Sri Lanka Society of
Transport and Logistics

MARITIME LOGISTICS RESEARCH BY AUTHORS BASED IN SOUTH ASIAN INSTITUTIONS: A SYSTEMATIC REVIEW

*B A Weerasinghe [a b c] * and H N Perera [a b c]*

a   Professor H.Y. Ranjit Perera Institute for Applied Research, Nugegoda, Sri Lanka

b   Center for Supply Chain, Operations and Logistics Optimization, University of Moratuwa, Moratuwa, Sri Lanka

c   Department of Transport Management and Logistics Engineering, Faculty of Engineering, University of Moratuwa, Sri Lanka

*   Correspondence should be addressed to *buddhiweerasinghe77@gmail.com*

ABSTRACT

Systematic reviews improve future research by providing an overall picture of how research is conducted in a particular field. As a result, they are growing in number. As South Asia emerges as a geopolitical and maritime hub, attention must be shifted to maritime logistics in the region. This study examines how authors based in South Asian institutes contribute to maritime logistics research by way of a systematic review. It indicates that most research on maritime logistics in South Asia comes from India. Presenting the formulation of networks between authors and countries, the study reveals four research clusters that are derived based on the paper pool systematically derived through Scopus: i) Container terminal optimization, ii) Logistics activities in the hinterland, iii) Geopolitics in the maritime supply chain, and iv) Maritime transport. The evolution of South Asian maritime logistics is discussed based on the four clusters so derived. Moreover, the way that authors based in South Asia and their institutions have contributed journal articles in maritime logistics is discussed. Directions for future studies in maritime logistics in South Asia are introduced. We find that more collaborations can enhance the region's maritime logistics research. Future studies may focus on industry academia and horizontal-vertical collaborations.

Keywords: *Maritime logistics, Systematic literature review, Bibliometric analysis, Shipping, South Asia, Container terminals*

1. INTRODUCTION

1.1. Maritime Logistics in South Asia

In its Review of Maritime Transport 2022, UNCTAD (United Nations Conference on Trade and Development) [1] reveals that the annual growth of maritime trade increased by 10% - 12% in 2021 after the global COVID crisis. The main sea route that connects Asia to Europe goes through South Asia. This route has recorded trade worth approximately 26.3 million TEUs between 2014 - 2022 [1]. This trade volume is equivalent to 80% of the trade along the Trans-Pacific trade route and thrice the trade along the Transatlantic trade route.

Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka are constituting South Asia. Of these, Afghanistan, Bhutan, and Nepal are landlocked. South Asia accounts for just 3.49% of the world's land area but 25% of the world's population [2]. According to Stopford [3], the population is a key component of maritime trade theory. Because South Asia's production and consumption are both positively correlated to population, and this makes the region significant due to the high population when it comes to maritime trade [4]. When it comes to maritime business, India is a key economic power player in the region and Sri Lanka has a major role given its strategic location [5]. Colombo Port was the 25th most occupied and fastest-growing container port in the world in 2018 [6]. These facts show the importance of research into maritime logistics in South Asia, both within the region and outside. Most importantly there is a gap in understanding how authors based in South Asia conduct maritime logistics research: in the context of South Asian maritime logistics as well as in more general studies of maritime logistics without considering geopolitics [7].

Maritime logistics is a broad field. If we derive it from a transport and logistics perspective, maritime transport is a mode of transport that uses water bodies as their main medium for transporting goods and passengers. When we discuss maritime logistics using geographical aspects, it represents maritime geography and routes [8]. We can elaborate on maritime logistics using a supply chain management perspective that integrates functions such as transport modes, storage facilities, cargo-handling facilities, and information management. In this new era, we cannot discuss maritime logistics by separating it from supply chain management since these core areas are integrated [3]. Maritime logistics can be defined through port operations and shipping operations, which are more popular since those two are the key constituents of maritime logistics [9].

1.2. Previously Published Review Studies

We conducted an extensive literature survey to identify previously published review studies within maritime logistics. Our Keyword Structure (KS) for the main analysis is defined in Figure 1. To find the previously published review papers, Level 3 of the KS is replaced with keywords; *"bibliometric analysis" OR "literature review*" OR "citation analysis" OR "systematic review*" OR "systematic literature review*" OR review OR "content analysis" OR "meta-analysis" OR overview OR "state-of-the-art"*. The KS was applied in Scopus,[1] and the search result is obtained with 293 peer-reviewed journal articles in English. Then the steps proposed in the review methodology are followed. Systematic reviews have not been found on the intersection of maritime logistics and South Asia.

However, we find five systematic reviews within maritime logistics: automating terminals [10], machine learning techniques [11], performance in container terminals [12], classifying games in container terminal logistics [13], and operations research techniques in container terminals [14]. Importantly, four out of these five studies were published in 2022 and 2023 indicating attention towards systematic methodologies in developing review studies are growing in scientific value. Further, we conducted the same extensive search on other related areas, such as supply chain management, air transport, land transport, and freight transport. We find two important papers within the domain of inventory management [15] and behavioural operations [16].

1.3. Research Gaps and Objectives

We identify that it is important to understand the art of publishing papers in the domain of maritime logistics published by authors based in South Asian institutions [7]. Our findings can help to shape the future work of authors based in South Asian institutions. Against that backdrop, we find a limited number of systematic reviews, as highlighted in subsection 1.2.

