

# Port Logistics Integration: Challenges and Approaches

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**Abstract-** The competitiveness of a seaport highly depends on its efficiency especially in terms of logistics practices, functions and activities and how all that is integrated with those of the other players in the supply chain. Despite the well-articulated importance of ports and terminals in integrated logistics, research on the success factors of port logistics integration remains scattered. The objective of this paper is to provide a review of the literature and based on this; provide an insight into how seaports and terminals may improve their logistics integration. A structured analysis of 78 papers published in Scopus indexed journals in logistics, supply chain and port management during the period 2000-2018 is conducted. A multidimensional conceptual framework for port logistics integration is proposed to incorporate the role of the three infrastructural variables emerging from the recent developments in the port logistics environment. The literature review has found the logistics process and operations, information integration, value-added services, and logistics practices, organisational activities, resource sharing and institutional support being influential factors in logistics integration. Based on the research discussion and conclusion which is drawn from the literature review offer a basis for future research, both in respect of research approaches, concept definition and the select of theoretical foundation. The framework could be more detailed on each factor and consider actors perspective. Further testing and examination of the framework are needed for the validity of the results. This study questioned current literature in port logistics integration, highlight role infrastructural factors and the actor's role in the port logistics chain.

**Keywords:** maritime logistics, port integration, logistics integration.

## 1. Introduction

Recent changes in the global production have led to the increasing complexity of supply chains and highlighted the critical importance of logistics efficiency to port competitiveness [1]. Growing competition has motivated manufacturing companies to not only expand their internal operations but also focus on integrating their suppliers into the whole value chain practice [2]. Port logistics with the antiquity of thousands of years has developed along the development of international trade. Around 90 percent of the world's merchandise trade is transported by ships. It encompasses 40 percent dry bulks, 38 percent liquid bulks, 14 percent containers and 8 per cent general cargo. This percentage and the volume commodities trade are changing over the last century [3-5]. Globalisation has allowed producers to relocate their production and assembly plants to more cost-efficient locations in developing economies, in turn generating a new spatial division of labour and it is increased the demand for ocean transport [6]. From the supply chain perspective, the role of ports can be defined as part of a group of entities in which different transport and logistics operators are involved in bringing value to the final consumers. Ports have become a linking point in larger logistics chain in a global distribution channel. A higher level of collaboration and coordination is needed for these distribution channels to be successful [7]. The conjunction of logistics and port transport may be mostly attributed to the physical integration of modes of transport facilitated by containerisation and the evolving demands of end-customers that

require the application of logistics practices. At the centre of port logistics is the concept of integration, be it physical (intermodal), economic/strategic (vertical integration, governance structure) or organisational (relational, people and process integration across Organisation) [8]. Although some similarities can be found between previous studies, it is necessary to take one step backwards and define logistics integration based on its critical factors. The current study aims to identify critical factors in port logistics integration (PLI) and propose a conceptual framework to measure PLI.

This article is structured as follows: section 2 presents the methodology and process of conducting the study including finding related journals and papers. In section 3, related literature will be reviewed. Section 4 is related to the main part of this study, which is proposing the conceptual framework. Section 5 describes the research propositions, implications and contributions of the current study. Finally, section 6 presents conclusions, limitations and future research opportunities.

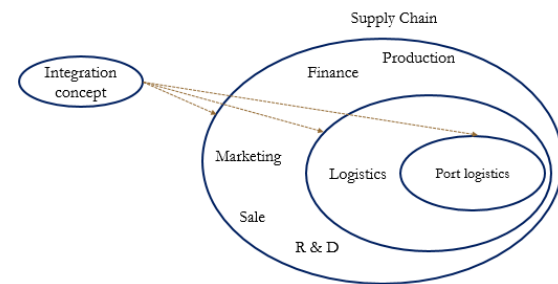
## 2. Methodology

The process of literature review is followed by Keele [9] method which includes: Planning the review (recognize rationale for review, starting the review, set the research question, develop and evaluate the review protocol), conducting the review (research identification, primary studies selection, quality assessment, data extraction and monitoring, synthesising the findings) and reporting the review (identify dissemination process, set a proper format, evaluate the final report). According to this aim, the main research question defined as follows:

Main research question: what are the critical factors of port logistics integration?

