A SCIENCE MAPPING AND LITERATURE REVIEW APPROACH TO ANALYSING THE RELATIONS AMONG THE TERMS LOGISTICS CENTER AND DISTRIBUTION CENTER

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Received: May 20, 2019
Received revised: July 2, 2019
Accepted for publishing: July 8, 2019

Abstract

Modern development has recognized the importance of coordinated logistics, which must function at the regional and global level. However, a need for uniform definitions and naming of logistics services, facilities, systems and functions is present. Terminology in the field of logistics centers is becoming increasingly important because the number of terms correlated with it is large and most terms are used interchangeably without any distinction. In the field of logistics and distribution centers, this problem is clearly evident and can be seen by anyone researching any aspect of these concepts. Various definitions of terms are used by different authors, for example "logistics center", "freight village", "plate forme logistique", "plat forme multimodales", "distribution center", "interporto", "transport centre" etc.. The importance of the logistics center theme has stimulated research into the problems of clarifying ambiguity and classifying concepts that are used in the field of logistics centers and/or distribution centers and warehouses. There has not yet been a clear answer on the delimitation among the two most broadly used terms, which are "logistics center" and "distribution center". The present paper applies science mapping and literature review in order to find which term is used more often, which researchers are most prominent in this research field, and whether definitions of both terms exist and what are their relations. The main research finding is a lack of consensus among scholars on whether the terms are the same or in a different hierarchical order in the logistics network.

Key words: Logistics center, distribution center, science mapping, literature review

1. INTRODUCTION

The concept of the warehouse as a place of storage of raw materials, semi-finished products, and products, is known the longest and goes back to ancient Egyptians. Warehousing as we know it today began to develop more rapidly during the period of colonization when new trade routes emerged, requiring storage facilities, from production to target markets and customers. The storage needs and concepts as we know today began to develop more rapidly during the period of colonization when new trade routes emerged that required storage facilities, from production to target markets and customers. The need for a distinction between logistics and distribution centers emerged in the 20th century, with the development of urbanization and increases in commerce and transport.

The occurrence of the terms distribution center and logistics center is more difficult to place accurately on the timeline. To a large extent, this is related to mixed definitions of these terms offered by various authors (Rimienė & Grundey, 2007). Thus, some authors connect the distribution center to the operation of the warehouse, either as a supernumerary or as a subset. Rimienė & Grundey (2007) claim that the term logistics center appeared in the 1970s. Distribution activities and storage are also included among the functions of the logistics center. According to the authors Rimienė & Grundey (2007), distribution management came to the forefront in the 1950s when companies developed new approaches to the market. The use of computer-controlled devices started to enable calculation and planning of new market tactics, such as market segmentation and additional profit maximization. With the development of the supply chain concept in the 1980s, the concept of consolidation developed. The term logistics center is, therefore, more recent and is a consequence of the development of the operation of distribution centers. Logistic centers have shifted to larger or smaller regional centers by providing services to the wider international environment (Du & Bergqvist, 2010). Recently, these concepts have been extended to the concept of logistic platforms worldwide, where several logistics trials and pilot projects have been dedicated to establishing LPs or in some cases regional LPs, going beyond the framework of a logistics center (Gajšek et al., 2018).

The differences between logistics and distribution centers are in the number of functions. Authors Rimienė & Grundey (2007) thus explain that there are three levels of logistics facilities, which can be attributed to activities that developed with the development of global trading. Distribution centers add the task of transport and transshipment to basic warehousing activities. Logistic centers also deal with the management of material and supplies and the final composition of products. In their recent work on logistics platforms, several authors rely on the findings of Meidute (2005) on logistics centers: “This phenomenon has not yet received an agreed name […]. The main terms for logistics centers utilized in Europe can be varied by country.” (Gajšek & Rosi, 2015).