Three research objectives are derived, covering all findings in our literature review: 1. Define past and present trends in maritime research in South Asia, 2. Introduce trending research directions for future maritime research, 3. Present research networks within the region and beyond to encourage more collaboration are the main

---

[1] Evidence supports the use of Scopus (managed by Elsevier publishing) as an excellent source of maritime research articles (e.g., Davarzani et al. [17]) Furthermore, Scopus is the largest abstract and citation database for peer-reviewed academic literature (i.e., scientific journals, books, and conference proceedings) within the fields of science, technology, medicine, social sciences, and arts and humanities. Scopus covers over 20,000 peer-reviewed journals, which is more comprehensive than the Web-of-Science database (managed by Thomson Reuters; includes only ISI-indexed journals thus limiting to approximately 12,000).

objectives of this study. This paper primarily assesses the status quo of the literature on maritime logistics published by South Asian authors.

First, we explain the review methodology (2) explain the systematic process that is employed in the study. Then the analysis is conducted introducing the bibliometric analysis (3.1) and cluster analysis (3.2). Future directions for authors based in South Asia are presented under cluster analysis (3.2). The development of research by South Asian authors is presented in the paper's findings (4).
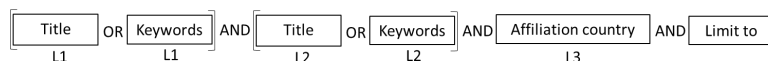
2. REVIEW METHODOLOGY

Perera et al. [15], Perera et al. [16], Davarzani et al. [17], and Weerasinghe et al. [14] suggest nine steps of the systematic process: 1) develop the keyword structure (KS), 2) search in the selected database, 3) narrow the result based on the topic, 4) extract the relevant publications with inclusion key words, 5) exclude the irrelevant publications with exclusion keywords, 6) check the reference lists of the selected important studies, 7) finalize the paper pool with the selected studies, 8) perform bibliometric analysis, 9) perform further analyses including clusters revealing trends.

The creation of KS is crucial because it shapes the direction in which the study is conducted. Usually, it takes time to define an appropriate KS, and it is not easy to apply a few keywords and get results. First, we conducted a detailed background search on the most important papers according to their contributions and timelines. KS (Figure 1) is defined after absorbing the concepts and terms following previously established papers in the domain [14], [18], [19], [11], [12], [13], [17].

Levels		Keywords in Scopus
Maritime logistics	L1	seaport* OR maritime OR shipping OR "container terminal*" OR "container port*" OR "container vessel" OR "container ship*" OR "container handling" OR stowage OR berth* OR "quay crane" OR "container yard" OR "terminal yard" OR "yard crane" OR "stacking crane" OR "terminal tractor" OR "terminal truck" OR "inter-terminal*" OR "break-bulk" OR "break bulk" OR "dry-bulk" OR "dry-bulk" OR "liquid bulk" OR "liquid-bulk" OR "ro-ro" OR "ro ro" OR tanker
Logistics operations	L2	suppl* OR logistics OR distribut* OR warehous* OR procure* OR purchas* OR planning OR schedul* OR sequenc* OR reshuffl* OR deployment OR allocat* OR rout* OR assignment OR load* OR unload* OR discharg* OR stack*
Affiliated country	L3	afghanistan OR bangladesh OR bhutan OR india OR maldives OR nepal OR pakistan OR "sri lanka"
Limit the result	Limit to	LIMIT-TO (SRCTYPE , "j") AND (LIMIT-TO (LANGUAGE , "English")

Keyword structure

Figure 1: KS – Maritime logistics research by authors based in South Asia

Normally, the definition of KS is the most important part of a systematic review because it determines the direction of the research. However, it is not only the establishment of a list of common words that generates search results. It must include

the possibility of including existing studies with an acceptable error rate in a defined database (to ensure that irrelevant documents are not captured, and relevant documents are not excluded). If studies already established in the field are not included, a sixth step of checking the results should be considered. The KS is defined in Figure 1 after some careful improvements. In addition, the KS structure contains three levels: i) maritime logistics ii) logistics operations, and iii) affiliated country. It is assumed that the intersections of these three levels may include previously published studies. The Scopus database is used as a second step in document search, as defined by KS. The search results are limited to English-language journals.

In the third stage of the review process, search results are restricted based on the target area. It should be carefully filtered because some of the relevant papers may be relevant to the subject area of the subject. Once this step is completed, the Comma-Separated Values (CSV) file is ready to be downloaded from Scopus. The original Scopus search results were 245 (Updated February 20, 2023). Keywords are used to identify the most relevant research to be reviewed. Studies containing title or author keywords representing identified words in both maritime logistics and logistics operations are selected in the first phase of selection. Keywords containing keywords are also searched in abstracts. Then the exclusion criteria (set of keywords including blue whale, cfd, dredging, hydrodynamics, microplastics, petroleum hydrocarbons, scanning electron microscopy, vibration, 16s rrna gene, actigraphy, etc.) reduces the paper pool up to 134 papers. Then the reference lists of previously established papers are cross-checked, and 10 more papers are added to the list. Ultimately, 144 papers were identified in the final paper list that is employed in the analysis of this study.