As mentioned above the literature review process begins with recognising the rationale for review. The rationale can be identified through problem formulation which is about what field is being examined and what is exactly its components or issues? So, due to the research problems and research questions, the keywords are divided into four main area: integration concept, logistics management, logistics/supply chain integration and port logistics integration. Various resources

selected to find suitable databases and articles in this area.



The most popular publishers such as Taylor and Francis, Elsevier, Emerald, Scopus, Thompson Reuters, google scholar and endnote search engine (web of Science) used to collect papers. Most of selected articles are extracted from highly cited journals such as Journal of operations management, The International Journal of Logistics Management, Journal of Business Logistics, International Journal of Physical Distribution & Logistics Management, Supply Chain Management: An International Journal, Maritime Policy & Management, Journal of Transport Economics and Policy, Transportation Journal, The Asian Journal of Shipping and Logistics.

After finalising searching articles, all the papers conveyed to endnote software and categorised by keyword. The total number of papers was 1809 papers. Selection criteria were determined to decide to include or exclude the papers. A large number of papers excluded from reading the title, keywords and date of publishing. Because new insight into maritime logistics is started since 2000, this paper filtered the articles based on their date of publishing which is after 2000. Other criteria for excluding papers were abstract reading, the source of publication, abstract reading, type of study, the main focus, study design, implication, publish date and finally reading the full text of the paper. Totally, approximately 78 highly related papers were selected out of 1809 papers. In order to decrease the risk of bias, types of extracting of data were planned before defining the project [10]. Then, the details of the main studies summarised in form of Microsoft word. Two tables designed to extract the study details: the first one was on logistics integration as a general concept without any focus to specialised industry, the second one was related to port logistics integration, which is limited to the papers belonging to the seaport and

maritime sector. Table 1 is extracted from the two main tables.

### 3. Literature review on port logistics integration

#### a. Logistics integration

Logistics management refers to the planning, implementing and controlling of the forward and reverse flow and storage of merchandises, related information and services between the point of origin and the point of consumption, to build efficient and profitable processes to meet customer needs [11]. It is also one of the important parts of a supply chain [12]. Tseng, Y-y, Yue and Taylor [13] introduce logistics as a part of supply chain process which comprise three stages, namely inbound logistics (handling the materials received from suppliers), material management (movement of materials within the firm) and physical distribution (transition of goods from final line in company to the customers). Logistics system comprises three main stages: logistics services, information systems and resources or infrastructures [14]. First two streams are about information and physical (material) flow and the second stream is about infrastructure and resources, which have a supportive role in logistics systems. Summarising the relevant studies in logistics integration shows that there are four main streams in this area.

- Internal-external view [15-17]
- Process integration view [18]
- Physical- information flow [19]
- Actors (partner) view [20, 21]

The first point of view have more strategic and organisational view to logistics integration activities. The most notable shortage of this approach is just focusing on the relationship between suppliers and customers without considering internal integration [15]. Almost all of the studies in process integration approach are in manufacturing and production sections and their central attention was on activities such as customer relationship management, customer service management, demand management, order fulfilment, manufacturing flow management and quality management. It is clear that this approach

considers business functions such as production and sale and other activities, which is more about supply chain integration rather than focusing on logistics integration activities [22]. The physical-information flow have an operational view to logistics integration and this approach which has been proposed with factors such as lean and agile logistics systems and enterprise resource planning system [23] and lean and agile information and operational integration in service sectors such as ports [24]. The last approach is about partner (actor) integration, which has been recently discussed in logistics integration studies. This approach mostly focused on the relationship between partners, the resources and infrastructures. This approach fills the gap in analysing logistics integration with focusing on the relationship between partners [25] as well as functional integration such as information and physical integrations.

Traditionally, ports have played a central role in cooperating-port logistics partners (providing infrastructure, setting the strategic plan and loading/unloading cargo). Nowadays, ports are considered clusters of organisations that aim at creating value for the supply chain [26]. Logistic integration in the port sector has rarely been studied in research papers [26]. According to Tseng and Liao [27], port logistics integration is important for two reasons. Firstly, the focus of the supply chain in manufacturing companies is on supplier integration, while, in service supply chain or specifically in port logistics the role of partner integration (like ports and container shipping firms) is much more important. Secondly, the port supply chain is more complex than the manufacturing supply chain due to its global service features and the uncertainty of market and customer demands. Wilmsmeier and Notteboom [28] believe that supply chains in ports are becoming more market-driven due to the need to respond to the increasing demands of customers in this sector.