With the emergence of the concept of a logistics center, which represents an important element in the management and control of goods flows, many definitions have emerged that define logistics centers and equate them with other concepts and concepts such as transport centers, ports, intermodal terminals, distribution centers, "Freight Villages", traffic nodes, etc. (Özdemir, 2010). The concept of Freight

Villages is defined as a designated area within which all transport, logistics, and distribution activities are carried out, both for national and international transit; these activities are performed by various contractors (The European Logistics Platforms Association, 2019). The Plate Forme Logistique and Plat Forme Multimodales concept is a French concept that follows the concept of logistics platforms that the authors equate with the Freight Villages concept. Leal & Salas (2009) equate the logistics platform with the Freight Villages concept and define it as a specialized area with the infrastructure and services needed for co-modal transport and value-added services where different agents coordinate activities to achieve competitiveness of products using the available infrastructure. The German concepts (Güterverkehrszentrum) are based on the assumption of rationalization of spatial and functional urbanized systems. The Italian significance of Interporto is linked to the strategy of liberalizing port services and increasing competition between ports aimed at promoting Italian exports and transit through Italian ports.

The term logistics center is very popular in the professional field and science. However, it is important to emphasize that there is often a misunderstanding of the variety of meanings of terms, such as logistics centers, distribution centers, or even freight terminals. The mismatch of terminology in logistics can have negative consequences for both economic and social functioning as well as for the development of environmental protection systems. Adopting the literature review is an expedient approach to gaining an in-depth understanding of the use of different terms for the same set of functions. With the combination of science mapping and a qualitative literature review, this paper aims to perform an in-depth analysis of the current literature in the field of logistics/distribution centers in order to determine the relationship among the terms “logistics center” and “distribution center” and to determine in which ways the terms are used in relevant literature, thus achieving the goals posed in the paper title. The main research question therefore is to determine in what scope, relation and context scholars use the terms logistics center and distribution center, and ultimately, to give a proposal for unification of scholarly use of bot terms in accordance to their common definitions.

2. METHODOLOGY

The study used a three-stage examination of the literature summarizing the research field of logistics center vs. distribution center. A science mapping approach was used in the review for bibliometric analysis and scientific analysis.

Bibliometric search in Scopus was the first step of the review process and was performed in June 2019. For purposes of filling the literature pool, the search string "logistics cent*" AND "distribution cent*" was used to search for publications. Since the main research aim is focused on examining the use of both terms in the literature, only publications concerning both terms in their various forms (such as singular/plural or British/American spelling of the word center) were searched for. The search was performed in Scopus because it is found to cover more journals and delivers more publications than e.g. WOS (Aghaei, et al., 2013). Moreover, all the publications that were the result of searching in WOS were also included in Scopus search results. We

searched in the whole document, not only in the title, abstract, and keywords, to ensure that all publications mentioning both terms were included. 549 documents were found, and out of those, 50.6 % were journal papers; 42 % were conference papers; 3.8 % reviews; 2 % books or book chapters; and 1,45 % other sources. In accordance with the set research goals, all the search results were included in the literature analysis.

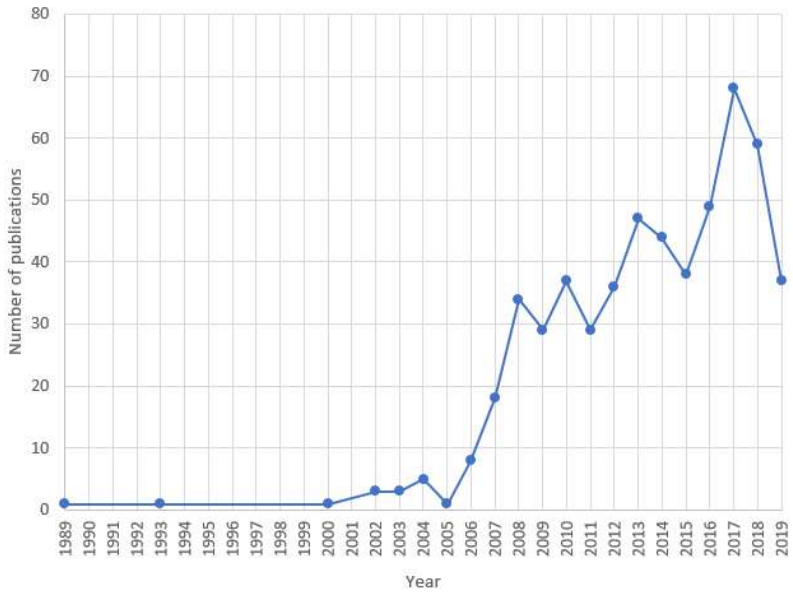
After the basic bibliometric search, scientometric analysis was conducted by utilizing the text-mining tool VOSviewer (van Eck & Waltman, 2014). The publications from the literature pool were analyzed first according to their publication year to determine whether there is a growing body of literature using the considered terms. Next, the most relevant sources of documents were determined in order to pinpoint the research fields that utilize the terms most. Then, a keyword analysis was performed to analyze the author keywords and find which expressions are most often used in the literature and their interrelations, which also enabled a visual display of the topics that are of largest interest to the research field. Moreover, an analysis of the most relevant authors and publications was performed in order to identify the main influential forces in the considered research field.