3. ANALYSIS

3.1. Bibliometric analysis

We find that authors based in South Asian institutes focus on publishing peer-reviewed journal articles within the scope of maritime logistics. As Figure 2 displays the trend can be calculated as 60% of the papers from the paper pool have been published within the last five years, 2018 – 2022. Similarly, we find that 91% of the papers have been published from 2011 onwards (2011-2022). This finding indicates the motivation of South Asian authors to publish papers in the domain of maritime logistics. Further, this finding ensures our intention to conduct a systematic review, of maritime logistics research authors based in South Asian Institutes.
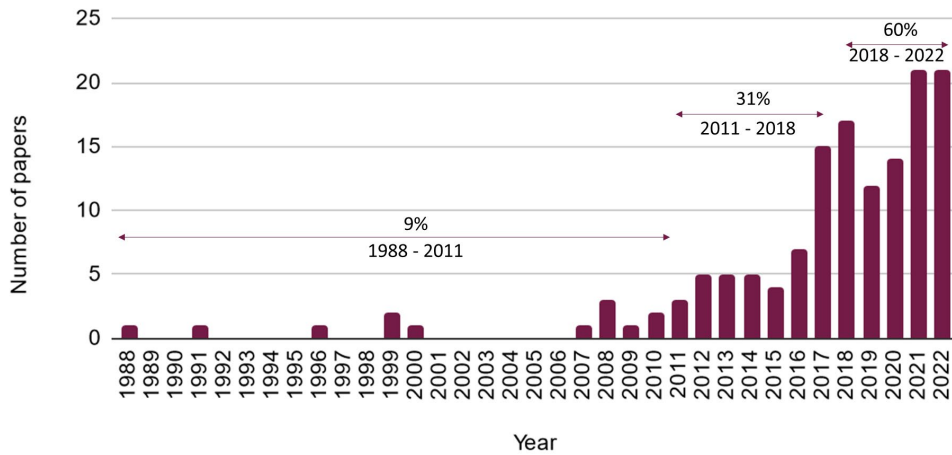
**Figure 2: Annual distribution of selected papers**

Table 1: Top publications outlets – Maritime research by Authors based in South Asian Institutes

Rank	Journal	Number of publications
1	International Journal of Logistics Systems and Management	7
2	International Journal of Production Research	5
2	Transportation Research Part E: Logistics and Transportation Review	5
4	Computers and Industrial Engineering	4
4	European Journal of Operational Research	4
4	Journal of The Institution of Engineers (India), Part MR: Marine Engineering Division	4
4	Maritime Policy and Management	4
8	Computers and Operations Research	3
8	Journal of Cleaner Production	3
8	Opsearch	3
8	Transport Policy	3

Table 1 displays the top outlets in the scope, *International Journal of Logistics Systems and Management* leads as the favourite journal outlet of authors based in South Asian institutes. *International Journal of Production Research* and *Transportation Research Part E: Logistics and Transportation Review* have shared the second position with a margin of two articles.

Then we analyse how the countries have contributed to our scope. Even though our scope defines papers on authors based in South Asian institutes, collaborations with authors from other regions of the world are included [14]. The criteria are defined to capture papers with at least one author from a South Asian institute. It is found that

India with 11 papers, China with 22 papers, and Sri Lanka with 19 papers are the top three contributing countries. In addition to that, the United States (14 papers), United Kingdom (13 papers), Netherlands (9 papers), Pakistan (8 papers), Australia (6 papers), Bangladesh (6 papers), and Hong Kong (6 papers) are positioned next in the list of countries which contribute towards the scope. The network of the countries has been developed in Figure 3.
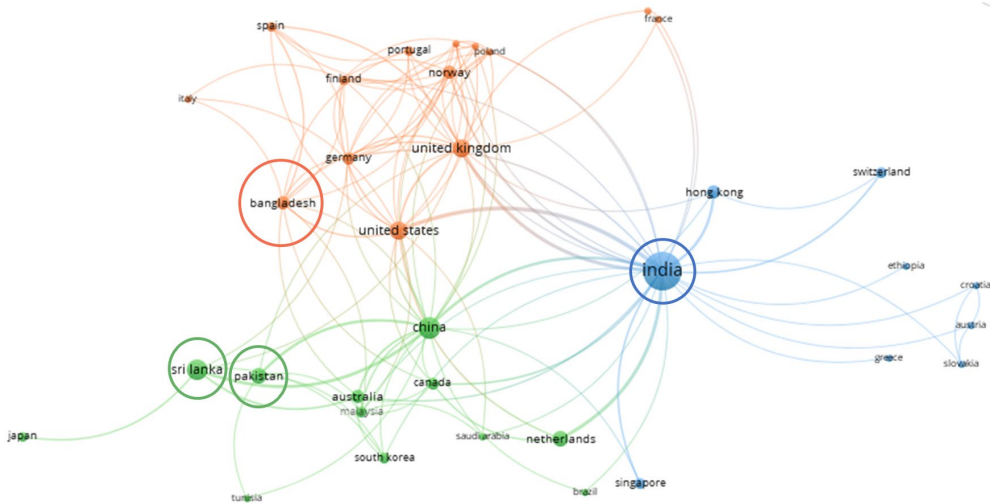
Figure 3: Network within countries of the authors

Figure 3 visualises how South Asian countries connect with other parts of the world through maritime research. Interestingly, there are no papers authored by researchers based in Afghanistan, Bhutan, Maldives, and Nepal: probably because these are landlocked countries. Three clusters can be identified in Figure 3; i) the Main cluster is connected to India and is linked to 27 countries, ii) Sri Lanka is linked to six countries while Pakistan has connected with five countries, and iii) Bangladesh has positioned in the next cluster connecting with 12 countries even though only six papers were produced.

According to World Higher Education Database [20], approximately 1278 Higher Education Institutes (HEIs) are located in South Asia; India – 64.01%, Pakistan - 12.52%, Afghanistan - 10.09%, Bangladesh - 9.39%, Sri Lanka - 2.11%, Nepal - 0.94%, Maldives - 0.70%, Bhutan - 0.23%. This finding further supports our figure on the number of publications based on countries.

Indian Institute of Technology, Kharagpur, India produced 19 research papers, becoming the highest contributor in our scope. Indian Institute of Management, Ahmedabad, India, was the second-highest contributor with 11 papers. University of

Moratuwa, Sri Lanka was in third position with nine publications. Erasmus University, Rotterdam, Netherlands (from outside South Asia) was in fourth place with eight papers. Three universities have shared the fifth place contributing with seven papers each: Colombo International Nautical and Engineering College (CINEC Campus), Malabe, Sri Lanka, Indian Institute of Technology, Mumbai, India, and Dalian Maritime University, China. We find that only 18 papers have been published by authors based in Sri Lanka. Surprisingly, two institutions from Sri Lanka have ensured their places within the top five institutions in the defined scope of the paper. We observed that papers coming from India have been distributed within many institutions while Sri Lanka's research is concentrated within a few institutions.

