Practical Cases of Locating Regional Logistics Hubs: A Systematic Literature Review

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Abstract

Logistics hub location problem is a trending topic both academically and among competing countries. Many authors were interested in selecting this kind of problems and especially in the last 20 years. However, most of the published works were focused on improving and developing solution techniques rather than implementing those techniques into real-life cases. Thus, only limited number of literatures had considered real-life aspects in locating logistics hubs within specific regions. 15 papers were found to be relevant with 3 main families of implemented tools and techniques in several different regions. Tools like spatial modeling and optimization modeling were usually linked with macro level allocation phases, while ordering and ranking criteria are usually applied on micro level phases to select set of alternatives or arrange/sort them according to some determined factors. This paper aims to analyze and benchmark different practical cases, and illustrate the use of different allocation models.

Keywords
Logistics Hubs, Case Study, Location Allocation, Systematic Literature Review.

1. Introduction
Being a global logistics hub is a strategic goal for most of the developed countries since it has a major positive influence on the country's economy. Attracting foreign direct investments and creating job opportunities are examples of the benefits that would be generated as consequence of realizing such a strategic goal.

Locating regional logistics hubs and effectively utilize them may ultimately serve the strategic goal of transforming the whole country to a global logistics hub. This paper analyzes the academic trend of this topic and reviews the most relevant academic practical cases including their implemented tools and techniques. A systematic based searching methodology will be considered to gather the most relevant practical cases before reviewing each practical case and benchmark the common usable academic tools and techniques which were applied on real life case studies.

Next section illustrates the full methodological approach which was used to collect and benchmark different academic relevant articles in a systematic procedure. Following section details the implementation strategy which includes analyzing the academic trends and presenting the results. Conclusion and authors' point of views will be discussed in section.

2. Methodology

Relevant literature has been analyzed and studied using sequential steps. Those steps are used to generally gather and discuss the number of articles which are relevant to the applied practical cases of locating regional logistics hubs into specific countries or regions. The main steps that will be considered within this research are the following:

- Specify the keywords that need to be used as search triggers.
- Select a single database that contain the largest number of relevant articles along with the advanced searching tool to be able to use different search relation if the search requires more than one keyword.
- Study and analyze the number of relevant published articles throughout the years.
- Select the articles which include implemented practical cases as a sample from all published articles.
- Benchmark the benefit of different tools and techniques that were used in locating logistics hubs.
- Propose a selection strategy to be used according to different scenarios.

Identifying all relevant keywords will ease the process and effectively find all relevant paper. In addition to the earlier mentioned benefits, selecting a sole source of database will also avoid redundancy in results. The third step is required to measure the trend of the selected topic and highlight the development of related tools and techniques. Focusing on the tested tools and techniques are is highly desired as they might be used to be tested by the field's practitioners and governmental entities. Validating and benchmarking the used tools and techniques is key step that will ultimately emphasize the recommendations and the purpose of this paper.

Below flowchart (Figure 1) represents the procedure of the systematic literature review which will be implemented in the current paper and may also be applicable for any different topic.

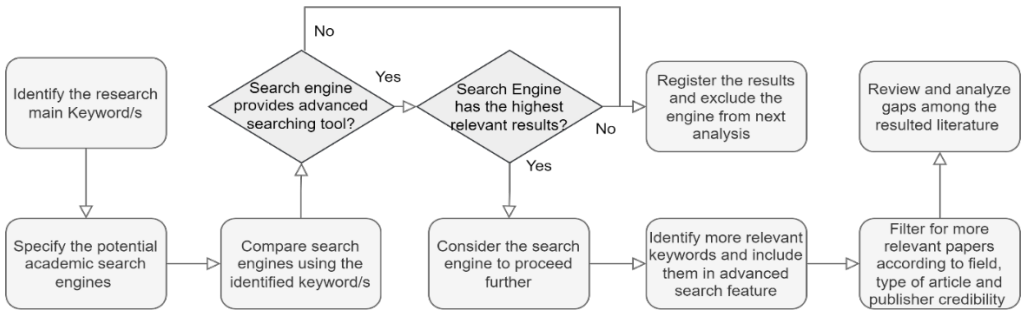

Figure 1. Flowchart of the Implemented Systematic Literature Review

3. Systematic Literature Review

Paperpile is the website that is known for simplifying the operation of collecting, managing and writing papers (Stefan et al. 2019). According to this website, the best academic searching engines that both came in top at their field and also provide free of charge searching services for academic researchers are Google Scholar, Baidu Scholar, Semantic Scholar, Science.gov, CORE, BASE, Microsoft Academic and RefSeek. RefSeek website is consider to be a more of general searching engine that has a lack of common articles' searching features unlike other searching engines. Hence, it will be removed the benchmarking analysis from the table below. In addition to those engines, Saudi Arabia provides a very large sophisticated digital library.