Based on results from the scientometric analysis, a qualitative literature review was performed which included the most cited publications from the literature pool to determine in what ways the most prominent scholars use the terms. The main goal of this part was to perform a deeper analysis of the use of both terms and to possibly find a commonly used definition to explain the relationship between these terms.

3. RESULTS

The 549 results from the literature pool were first analyzed from the perspective of their year of publication (see Fig. 1). Since this paper is published in 2019, the number of results for this year is expected to rise significantly by the end of the year (the literature pool includes publications, published up to June 2019).

Figure 1. Time distribution of results

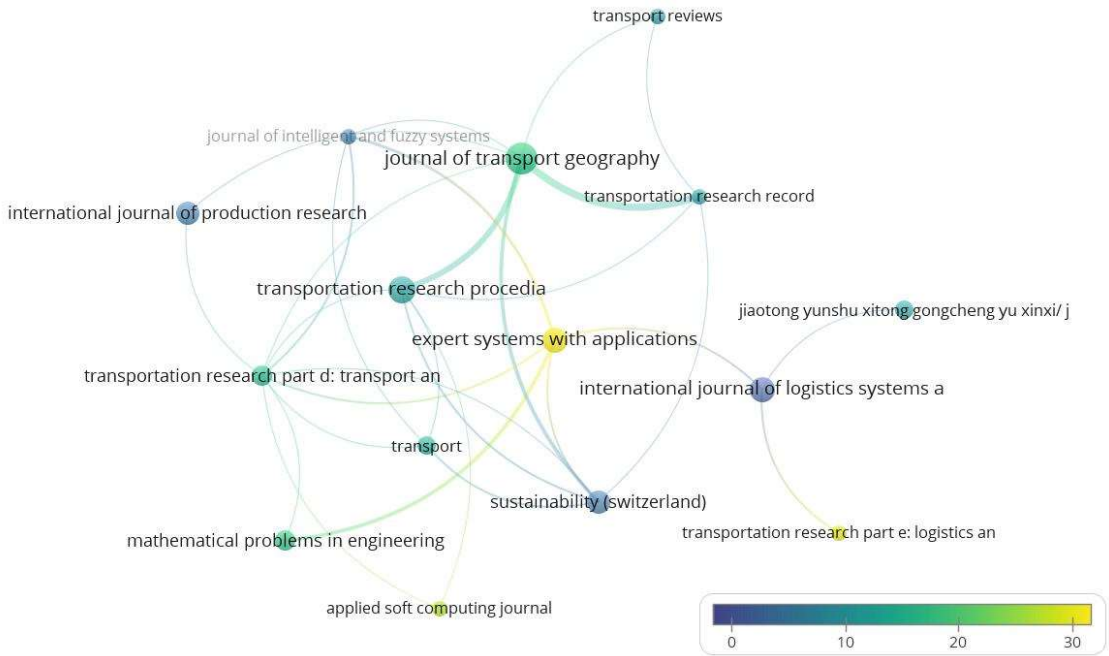


The first releases in this area originate from 1989, and an increase in publications is recorded after 2005. Most results in the area of simultaneous use of the term "logistics center" and "distribution center" were in 2017 (68 documents).

3.1 Publication sources

An analysis of sources of publications (journals, conferences, books) was performed in order to determine where scholars, researching the selected field, mostly publish their results, and which sources are most cited and therefore most relevant for the research field. VOSviewer identified 343 unique sources. For further analysis, only sources with at least 3 publications in the literature pool and that were cited at least 15 times were included. This way, only the most relevant sources were included in the science mapping process in this stage. Out of the unique sources, 19 met the given threshold. One of those, Transportation research procedia is connected to publishing conference papers, others are scientific journals (see Fig. 2.). The size of the nodes indicates the output of individual sources in terms of the total number of publications and the color of the node indicates the average number of citations of a document, published in that source. The most productive source in those terms is Journal of transport geography (11 documents, 192 citations), followed by Expert systems with applications (7 documents, 1142 cittaions) and Transportation research procedia (8 documents, 86 citations). The color and thickness of the links between sources point to sources that have cited each other. The strongest connection in this regard can be detected among the pair of Expert systems with applications and Mathematical problems in engineering, and the pair of Journal of transport geography and Transportation research procedia. Only 15 sources have links (citations) among them, so only those are shown on the figure.