Figure 4: Network of authors

M. K, Tiwari of the Indian Institute of Technology Kharagpur, India is the top author who has produced 14 papers within the defined scope of our paper. D. Roy of the Indian Institute of Management, Ahmedabad, India is the second main contributor who has produced nine papers within the scope. Arjit De from The University of Hong Kong, Hong Kong has reached third place with six studies while contributing from outside of South Asia. Figure 4 introduces how authors are grouped based on the network they have contributed to.

3.2. Cluster analysis

The association strength normalization

$$s_{ij} = \frac{2ma_{ij}}{k_i k_j}$$ --(1)

The total weight of all edges in the network

$$k_i = \sum_j a_{ij} \text{ and } m = \frac{1}{2}\sum_i k_i$$ --(2)

Mapping technique - minimization function

$$V(x_1, \dots, x_n) = \frac{1}{2}\sum_{i<j} s_{ij} \left|\left|X_i - X_j\right|\right|^2 \text{ and } \frac{2}{n(n-1)}\sum_{i<j}\left|\left|X_i - X_j\right|\right| = 1$$ -----------(3)

Clustering technique - maximization function

$$V(c_1, \dots, c_n) = \sum_{i<j} \delta(c_i, c_j)(s_{ij} - \gamma)$$ ---(4)

Where,

a_{ij}	The weight of the edge between nodes i and j. $a_{ij}= 0$ if there is no edge between the two nodes.
k_i	The total weight of all edges of node i
k_j	The total weight of all edges of node j
m	The total weight of all edges in the network.
n	The number of nodes in the network
x_i	The location of node i in a two-dimensional space
$\|x_i - x_j\|$	The Euclidean distances between nodes i and j
c_1	The cluster to which node i is assigned
$\delta(c_i, c_j)$	A function that equals 1 if $c_i = c_j$ and 0 otherwise
γ	A resolution parameter that determines the level of detail of the clustering

Generating research clusters to underscore the connectivity between countries and keywords and their development is the next task. The following equations introduced by Van Eck & Waltman [21], have been applied in the recommended network analysis software [17] [16]. The equation developed by Van Eck & Waltman [21], depicts as follows how association strength normalization constructs a normalized network in which the weight of the edge between nodes appears as i and j:

Figure 5: Research clusters

The author keywords in the selected studies contribute to generating cluster graphs using VOSviewer software that are functioned based on Equations 1, 2, 3, and 4. Accordingly, Figure 5 is generated using the keywords that appear at a frequency of 2 times or above in the relevant literature. By analysing the author keywords that appear in each cluster, four main research clusters can be formulated: i) Container terminal optimization, ii) Logistics activities in the hinterland, iii) Geopolitics in the maritime supply chain, and iv) Maritime transport.

3.2.1. Container terminal optimization

The first cluster focuses on container terminal optimization which is a broader area. This cluster is not a narrow topic that only discusses South Asia. The study of container terminal operations is becoming more popular, while other types of operations as dry bulk and liquid, have not been much studied. According to our paper pool Raman & Ramkumar [22], started the discussion on optimizing container terminals in 1988 by conducting their study on the simulation of the waiting time of ships and berth occupancy in ports.

Then we go through the contents of papers aiming to capture crucial findings for future study. As Dhingra et al. [23], illustrate that the frequently employed time-

homogeneous estimate of time-varying truck arrivals is unreliable for evaluating the landside activities of container terminals. When it comes to quay crane operations, both overlapping and single quay crane operations should be classified to understand the distinction between both operations [24]. The dynamic stacking approach is discussed by Gunawardhana, et al. [25] highlighting the importance of identifying the real dynamics in container terminal operations. A systematic review conducted by Weerasinghe et al. [14] further claim that dynamic approaches must be considered in future studies.

When the studies that are conducted by authors not based in South Asia are considered, integrated operations can be identified as one of the trending areas [14]. As Integrated approaches within dynamic problems inside container terminals can be introduced as a future research direction according to Weerasinghe et al. [26]. As Weerasinghe et al. [26] illustrate, even integrated studies have not provided an overarching image to get an understanding of dynamic behaviour. Moreover, previous studies have not focused on the integrated planning perspective sufficiently.

Gunawardhana, et al. [25] suggest testing dynamic stacking methods in gateway container terminals as an expansion of their study. Weerasinghe et al. [26] propose to apply integrated approaches in container terminal planning while connecting silos between landside and quayside operations. Understanding how to deploy different types of handling systems in mixed operations will help to improve container terminal operations further [27]. Existing Integer Linear Programming (ILP) models include several restrictions, making it difficult for commercial solvers to produce the best results. Therefore, future studies must adhere to industrial limitations [28].

3.2.2. Logistics activities in the hinterland

Logistics activities in the hinterland cluster discuss the overall connectivity between hinterland activities and maritime transportation. However, maritime transport is discussed focusing on the logistics function in this cluster. Pinakpani et al. [29] have discussed the importance of focusing on opportunities raised within industries such as Fertilizers, Hydrocarbons, Coal, Lubricants, and Oil.

Container inventory imbalance is discussed as a crucial point by Edirisinghe et al. [30]. Edirisinghe et al. [30], further explain that the organizational aspects of container exchange are crucial. Dong et al. [31], conduct their study to design of a sustainable maritime multi-modal distribution network. Identifying how different industries demand logistics operations is crucial; Dong et al. [31] conduct a case study in automotive logistics.

To enhance the overall operations, it is important to connect all working points in a process. Misra et al. [32] propose a multi-grid discrete-time formulation used in the

mathematical framework to accurately depict several complexities associated with ship trips, jetty activities, and the loading and unloading of cargo.