A comparison analysis needs to be implemented to validate each searching engine and select single source of engine to start the further steps of the systematic review. As a start, the main keyword "logistics hub" will be used initially to specify which of the selected engines are more relevant to the scope of this research. In order to select the prefered academic searching engines, the following (Table 1) compares all engines with Saudi Digital Library (SDL) according to multiple important factors considering the number of search's resulted articles and the advanced searching feature as the two most critical factors in this selection step.

Table 1. Search Engines Comparison

Factor	Google Scholar	Baidu Scholar	Semantic Scholar	Science.gov	CORE	BASE	Microsoft Academic	Saudi Digital Library
Number of relevant articles	215,000	21,300	361,000	610	39,548	4,775	61,069	225,014
Date Filter	✔	✔	✔	✔	✔	✔	✔	✔
Article Type Filter		✔	✔	✔	✔	✔	✔	✔
Advanced Search Feature		✔			✔	✔		✔
Access Limitation	Open Access	Open Access	Open Access	Open Access	Open Access	Open Access	Limited Access	Limited Access
Language Filter					✔	✔	✔	✔
Publisher Filter		✔	✔		✔	✔		✔
Source Type Filter		✔	✔			✔		✔
Geography Filter								✔
Subject Filter			✔	✔		✔		✔
Content Provider Filter		✔	✔			✔		✔

Although Semantic Scholar contains more results, SDL search engine will be selected to go forward in this research due to the multiple embedded features and the abundance of available information. Also, SDL has a very important feature that allows researchers to include multiple keywords in the search fields and using an and-or relation for each keyword which is a missing feature that Semantic Scholar lacks in compare to SDL. Number of relevant articles is representing the actual data as of 20th of April, 2022.

3.1 Academic Trend

Nowadays, countries compete to be globally noticed and considered as a logistics hub. This recognition will add a huge value to the country economy and encourage the foreign direct investment. On the other side, logistics hub topics became more and more attractive for the academic researchers and especially through the last 20 years. According to SDL database, the number of articles relevant to the topic of logistics hub which have been published on the last 12 years approximately represents 80% from all published articles. The following chart (Figure 2) shows the number of logistics hub's relevant articles existing in the SDL database.

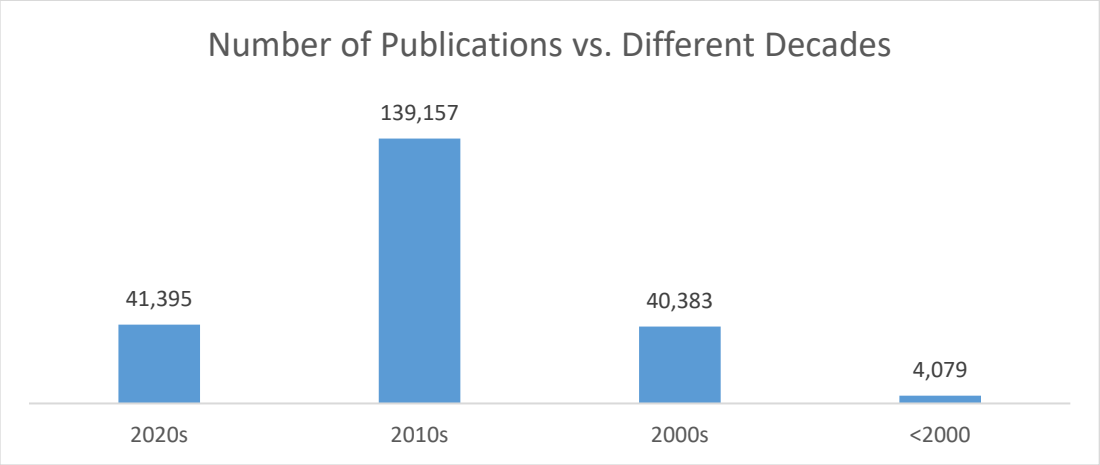

Figure 2. Frequency of Logistics Hub's Published Articles Throughout Decades

3.2 Practical Cases

In order to find the most relevant articles that consider practical cases of locating logistics hubs, an advanced search has been accomplished using "logistics hub" keyword as mandatory word that should be written within an article's tittle in addition to "location" and "case study" as mandatory words that should be appeared in the context of an article. The first word represents the main keyword and it was selected as a mandatory word, while the second one aims to include the articles that contain applied case studies. However, the third word is added just to narrow the research and consider the articles that mentioned locating hubs within their context. In addition to the three keywords, the search is only limited to academic (peer-reviewed) journals.