Figure 2. Visualization of sources



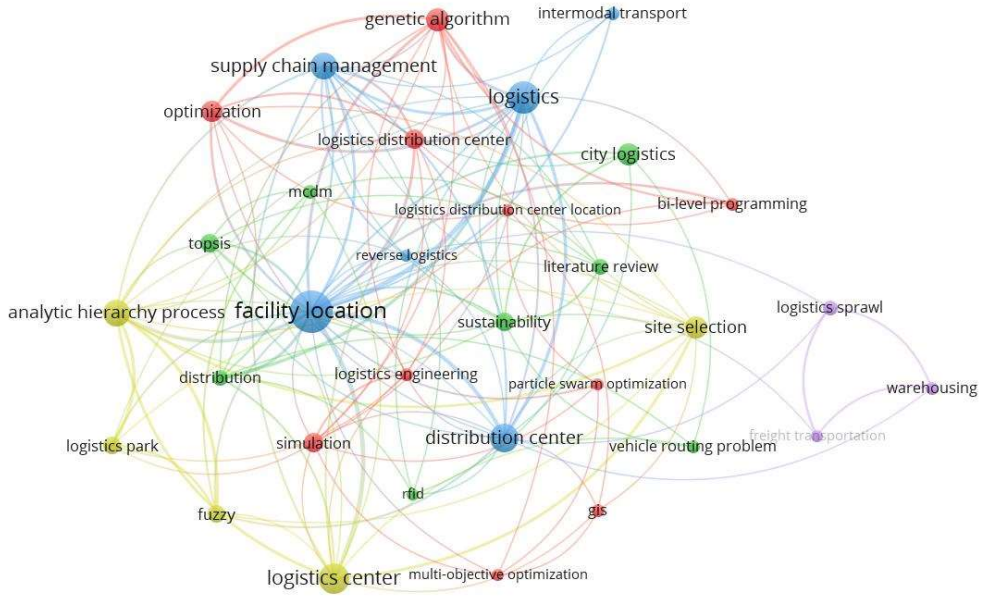
3.2 Keyword analysis

Keyword research is particularly appropriate in this case since it enables the identification of the core content of existing research and describes the research topics. The network of the author keywords defines what the most important elements of research in a specific field are can be essential for understanding the field (Su & Lee, 2010). The keyword co-occurrence also presents a different level of science and bibliography research which potentially establishes the relationships among network actors (Su & Lee, 2010).

With the co-occurrence of author keywords analysis, the inter-closeness among them can be determined (van Eck & Waltman, 2014). There are a total of 1430 unique author keywords in the entire database of documents used. With the inclusion criteria set so that the minimum number of occurrences of a keyword is set at 5, 45 author keywords remained. A further refinement of keyword hits was made to combine synonyms (for example »urban logistics« and »city logistics«; »distribution center« and »distribution centre«). Finally, 32 keywords were used to generate the visualization of author keywords (Fig. 3). Keywords are also divided into clusters within which the keywords have closer internal relationships. As with the previous figure, the size of the node and font indicate a keyword's occurrence frequency. The most frequently studied keywords include »facility location«, »logistics«, »logistics center«, »distribution center«, and "supply chain management". The keyword "logistics center" is mostly connected with location (»site selection«, »location selection«, etc.) and "distribution center" is mostly connected with logistics/SCM and location.

As the analysis showed, there is no notable connection between »logistics center« and »distribution center« itself, which points to the fact that authors do not use both terms interchangeably or do not perform research that would focus on various aspects of difference among the two concepts.