Because South Asia is located on the major sea route between Asia and Europe (1), its location is critical regardless of the type of cargo. Bunkering provides services to the vessels in the ports as well as at sea [33]. Bunkering and maintenance activities are very important for the South Asian region since many shipping agents who provide husbandry services to vessels are working in the region [34]. However, we identify that the current discussion is built on the broader perspective which is sufficient to provide insights into literature on bunkering [35].

We encourage future studies to look at integration between hinterland and maritime operations. It was a trend to focus on non-containerized operations within this cluster, but integration between the hinterland and maritime operations is important for the growth of the industry.

3.2.3. Geopolitics in the maritime supply chain

Cluster 3 reveals the connectivity between South Asian countries, other regions of the world, the Indian Ocean, and the Bay of Bengal specifically. The connection between shipping, shipbuilding, and the shipping industry is focused within operational perspective of a vessel is considered. Sri Lankan shipping operations have been considered within these common types of operations. At the same time, India is considered under geopolitical concerns.

Sustainability has also been considered in this cluster that discusses geopolitical concerns. Bathrinath et al. [36], have conducted a study analysing the factors affecting sustainability in ship ports. Bathrinath et al. [36], further mention that a technological viewpoint might be used to evaluate a port's sustainability. Additionally, using an integrated hybrid strategy will improve future port operations. Blockchain is applied as a solution to avoid lengthy documentation processes. Tyagi and Goyal [37], discuss smart contracts which are based on blockchain for the issuance of the country of origin certificate for Exports Clearance. This study focuses on the Indian customs clearance process.

The green concept in maritime transport has been trending over the past decade (2010-2020) [17]. Ports face pressure when the shipping lines demand a higher efficiency with a lower vessel turnaround time. Therefore, ports try to increase efficiency while limiting focus on green operations. Moreover, it is important to balance these operations through green approaches. We suggest that authors further investigate ports such as Colombo and Chittagong. Authors may also consider how global trends in green port operations can be applied to ports in South Asia. The risk

of applying inefficient mechanisms to approach green port operations can be reduced further.

It is identified that discussion on the integrated operations between South Asian countries is limited. Kavirathna et al. [5] have discussed the competitiveness of the Port of Colombo against the major Southeast Asian hub ports. It is suggested to follow this path within South Asian studies where the ports are benchmarked and studied further. Moreover, we encourage future research to focus on the integration of shipping and logistics operations in South Asia. In this cluster, we encourage authors' collaborations between South Asian countries since we identify a limitation within South Asian authors.

Logistics Performance Index (LPI) is an interactive benchmark tool that helps countries identify challenges and opportunities in their trade logistics performance and how to improve their performance. Aggregated LPI (2012-2018) [38] highlights each South Asian country's rank: India-42, Sri Lanka-92, Pakistan-95, Maldives-97, Bangladesh-100, Nepal -121, Bhutan-151, Afghanistan-165. We suggest that South Asian institutes must focus on how the LPI ranking can be improved.

Further, we suggest going beyond the discussion on threats from Chinese strategy in the South Asian region. It can be suggested to discuss opportunities from all around the world towards South Asia since the contribution from the authors based on European, American, and Australian regions are robust.

3.2.4. Maritime transport

Maritime logistics is explained from the perspective of transportation in this cluster. Transport activities are involved throughout the horizon of maritime operations. Routing problems can be identified as one of the areas that discuss ship routing, maritime inventory problems, and truck operations. Sustainability can be achieved through design ship routing effectively [39]. Maritime inventory and shipping routing problems have been tested using various methods in literature; Composite particle algorithm [39], software-defined networking [40], meta-heuristics [41], particle Swarm Optimization [42], [43], Nondominated Sorting Genetic Algorithm II (NSGA-II) [44], genetic algorithm [45], and Mixed Integer Linear Programming (MILP) [46].

Digitalization is an ongoing discussion in the fields of transport and logistics. Even though only cloud computing and the Internet of Things (IoT) have been discussed within this cluster, this is being discussed heavily in studies coming from other parts of the world. Munim, et al. [47] argue that big data and artificial intelligence is trending in the maritime industry. We suggest improving this research direction by focusing on four directions as Munim, et al. [47] suggested: 1) Digital transformation

in the maritime industry, 2) Applications of big data from AIS, 3) Energy efficiency, and 4) Predictive analytics. Especially, it is needed to discuss port community systems where it creates the space for collaboration between the port and its stakeholders. It is better to discuss how the current knowledge of port community systems can be gained and applied within the context of South Asia.

Sigera & Cahoon [48], have identified the processes adopted to integrate intangible resources in global acquisitions among container lines. More studies that discuss the practical circumstances that are faced by shipping lines should be discussed. Manatunga et al. [49] have developed a new System Dynamics model to identify the operational process of a ro-ro terminal using system dynamics modelling. They suggest landside transportation of ro-ro terminals must be considered with quayside operations in building models in the future.

Further, we realize that collaboration between industry and academia is limited under the overall literature pool. Therefore, we suggest for South Asian authors work on more collaborations between industry and academia which creates a win/win environment for both parties.