18 articles were appeared as initial results for the search before the engine removes duplicates results and provide 15 articles as final results. The 15 resulted shortlisted articles are listed in (Table 2) below.

Table 2. Literature Review of Logistics Hubs Practical Cases

Ref	Title	Author/s	Publication Year	Case Study
(de Villiers, 2013)	South African perspective on freight logistics hubs	De Villiers Gerard	2013	South Africa
(Haralambides et al., 2011)	Determinants of a regional port-centric logistics hub: The case of East Africa	Hercules Haralambides Simme Veldman Eric van Drunen Miaojia Liu	2011	East Africa
(Louis Faugère et al., 2020)	Mobile Access Hub Deployment for Urban Parcel Logistics	Louis Faugère Chelsea White Benoit Montreuil	2020	Asian Mega City
(Maharjan & Hanaoka, 2018)	A multi-actor multi-objective optimization approach for locating temporary logistics hubs during disaster response	Rajali Maharjan Shinya Hanaoka	2018	Nepal
(Hu et al., 2020)	Network planning of urban underground logistics system with hub-and-spoke layout: two phase cluster-based approach	Wanjie Hu Jianjun Dong Bon-Gang Hwang Rui Ren Zhilong Chen	2020	China

(Kirkland, 2017)	Tourism and global logistics hub development in the Caribbean: Will there be a symbiotic relationship?	Kirkland Robert Anderson	2017	Jamaica
(Zhen & Yingjin, 2013)	Hub-Spoken Major Appliance Logistics Net Work Building and Practice	Chen Zhen Lu Yingjin	2013	China
(Zhang et al., 2021)	Hybrid MCDM Model for Location of Logistics Hub: A Case in China Under the Belt and Road Initiative	Zhang, X. Lu, J. Peng, Y.	2021	China
(Li et al., 2021)	The Design of Hybrid Hub-and-spoke Networks for Large-scale Dynamic Express Logistics: A Case Study of Chinese Express	Li, Yue Zhuang, Zilong Qin, Wei	2021	China
(El-Nakib, 2010)	Location preference of Egyptian firms for logistics hub in Southeast Africa	El-Nakib, I	2010	Southeast Africa
(Lee & Moon, 2014)	A hybrid hub-and-spoke postal logistics network with realistic restrictions: A case study of Korea Post	Lee, Jeong-Hun Moon, Ilkyeong	2014	South Korea
(Xu et al., 2021)	Study on the Optimization of Hub-and-Spoke Logistics Network regarding Traffic Congestion	Wei Xu JinCan Huang YanZhao Qiu	2021	China
(Zhao et al., 2018)	Location selection of intra-city distribution hubs in the metro-integrated logistics system	Zhao, Laijun Li, Huiyong Li, Meichen Sun, Yan Hu, Qingmi Mao, Shirong Li, Jianguang Xue, Jian	2018	Shanghai
(Shahparvari et al., 2020)	A GIS-LP integrated approach for the logistics hub location problem	Shahparvari, Shahrooz Nasirian, Araz Mohammadi, Alireza Noori, Sepideh Chhetri, Prem	2020	Iran
(Liu et al., 2008)	Analysis and design of a supply chain logistics hub for after market automotive parts distribution	Liu, C.S. Trappey, C.V. Trappey, A.J.C. Hung, A.Y.L. Huang, A.Y.L. Lee, W.T.	2008	Taiwan

3.3 Tools and Techniques

Most of the literature consider multi-phase methodologies to solve and conclude the solution for their location problems. Implemented tools and techniques are varied from case to case depend on the targeted objective/s, nature and number of constraints, author preference and the complexity of the selected case study. However, all of the chosen tools and techniques are falling under one of the below categories.

a. Spatial Model

Spatial modeling is usually used for a very large areas whenever there is a need of cutting the feasible space and removing the non-considered areas due to some constraints or requirements. S. Shahparvari et al. use a geographic information system (GIS) based approach with a combination of different techniques to identify the initial suitable townships within the buffered areas (Shahparvari et al. 2020). The implementation of the GIS tool was only considered for a macro scale level and the use of such tool was limited to few basic features such as buffering tool.
X. Zhang et al. consider spatial geographical locations for different cities which were used later on as input for other tools (Zhang et al. 2021).

b. Optimization Model

Optimization modeling and linear programming driven methodologies are usually considered to solve problems with different constraints and single or multiple objectives. S. Shahparvari et al. use similar technique identify the main clusters as a second phase for their model (Shahparvari et al. 2020). Heuristic algorithm was later on implemented to solve the mixed integer quadratic constraint problem which aims to minimize the distance between the centroid of each cluster to the center of pre-defined grids with respect to multiple constraints.