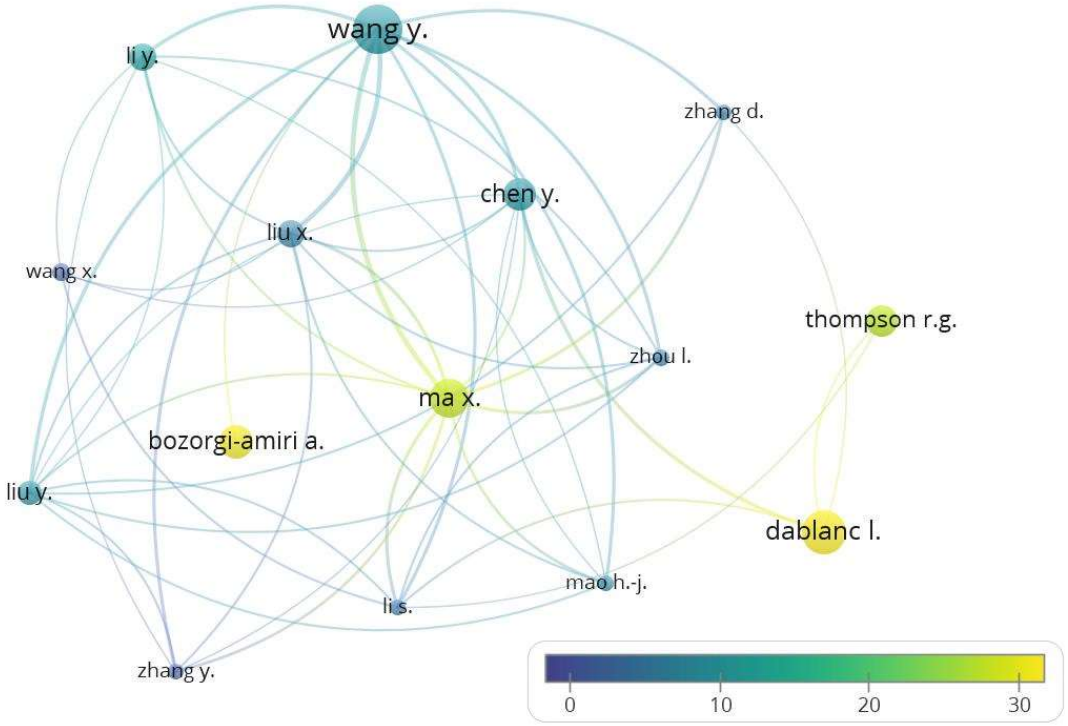
Figure 3. Visualization of author keywords (connections show interrelated keywords)



3.3 Scholars in the field of logistics and distribution centers research

The analysis of most cited authors in the field of logistics/distribution centers was also carried out using VOSviewer. 1142 scholars were identified as contributiong to the research field. In this part, the minimum number of documents and minimum citation number of a scholar were set at 3 and 20 respectively to ensure inclusion of the most important publications and scholars. As a result, a total of 24 scholars met the threshold, but only 15 of them relate to each other and are therefore shown on the network (Fig. 4). The font and circle size for each scholar indicates their number of publications in the literature pool, and the colour of the node represents the number of citations of the scholar.

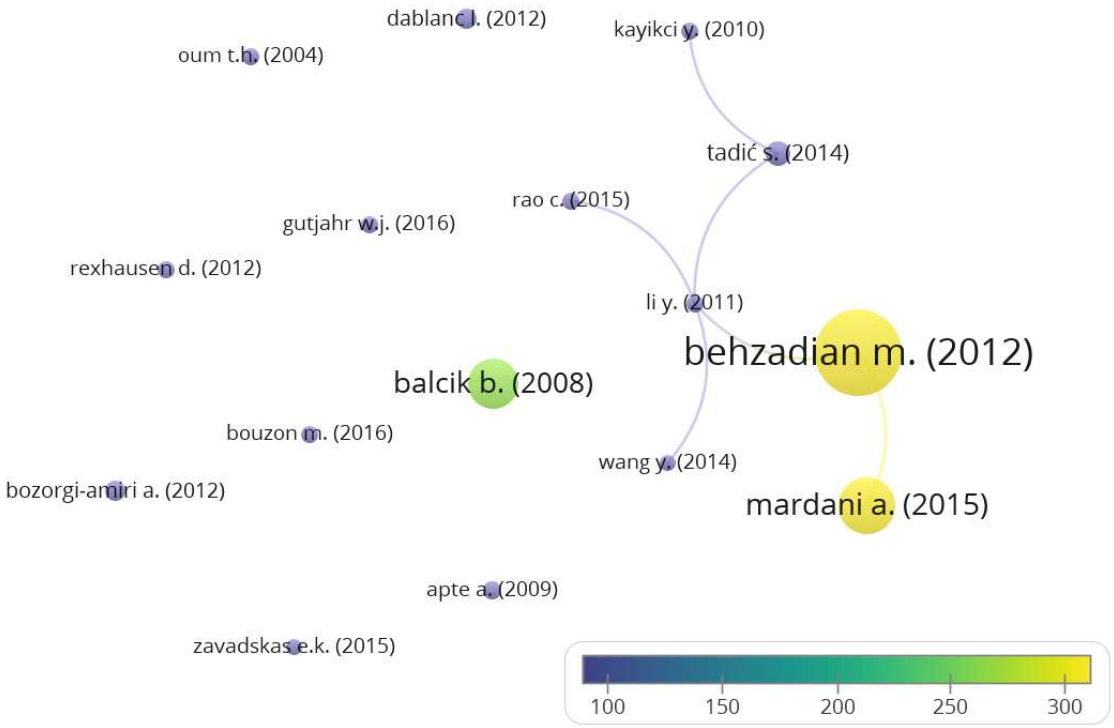
Figure 4. Visualization of scholars in logistics and distribution centers publications (weights: citation)