4. FINDINGS

Figure 5 discusses research clusters that are derived through keywords. Figure 6 showcases how the evolution of maritime research in South Asia happened in two aspects: 1) How the clusters have been changed over time and 2) How the clusters have been added to the maritime research conducted by authors based in South Asian institutions.
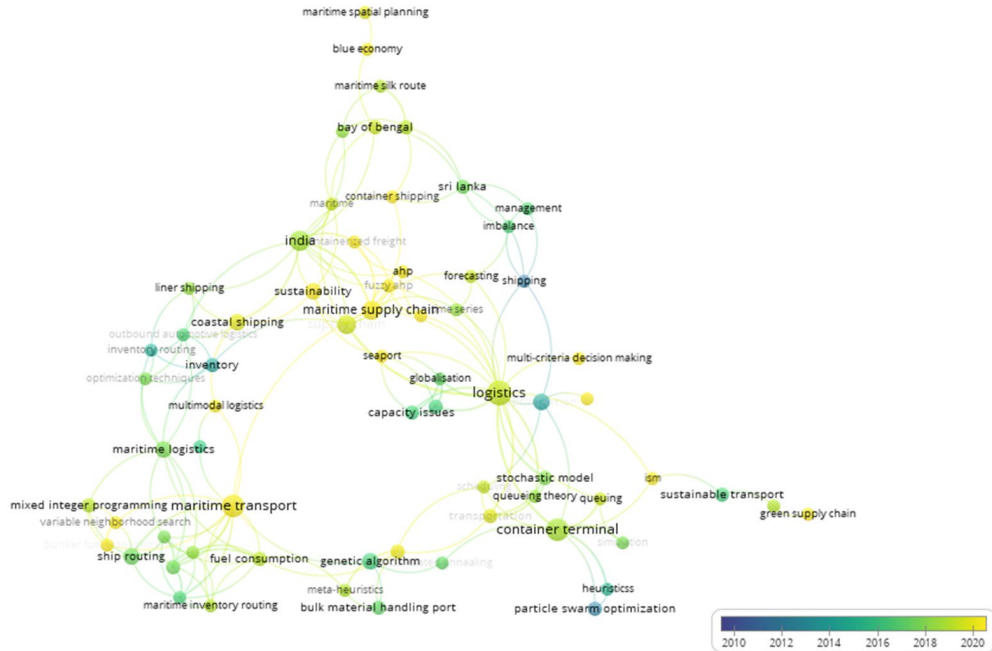
Figure 6: Evolution of maritime logistics research by authors based in South Asian institutes

It is easy to understand that the South Asian shipping and logistics cluster and the container terminal optimization cluster are the matured clusters in South Asian maritime logistics. Research areas that are recorded in their average year of publication as 2020 or after that are identified as integrated planning in container terminals, dynamic scheduling in container terminals, Fuzzy models, Analytic Hierarchy Process (AHP), green supply chain, information technology, artificial intelligence, containerized freight, multi-criteria decision making, bunker fuel management, multimodal logistics, seaport, sustainability, variable neighbourhood search, blue economy, berth allocation, bay of Bengal, coastal shipping and maritime spatial planning. According to the findings, the focus on India and overall logistics function are some never-ending research focuses within identified clusters.

5. CONCLUSION

This study is conducted as a systematic review of the scope of maritime logistics research conducted by authors based in South Asian institutes. In other words, our focus is on South Asian affiliations. Therefore, this is a study to understand how maritime logistics research has evolved through contributions from authors based in South Asia. Our literature review finds that India has dominated the contribution to the literature. Sri Lanka is in second place leading Pakistan and Bangladesh. This

underscores a dearth of research coming from countries playing a pivotal role in the Belt Road Initiative. Moreover, the focus on industrial collaborations has been quite low for authors based in South Asia despite the growth of publications under maritime logistics in other regions. Through careful analysis of author keywords, four research clusters were identified; i) Container terminal optimization, ii) Logistics activities in the hinterland, iii) Geopolitics in the maritime supply chain, and iv) Maritime transport. Recent studies predominantly focus on the digitalization, and sustainability aspects in coastal and liner shipping industries, and focus on container terminal operations with integrated and dynamic port logistics functions. More work in collaboration with the industry is important for the growth of the industry. Future studies based on South Asia must be based on understanding the directions of research within or outside the four research clusters identified in the study. Further cooperation is needed between South Asian countries to improve maritime logistics research in the region. Considering industry and academia and horizontal-vertical collaborations will be potential directions for future studies. Further, other databases such as Web of Science can be considered in future studies to ensure covering more literature in parallel to the use of Scopus. To provide a comprehensive understanding of the state of the art, more systematic reviews in maritime logistics are needed.

REFERENCES

[1]   United Nations, *REVIEW OF MARITIME TRANSPORT 2022*. 2022.

[2]   Worldometer, 'Southern Asia Population (Live)', *worldometers.info*, 2021. [Online]. Available: https://www.worldometers.info/world-population/southern-asia-population/.

[3]   M. Stopford, *Maritime economics*, vol. 47, no. 07. 2009.

[4]   UNCTAD, 'COVID-19 and maritime transport: Impact and responses', p. 77, 2020.

[5]   C. A. Kavirathna, T. Kawasaki, and S. Hanaoka, 'Transshipment Hub Port Competitiveness of the Port of Colombo against the Major Southeast Asian Hub Ports*', *Asian J. Shipp. Logist.*, vol. 34, no. 2, pp. 71–82, 2018, doi: 10.1016/j.ajsl.2018.06.004.

[6]   Port Technology International Team, 'Colombo Ranked Fastest Growing Port Worldwide', *port technology*, 2018. [Online]. Available: https://www.porttechnology.org/news/colombo_ranked_fastest_growing_port_worldwide/.

[7] B. A. Weerasinghe and H. N. Perera, 'Maritime Logistics Research in South Asia: A Systematic Review', in *Research for Transport and Logistics Industry (R4TLI) – 2021*, 2021, doi: http://dl.lib.uom.lk/handle/123/18301.

[8] J. P. Rodrigue, *The geography of transport systems*. 2020.

[9] T. Koukaki and A. Tei, 'Innovation and maritime transport: A systematic review', *Case Stud. Transp. Policy*, vol. 8, no. 3, pp. 700–710, 2020, doi: 10.1016/j.cstp.2020.07.009.