W. Hu, J. Dong develop a mixed-integer programming model (MIP) that minimize the system cost with a combination of Genetic-based fuzzy C-means algorithm (GA-FCM), Depth-first-search FCM (DFS-FCM) algorithm and Dijkstra algorithm (DA) (Hu et al. 2020). Applying multiple optimizations methods has enhanced the solution from cost reduction perspective. However, including more real-life aspects such as the available underground spaces might reflect the real case and increase the validity of the results.

Another case was implemented in Nepal where R. Maharjan and S. Hanaoka develop a multi-objective model to locate temporary logistics hubs using the data of the 2015 Nepal's earthquake disaster (Maharjan & Hanaoka 2018). The ultimate objectives of the model are to minimize both the cost and the unsatisfied demand with respect to multiple constraints such as the availability of emergency materials.

Louis Faugère et al. examine last mile mobile access hubs new alternative using an optimization model based on integer programming mathematical modeling. The authors focus on assessing the economic, time efficiency and environmental performance of the new solution rather than allocating those hubs (Louis Faugère et al. 2020).

Y. Li et al. (2021) develop a mixed integer linear programming and a two-stage genetic algorithm to solve a hybrid hub and spoke network design problem and design the hubs' locations and the straight connections between nodes (Li et al. 2021). This model aims to dynamically redesign the network to adapt the fluctuating in demand and minimize the total logistics cost.

J. Lee and I. Moon develop double mathematical models that minimizes the sum of the transportation costs and fixed costs for using the vehicles for the Korean postal logistics network with realistic restrictions by considering locations and allocations approach (Lee & Moon 2014). The authors design one of the most interesting hubs to spoke model that is suitable to be implemented almost for any supply chain operational organization.

W. Xu, J. Huang and Y. Qiu design a hub to spoke location allocation optimization model minimizes the total cost of the road network under traffic congestion (Xu et al. 2021). This study is only limited to a singly type or mode of transportation, while there are multiple modes in real life situations.

c. Decision Making Method

Weighting, ordering and selecting techniques are usually used to arrange set of alternatives based on subject matter experts' judgment or pre-defined criteria. S. Shahparvari et al. implement multiple decision-making methods such as Delphi weighting criteria, VIKOR ranking criteria and PROMETHEE ranking criteria (Shahparvari et al. 2020).

R. Maharjan and S. Hanaoka implement a fuzzy factor rating system (FFRS) considering a group of decision makers to determine the weights of the two early considered objectives (Maharjan & Hanaoka 2018). X. Zhang et al. rely heavily on multi-criteria decision making (MCDM) techniques by using a grey area relational analysis-technique for order preference by similarity to ideal solution GARA-TOPSIS in combination with analytic hierarchy process (AHP), entropy method and game theory (Zhang et al. 2021).

L. Zhao et al. integrate the existing metro network with the last mile delivery services through a segmentation model followed by decision making methods such as AHP and TOPSIS.

Even though, the keyword "location" was considered earlier in the search, few articles were found to be irrelevant to the logistics hubs location problems. R.A. Kirkland relies on surveys methodology to study and examine the relationship between transforming into global logistics hub and the improvement of the agritourism sub-sector (Kirkland 2017). I. El-Nakib uses similar questionaries'-based methodology to select the most suitable location for a regional distribution center (RDC) considering multiple factors (El-Nakib 2010). "South African perspective on freight logistics hubs" is another article where G. de Villiers presents a real life implemented case study in a form of briefing rather than academically discussing and detailing the methodology (de Villiers 2013). propose a statistical based approach that compares the logistics costs of routings and highlights ports in Eastern Africa as potential hubs (Haralambides et al. 2011). C. Zhen and L. Yingjin wrote a very complex article where the considered tools are hard to define and the flow of context is hard to follow (Zhen & Yingjin 2013). use simulation model to improve the logistics processes of parts manufacturing company. C.S. Liu et al. studied the As-Is situation and suggest a To-Be model that enhance the logistics cost and the lead time (Liu et al. 2008).

4. Conclusion

In conclusion, logistics hubs became more and more attractive in the last 20 years. Many researchers considered this topic and tried to design or develop methodologies for hubs location allocation. However, only few practical cases were implemented and tested in realistic scenarios. Asian countries have the highest frequency of implemented cases which indicates the current logistics development among those countries. Most of the relevant practical cases consider one, two or all of the following solving models and those include spatial modeling, optimization modeling and decision-making methodologies. Spatial model might be really effective as first phase whenever the feasible space is widely spread, while optimization models can be used as a single method which might solve the whole problem and lead to optimum or near optimum solution. Lastly, decision making methodologies could be used in many scenarios and whenever there is a lack of data, set of alternatives need to be ranked or very complex problem which is hard to be mathematically formulated.

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