3.4. Document analysis

The purpose of this part of the research is to examine the citation number of each document, which will point to the most important and influential publications on the topic of logistics and distribution centers. In this case, the minimum number of citations of each document was set at 50, which resulted in the inclusion of 17 documents, which were also the subject of further investigation in the qualitative discussion of the literature pool (Fig. 5). Behzadian, M., Balcik, B., Merdani, A., and Tadič, S., whose paper proved to be the most cited in the literature pool, are authors who mainly deal with methodology (Topsis, Fuzzy, ..) and their work is, therefore, most relevant for almost all scholars in the considered field.

Figure 5. Visualization of the most cited documents



4. QUALITATIVE REVIEW

Displayed bibliometric analysis and science mapping of the literature is the basis for qualitative work, which will focus on the field of summarizing the main research areas within the logistics/distribution centers research field. The five clusters of keywords identified in Fig. 3 are not separated but are interconnected as a whole. For example, the keyword »logistics center« has a strong link with »location selection«, which has an important link with the »distribution center«.

As mentioned above, the separation between logistics centers and distribution centers is difficult to place in a multitude of different definitions. Many authors tend to analyze the historical development of logistics services and facilities and consequently also define the concept of a logistics center or a distribution center (Rimienė & Grundey, 2007; Gafurov, et al. 2014; Montwiłł, 2014; Skjött-Larsen, et al., 2003; Özdemir, 2010; Kabashkin, 2007; Cheung, et al., 2003). Meidute (2005) defines a logistics center as a link that combines different types of transport with the task of promoting intermodality. The author equates the concept of a logistics center with an intermodal terminal, which is a key element of the intermodal transport chain. Rimienė and Grundey (2007) state that the most comprehensive explanation of the concept of a logistics center is related to the understanding of distribution centers, central warehouses, freight/transport terminals, transport hubs, logistics platforms, freight villages, etc. Only some authors who define the logistics/distribution center in their work are mentioned here, but one definition or rather concept stands out as the most comprehensive. Du and Bergqvist (2010) developed a conceptual framework of

international logistics centers to define characteristics of logistics centers with cluster analysis of diverse terms and concepts which relate to logistics centers, and with that, this paper can be seen as the most important from the viewpoint of classifications of various development stages of distribution and logistics centers.

There have been multiple studies focusing on researching aspects of logistics centers or distribution centers, however, there are only a few studies that mention both terms at the same time (logistics center and distribution center). The key documents in this field have already been presented here with bibliometric and science mapping approaches, and in the following, we provide an analysis of the definitions of these terms within these documents based on the publications, which mention logistics centers and distribution centers and have been cited 50 times or more. There are 17 publications that fit the criteria (see Fig. 4). These publications were read and analyzed based on their mention or use of the terms distribution and logistics center. The results of this analysis are shown in Table 1.

Table 1. Analysis of the use of "logistics center" and "distribution center" in most cited papers from the literature pool.

