 | 40.80 | 8 |
| Jahre M. | 10 | 312 | 31.20 | 8 |
| Spens K. | 10 | 1070 | 107.00 | 6 |
| Lodree E.J. | 9 | 231 | 25.67 | 6 |
| Kunz N. | 9 | 276 | 30.67 | 7 |
| Apte A. | 8 | 254 | 31.75 | 5 |
| Gunasekaran A. | 8 | 463 | 57.88 | 8 |
| Besiou M. | 8 | 129 | 16.13 | 4 |
| Hanaoka S. | 8 | 48 | 6.00 | 5 |
| de Leeuw S. | 8 | 193 | 24.13 | 6 |
| Pazirandeh A. | 8 | 132 | 16.50 | 7 |

In terms of citation counts, van Wassenhove L.N stands out from the rest, receiving the highest number of citations, 2288. To a lesser extent, Kovacs G. is the second highly cited scholar with 1457 citations, and Spens K. is the third highly cited author with 1070 citations. Despite having more publications, Tatham P. holds the fourth position according to the number of citations received.

V. CONCLUSIONS AND FUTURE RESEARCH

This bibliometric review reports scientific output evolution in the HL field from 1978-2020 and publications indexed in the Scopus database. The study confirms past research findings in that HL is still an emerging field with a multidisciplinary nature. This review provides a holistic overview of the research progress in the HL field using various bibliometric indicators.

Initially, the review analyzes the evolution of academic publications on HL, revealing three different phases throughout the 40 years of scholarly work in this field. Moreover, the review examines the national productivity, identifying the leading country with the largest number of publications in the USA. This may be explained by the high proportion of journals publishing on HL in the USA. Nonetheless, the high productivity of a country does not often mirror the high quality of research output. Most publications in the reviewed sample journal articles as this format enable authors to disseminate knowledge, promote research, and publish scientific outputs in prestigious academic journals. To inform researchers, this study identifies that the most relevant journal to stay current with HL research is *The International Journal of Humanitarian Logistics and Supply Chain Management* with 148 articles,

Production and Operations Management with 48 articles, and *Jane's Defence Weekly* with 46 articles. The first journal's popularity is explained by its exclusive focus on HL research and the increasing number of submissions to the journal over recent years. The eminent scholars with the largest number of publications on HL are van Wassenhove L.N., Tatham P., and Kovacs G. Being aware of the influential authors in the HL field, researchers would be able to discover the seminal studies reshaping the development of HL research and to create more networking and co-authorship opportunities with authors from the HL field and beyond. The findings of the bibliometric analysis also suggest that HL research still has poor representation in business and management because top-tier supply chain management and logistics journals published few articles over a four-decade period, with only one journal dominating the annual publication output.

Given the critical role that modern technologies such as big data analytics [57], [58], blockchain [59], [60], drones [61], [62], and artificial intelligence [63], [64] play in enhancing not only cooperation and coordination among various HL stakeholders, but also humanitarian processes during disaster response, additional research on the intersection of these technologies and HL is highly recommended. For example, future research may look at how these technological advancements can improve all stages of the disaster management cycle, including preparedness, response, recovery, and mitigation. Additionally, future research may employ a multidisciplinary approach and incorporate well-established theories to assess the impact of emerging technologies on HL.

More precisely, examining how social media platforms such as Facebook, Instagram, and Twitter, plus additive manufacturing, big data analytics, drones, robotics, and artificial intelligence can be used in disaster response is an intriguing and nascent

area of research. Indeed, social media platforms have been successfully used at various stages of HL [65]. As an example, Twitter has been successfully used to improve early warning and response to disasters [66]. Facebook has also been used to forecast demand relief products during disaster relief efforts [67]. Potential research directions in this area include an examination of the key issues and benefits associated with the integration of data generated across multiple social media platforms in order to enhance HL activities and decision-making processes. Researchers could concentrate on the impact of big data analytics on HL, as this technology application has been demonstrated to be critical for achieving sustainable disaster management [68], collaborative performance and trust among various HL stakeholders (e.g., NGOs, military organizations) engaged in emergency relief activities [69].

Future research could also focus on the use of drones to map and survey disaster-stricken areas [61], particularly those that are landlocked. This technology is expected to improve disaster response times, aid supply distribution and enhance search and rescue operations.

Additionally, future research could examine how additive manufacturing could be used to rapidly produce critical relief supplies that can be used for shelter and to augment or repair vital infrastructures [70]. Clearly, the growing body of knowledge on additive manufacturing has demonstrated the ability to efficiently produce relief supplies, such as sanitation items and health-related equipment [71]. Additionally, scholars could investigate the value of robots to support disaster relief efforts [61].

With the exception of a few developing countries, developed countries are the most productive contributing to HL logistics. As a result, academic institutions from both developed and

developing countries should engage and collaborate to expand this knowledge field. Academic organizations located in disaster-prone areas have the advantage of being on the ground and will have a better understanding of the specific circumstances including the political and social environments and immediate relief needs. The difficulty of collecting empirical data in disaster areas has been identified as a major issue in evidence-based research on HL [72]. More collaborative partnerships with local aid organizations and academic institutions are encouraged in future research efforts to address this challenge.

Despite its contributions, the present study has several limitations. The bibliometric indicators analyzed enable us to obtain a static picture of the HL literature within a particular research period (1978-2020). Furthermore, bibliographic citations need time to accumulate, making backward-looking more biased towards older publications. Therefore, future researchers may conduct co-citation analysis to examine the constant change and development of topics studied in HL. This review does not capture

all studies discussing HL because many publications on HL are available in non-indexed journals, which are not available in Scopus. As a result, researchers should consider other databases such as Google Scholar when replicating this bibliometric analysis. The comparison of the results from other databases with those of this review is another intriguing research opportunity.

AUTHOR CONTRIBUTIONS

A. Rejeb: conceptualization, experiments, theoretical analysis.

K. Rejeb: finite element modelling, writing, review and editing.

J.G. Keogh: supervision, review and editing.

DISCLOSURE STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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