[10] W. K. Kon, N. S. F. Abdul Rahman, R. Md Hanafiah, and S. Abdul Hamid, 'The global trends of automated container terminal: a systematic literature review', *Marit. Bus. Rev.*, vol. 6, no. 3, pp. 206–233, 2021, doi: 10.1108/mabr-03-2020-0016.

[11] S. Filom, A. M. Amiri, and S. Razavi, 'Applications of machine learning methods in port operations – A systematic literature review', *Transp. Res. Part E Logist. Transp. Rev.*, vol. 161, 2022, doi: 10.1016/j.tre.2022.102722.

[12] F. Kurniawan, S. N. Musa, N. H. Moin, and T. R. Sahroni, 'A Systematic Review on Factors Influencing Container Terminal's Performance', *Oper. Supply Chain Manag.*, vol. 15, no. 2, pp. 174–192, 2022, doi: 10.31387/oscm0490339.

[13] N. K. G. Nasution, X. Jin, and I. K. Singgih, 'Classifying games in container terminal logistics field: A systematic review', *Entertain. Comput.*, vol. 40, 2022, doi: 10.1016/j.entcom.2021.100465.

[14] B. A. Weerasinghe, H. N. Perera, and X. Bai, 'Optimizing Container Terminal Operations: A Systematic Review of Operations Research Applications', *Marit. Econ. Logist.*, 2023, doi: https://doi.org/10.1057/s41278-023-00254-0.

[15] H. N. Perera, B. Fahimnia, and T. Tokar, 'Inventory and ordering decisions: a systematic review on research-driven through behavioural experiments', *Int. J. Oper. Prod. Manag.*, vol. 40, no. 7–8, pp. 997–1039, 2020, doi: 10.1108/IJOPM-05-2019-0339.

[16] H. N. Perera, J. Hurley, B. Fahimnia, and M. Reisi, 'The human factor in supply chain forecasting: A systematic review', *Eur. J. Oper. Res.*, vol. 274, no. 2, pp. 574–600, 2019, doi: 10.1016/j.ejor.2018.10.028.

[17] H. Davarzani, B. Fahimnia, M. Bell, and J. Sarkis, 'Greening ports and maritime logistics: A review', *Transp. Res. Part D Transp. Environ.*, vol. 48, pp. 473–487, 2016, doi: 10.1016/j.trd.2015.07.007.

[18] W. K. Kon, N. S. F. Abdul Rahman, R. Md Hanafiah, and S. Abdul Hamid, 'The global trends of automated container terminal: a systematic literature review', *Marit. Bus. Rev.*, vol. 6, no. 3, pp. 206–233, 2020, doi: 10.1108/MABR-03-2020-0016.

[19] N. Lamii, F. Bentaleb, M. Fri, K. Douaioui, C. Mabrouki, and E. A. Semma, 'Systematic review of literature on dry port - concept evolution', *Trans. Marit. Sci.*, vol. 9, no. 2, pp. 248–270, 2020, doi: 10.7225/toms.v09.n02.009.

[20] World Higher Education Database, 'The word of higher education at your fingertips', 2023. [Online]. Available: https://www.whed.net/home.php.

[21] N. J. van-Eck and L. Waltman, *Measuring Scholarly Impact*. 2014.

[22] H. Raman and G. Ramkumar, 'Simulation model for analysis of waiting for time of ships and berth occupancy in ports', *J. Inst. Eng. (India), Part MR Mar. Eng. Div.*, vol. 68 pt 2, pp. 35–40, 1988.

[23] V. Dhingra, G. L. Kumawat, D. Roy, and R. D. Koster, 'Solving semi-open queuing networks with time-varying arrivals: An application in container terminal landside operations', *Eur. J. Oper. Res.*, vol. 267, no. 3, pp. 855–876, 2018, doi: 10.1016/j.ejor.2017.12.020.

[24] D. Roy and R. de Koster, 'Stochastic modelling of unloading and loading operations at a container terminal using automated lifting vehicles', *Eur. J. Oper. Res.*, vol. 266, no. 3, pp. 895–910, 2018, doi: 10.1016/j.ejor.2017.10.031.

[25] J. A. Gunawardhana, H. N. Perera, and A. Thibbotuwawa, 'Rule-based dynamic container stacking to optimize yard operations at port terminals', *Marit. Transp. Res.*, vol. 2, no. March, p. 100034, 2021, doi: 10.1016/j.martra.2021.100034.

[26] B. A. Weerasinghe, H. N. Perera, and P. Kießner, 'Planning decision alterations and container terminal efficiency', *Marit. Bus. Rev.*, 2022.

[27]   A. Gharehgozli, D. Roy, S. Saini, and J.-K. van Ommeren, 'Loading and unloading trains at the landside of container terminals', *Marit. Econ. Logist.*, 2022, doi: 10.1057/s41278-022-00219-9.

[28]   T. R. Lalita and G. S. R. Murthy, 'Compact ILP formulations for a class of solutions to berth allocation and quay crane scheduling problems', *OPSEARCH*, vol. 59, no. 1, pp. 413–439, 2022, doi: 10.1007/s12597-021-00552-2.

[29]   P. Pinakpani *et al.*, 'An algorithmic approach for maritime transportation', *Int. J. Adv. Comput. Sci. Appl.*, no. 2, pp. 764–775, 2020, doi: 10.14569/ijacsa.2020.0110296.

[30]   L. Edirisinghe, Z. Jin, and A. W. Wijeratne, 'The reality of container exchange between shipping lines: Clearing the pathway to virtual container yard', *Transp. Policy*, vol. 72, pp. 55–66, 2018, doi: 10.1016/j.tranpol.2018.09.009.