Authors	Publication title	Use of terms
Behzadian, Otaghsara, Yazdani, & Ignatius, 2012	A state-of the-art survey of TOPSIS applications	The paper does not directly mention distribution or logistics centers, it only mentions the terms in titles of papers it analyses.
Mardani, Jusoh, & Zavadskas, 2015	Fuzzy multiple criteria decision-making techniques and applications – two decades review from 1994 to 2014	The paper does not directly mention distribution or logistics centers, it only mentions the terms in titles of papers it analyses.
Balcik, Beamon, & Smilowitz, 2008	Last mile distribution in humanitarian relief	Mentions the United Nations Joint Logistics Centre (UNJLC). Defines distribution centers as tertiary hubs (local and temporary distribution centers) as the beginning of last mile delivery to deliver relief supplies.
Tadić, Zečević, & Krstić, 2014	A novel hybrid MCDM model based on fuzzy DEMANTEL, fuzzy ANP and fuzzy VIKOR for city logistics concept selection	The paper defines a logistics center as one of the initiatives in city logistics that "enable the consolidation of flows starting outside the specific metropolitan area or the city, with the aim of unifying transport activities within the area or the city." It defines different categories of logistics centers: freight villages, city logistics terminals, satellite terminals, intermodal terminals.

		Distribution centers (or warehouses) are defined as points on the outskirts of the central city area where freight is transshipped to smaller vehicles for further distribution.
Bozorgi-Amiri, Jabalameli, Alinaghian, & Heydari, 2012	A modified particle swarm optimization for disaster relief logistics under uncertain environment	(Relief) distribution centers are used as nodes where supplies are stored and from which supplies are shipped to affected areas in a relief operation. Logistics centers are only mentioned in the literature review.
Dablanc, & Ross, 2012	Atlanta: a mega logistics center in the Piedmont Atlantic Megaregion (PAM)	The paper recognises that the city of Atlanta is a "logistics centre" in the PAM region, and uses the term "distribution centre" as a name for a warehousing/freight forwarding hub.
Apte, 2010	Humanitarian logistics: A new field of research and action	The paper defines distribution centers as an important part of humanitarian logistics. They represent critical facilities for relief efforts and supply emergency supplies and services. The term "logistics center" is mentioned only in the literature review.
Rao, Goh., Zhao, & Zheng, 2015	Location selection of city logistics centers under sustainability	The paper describes a City logistics center as a key logistics node, and uses the definition that a CLC is "a logistics facility that is situated in relatively close proximity to the geographic area that it serves, from which consolidated deliveries are performed within that vicinity (…), and a range of other value-added logistics and retail services can also be provided at the CLC." The term "distribution center" is mentioned only in the references.
Li, Liu, & Chen, 2011	Selection of logistics center location using Axiomatic Fuzzy Set and TOPSIS methodology in logistics management	No definition of a logistics center is given. The term "distribution center" is mentioned only in the literature review.
Kayikci, 2010	A conceptual model for intermodal freight logistics centre location decision	The paper uses the definition: "An intermodal freight logistics center is a cluster of quality industrial/intermodal /distribution/logistics buildings located within a secure perimeter where a

		range of support services are provided by every user." The term "distribution center" is mentioned only in the literature review.
Bouzon, Govindan, Rodriguez, & Campos, 2016	Identification and analysis of reverse logistics barriers using fuzzy Delphi method and AHP	The terms "distribution center" and "logistics center" are mentioned only in the literature review.
Gutjahr, & Nolz, 2016	Multicriteria optimization in humanitarian aid	The paper uses the term "distribution center" for describing the intermediate facility connecting suppliers and areas needing relief supplies. The term "logistics center" is mentioned only in the literature review.
Rexhauen, Pibernik, & Kaiser, 2012	Customer-facing supply chain practices – the impact of demand and distribution management on supply chain success	The terms "distribution center" and "logistics center" are mentioned only in the references.
Oum, & Park, 2004	Multinational firms' location preference for regional distribution centers: focus on the northeast Asian region	The paper defines a firm's distribution center as "a base for providing raw materials, components, and/or finished goods to its surrounding region, in connection with the rest of its global logistics system". A logistics center is seen as a broad term describing a concentration on logistics activities in a wider geographical area, such as a city.
Wang, Ma, Lao, & Wang, 2014	A fuzzy-based customer clustering approach with hierarchical structure for logistics network optimization	A distribution center is seen as a transport hub, operated by logistics companies. The term "logistics center" is mentioned only in the references.
Zavadskas, Turskis, & Bagočius, 2015	Multi-criteria selection of deep-water port in the eastern Baltic sea	The paper equates the terms logistics center and distribution center (e.g. "(…) adds to the port's attractiveness by readying lands for a port-related Export Processing Zone or Distribution Centre (logistic centre) for potential investors." It does not offer a definition of any term.

Soto-Silva, Nadal-Roig, González-Araya, & Pla-Aragones, 2016	Operational research models applied to the fresh fruit supply chain	The terms "distribution center" and "logistics center" are mentioned only in the literature review.

Overall, it is evident that the most cited papers, which contain both "distribution center" and "logistics center" in their text, would not offer much insight into information regarding the main goal of the present research, which is to find a delimitation between logistics and distribution centers. For this reason, a qualitative examination of publications that have both terms in their keywords (logistics center and distribution center) was performed. Out of the 549 Scopus documents in the literature pool, both terms are contained in 21 publications' keywords, meaning that those publications are concerned directly with those concepts. Chang and Lin (2017) find that most of the cities do not have both types of centers (logistics and distribution), and thus there is a problem to compare the differences. Ying (2014) uses the term Logistics Distribution Center in his work and defines Logistics center as a new concept that is mainly in use in academic and corporate circles in Asian countries, and even there, the term can have a broader meaning that focuses on a wide array of logistics activities an facilities, including various freight terminals and operators, and a narrower meaning which focuses on the management efficiency of logistics and behavior. Even then, the paper does not offer a definition of a logistics center, but rather focuses on its locating and role in the logistics network. Ren and Peng (2014) see a logistics center as a second level node and as a supporting facility for logistics parks that aim to maximize efficiency using the centralization and scale effect. A logistics center is an important terminal in a logistics system, and it plays an important role in the whole logistics system, whereas distribution centers are supporting actors for logistics centers in a logistics network and need to be allocated accordingly (e.g. Sternad et al., 2018). Changjiang and Jinxing (2009) studied the site selection of logistics distribution centers and proposed a model for it. They used the term "logistics distribution center", but they do not define the term itself, nor is the scope of activity in such a center determined. Chou (2010) pointed out that in order to reduce the international supply chain operation cost (see e.g Sternad (2018) for more details about this), the company needs to invest in international logistics centers, because their role as bases for merchandise transportation and distribution has become increasingly important. Yu et al. (2009) find that logistics centers are used as a facility to improve commodity handling (sorting, storage, processing) and its location needs to be determined precisely in order to enable overcoming barriers in the transportation process. They do not, however, define a distribution center, even though the paper title talks about locating distribution centers in logistics. Guan et al. (2009) point out the role logistics centers have in ensuring efficiency in logistics by enabling storage, transport, and distribution processes, whereas distribution centers have limitations due to competition and their inability to process demands from a single customer. They do not, however, delimitate both terms further.

Qualitative analysis of the most relevant publications in the literature pool has inevitably shown that the terms "logistics center" and "distribution center" are commonly used, but there are no sources that would clearly define both terms and show their common points and differences. Publications that use both terms either define just one or the other or do not define them at all.

5. CONCLUSION

Researchers use the terms "logistics center" and "distribution center" vastly, but there does not seem to be a consensus on the meaning of both terms and especially on their relationship. Based on the results of the presented research, we can conclude that the terms are most often not viewed as synonyms, but this is not the generally accepted norm either. Various authors use various combinations of both terms; even terms like "logistics distribution center" appear in the relevant literature. Therefore, the main conclusion of this paper is that there is a dire need to unify the terminology used in the logistics field when it comes to logistics and distribution centers. We can conclude with some reservations that most scholars see distribution centers as a narrower concept than logistics centers, where distribution centers most often serve as a warehousing and transshipment facility, and logistics centers include a broader scope of services, including value-adding services, and encompass a larger array of customers and logistics providers.

Further research should focus on determining the attitude of scholars and practitioners towards the terms logistics center and distribution center and mostly on evaluating their differences and relationships. With this, scholarly and practitioner work will have a better understanding of the concepts and a framework to use when talking about logistics facilities. A deeper literature review with the goal of extracting definitions for both terms from the literature concerning only one of the two concepts individually should also be performed.

In the meantime, however, we advise scholars and practitioners to include a definition of the used terms and an explanation of their relationships when both terms are being used simultaneously. By using an already existing hierarchy of different scopes of logistics centers, such as that by Du and Bergqvist, an additional layer of clarity can be achieved in the logistics centers research field as well.

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