[31]   B. Dong, M. Christiansen, K. Fagerholt, and S. Chandra, 'Design of a sustainable maritime multi-modal distribution network – Case study from automotive logistics', *Transp. Res. Part E Logist. Transp. Rev.*, vol. 143, 2020, doi: 10.1016/j.tre.2020.102086.

[32]   S. Misra, M. Kapadi, and R. D. Gudi, 'A multi grid discrete time based framework for maritime distribution logistics & inventory planning for refinery products', *Comput. Ind. Eng.*, vol. 146, 2020, doi: 10.1016/j.cie.2020.106568.

[33]   M. Fernando and I. Sigera, 'Assessing the Oil Supply Chain Risk in Sri Lankan Petroleum Industry', in *MERCon 2021 - 7th International Multidisciplinary Moratuwa Engineering Research Conference, Proceedings*, 2021, doi: 10.1109/MERCon52712.2021.9525691.

[34]   H. Oalumali Sirisena and N. A. Samarasekera, 'Vessel Spare Parts Distribution Center Location Decision Model for Ship Maintenance Supply Chain', *Proc. 2018 IEEE Int. Conf. Serv. Oper. Logist. Informatics, SOLI 2018*, pp. 185–190, 2018, doi: 10.1109/SOLI.2018.8476802.

[35]   A. De, J. Wang, and M. K. Tiwari, 'Fuel Bunker Management Strategies within Sustainable Container Shipping Operation Considering Disruption and Recovery Policies', *IEEE Trans. Eng. Manag.*, vol. 68, no. 4, pp. 1089–1111, 2021, doi: 10.1109/TEM.2019.2923342.

[36] S. Bathrinath, P. S. Kumar, S. Venkadesh, S. S. Suprriyan, K. Koppiahraj, and R. K. A. Bhalaji, 'A fuzzy COPRAS approach for analysing the factors affecting sustainability in ship ports', vol. 50, pp. 1017–1021, 2021, doi: 10.1016/j.matpr.2021.07.350.

[37] N. K. Tyagi and M. Goyal, 'Blockchain-based smart contract for issuance of country of origin certificate for Indian Customs Exports Clearance', *Concur. Comput.*, 2021, doi: 10.1002/cpe.6249.

[38] The World Bank, 'Aggregated LPI 2012-2018', *LPI*, 2023. [Online]. Available: https://lpi.worldbank.org/international/aggregated-ranking.

[39] A. De, V. K. R. Mamanduru, A. Gunasekaran, N. Subramanian, and M. K. Tiwari, 'Composite particle algorithm for sustainable integrated dynamic ship routing and scheduling optimization', *Comput. Ind. Eng.*, vol. 96, pp. 201–215, 2016, doi: 10.1016/j.cie.2016.04.002.

[40] H. Ghafoor and I. Koo, 'Cognitive Routing in Software-Defined Maritime Networks', *Wirel. Commun. Mob. Comput.*, vol. 2020, 2020, doi: 10.1155/2020/8820838.

[41] S. Santhanakrishnan, T. T. Narendran, K. Ganesh, and S. P. Anbuudayasankar, 'Comparison of meta-heuristics for container ship routing problem', *Int. J. Serv. Oper. Manag.*, vol. 12, no. 3, pp. 348–367, 2012, doi: 10.1504/IJSOM.2012.047625.

[42] A. De, S. K. Kumar, A. Gunasekaran, and M. K. Tiwari, 'Sustainable maritime inventory routing problem with time window constraints', *Eng. Appl. Artif. Intell.*, vol. 61, pp. 77–95, 2017, doi: 10.1016/j.engappai.2017.02.012.

[43] A. De, J. Wang, and M. K. Tiwari, 'Hybridizing basic variable neighbourhood search with particle swarm optimization for solving sustainable ship routing and bunker management problem', *IEEE Trans. Intell. Transp. Syst.*, vol. 21, no. 3, pp. 986–997, 2020, doi: 10.1109/TITS.2019.2900490.

[44] A. De, A. Choudhary, and M. K. Tiwari, 'Multiobjective Approach for Sustainable Ship Routing and Scheduling with Draft Restrictions', *IEEE Trans. Eng. Manag.*, vol. 66, no. 1, pp. 35–51, 2019, doi: 10.1109/TEM.2017.2766443.

[45] P. Tyagi and G. Agarwal, 'Supply chain integration through ship routing optimization among BRICS by using meta-heuristic technique', *Indian J. Geo-Marine Sci.*, vol. 48, no. 3, pp. 397–402, 2019.

[46] S. Misra, M. Kapadi, and R. D. Gudi, 'Hybrid Time-Based Framework for Maritime Inventory Routing Problem', *Ind. Eng. Chem. Res.*, vol. 59, no. 46, pp. 20394–20409, 2020, doi: 10.1021/acs.iecr.0c03186.

[47] Z. H. Munim, M. Dushenko, V. J. Jimenez, M. H. Shakil, and M. Imset, 'Big data and artificial intelligence in the maritime industry: a bibliometric review and future research directions', *Marit. Policy Manag.*, vol. 00, no. 00, pp. 577–597, 2020, doi: 10.1080/03088839.2020.1788731.

[48] I. Sigera and S. Cahoon, 'Processes Adopted to Integrate Intangible Resources in Global Acquisitions among Container Lines: Perceptions of Acquirer and Acquired', *Asian J. Shipp. Logist.*, vol. 34, no. 1, pp. 1–11, 2018, doi: 10.1016/j.ajsl.2018.03.001.

[49] A. Manatunga, B. A. Weerasinghe, H. N. Perera, and P. Kiessner, 'Identifying the operational process of a ro-ro terminal using system dynamics modelling', in *Research for Transport and Logistics Industry (R4TLI 2022)*, 2022, doi: https://slstl.lk/wp-content/uploads/2022/10/R4TLI-2022-Proceedings.pdf#page=119.