A body of literature has examined the causes, patterns and implications of the integration of logistics in the port sector [29, 30]. Logistics integration and the changing role of port authorities in the new logistics-restructured environment is addressed by Notteboom and Winkelmanns [29]. Robinson [30] places the role of seaports within a new paradigm of ports as elements in value-driven chain systems. Bichou and Gray [31] study reveal

that logistics integration in ports can be defined in two different ways. The first perspective is about intermodalism, which defines as inter-links between nodes and transport modes in the port logistics system. The second view is related to organisational integration and partnership, which is about logistics channel restructuring and considering the relationship between port logistics chain partners. Notteboom and Rodrigue [32] added an important view of port regionalisation to port logistics integration literature. They propose the importance of inland terminals and relationship between different ports in a region to develop the level of port logistics integration. Panayides and Song [33] limited port logistics integration definition to effective collaboration of four functions in logistics system of the port information and communication systems, value-added services, multimodal systems and operations and supply chain integration practices. To sum up, port logistics integration means integration between functions and actors of the port.

#### **b. Logistics in seaports**

Seaports are considered as commercial, historic and infrastructural assets, which form the backbone of national and regional economies. These large entities consist of several services and activities (functions). Alderton and Saieva [34] state that port functions can be divided into three main groups administrative functions, operational functions and civil engineering functions. Administrative functions focus on port commuting control, environmental control, safety and security, dangerous goods, health and customs control. Operational functions include the use of berths and sheds, loading and discharging storage and cargo distribution, Pilotage, tugging and mooring activities and finally, civil engineering activities encompass infrastructure development, sea and land access, road and rail network and industrial area management. In another category, port services can be divided into three main activities and functions: Marine services (nautical infrastructure), terminal services (quay and berth infrastructure), logistics and value-added services (port superstructure) [35]. In sum, providing the base (infrastructure) for the seaports is the most important function.

#### **c. Influential factors and issues in port logistics integration**

Based on process and activities, which has been mentioned in the previous section, influential factors in logistics integration of port will be reviewed in this part. These factors divided into two major categories in port context, partners (actor) of the port logistics system and the relationship between them [36] and activities and functions [26, 33, 37, 38]. As mentioned before in logistics integration context, there is a gap in partner integration approach specifically in port context. Next section will identify and explain port logistics chain actors and their relationships. The other influencing factors to port logistics integration are related to actors and activities in the port logistics chain. In activities and functions part, the study will focus on series of studies by Song and Panayides [26] and the factors related to resources and infrastructures of logistics system which haven't been investigated before in port logistics integration studies.

#### **d. Partner (actor) integration in the port sector**

As mentioned above this section will discuss the port logistics chain partners and the relationships and integration, which can happen in the port system. One of the studies in partner integration is Kalwani and Narayandas [39] study, which worked on the long-term relationship between supply chain partners. They stated that a long-term relationship with specific customers related directly to sales growth and increased profitability. Also, in order to have acceptable synchronisation with partners, setting appropriate governance structures in ports is seen as essential. One of the most valuable works in this area has been done by Carbone and Martino [40] in the potential role of ports in the automotive supply chain. They introduced 'relationships between the port operators and the focal firm', 'supplied services that add value', 'information and communication technologies', and 'performance measurement' factors as common variables for integrating supply chain partners. Paixão and Bernard Marlow [24], as well as Marlow and Casaca [41], worked on lean and agile concepts in the port industry, which had never been studied before. They proposed some factors in a framework to increase integration and add value to the port

supply chain. They encompassed the capability to deliver suitable services, to manage the capacity of sending cargo in terms of time and path length so as to set the optimum time, to change processes and set a flexible ordering method to meet customers' expectations every time, to provide infrastructures in the hinterland and foreland of the port to have suitable access to rail or road. They stated that lean and agile strategies can improve firm performance. According to Notteboom [36], different parties were engaged in internal port activities, which encompassed logistics service providers, transport operators (rail, road, barge and Short Sea), shipping lines, port authorities and terminal operators.

According to Fabbe-Costes and Jahre [42]-, one important factor of logistics/supply chain integration was the integration of actors. In this section, key actors in port logistics are identified and discussed. Figure 2 shows the different actors in the port logistics system and the relationship between the actors of each port, and the ports' relationships which each other.

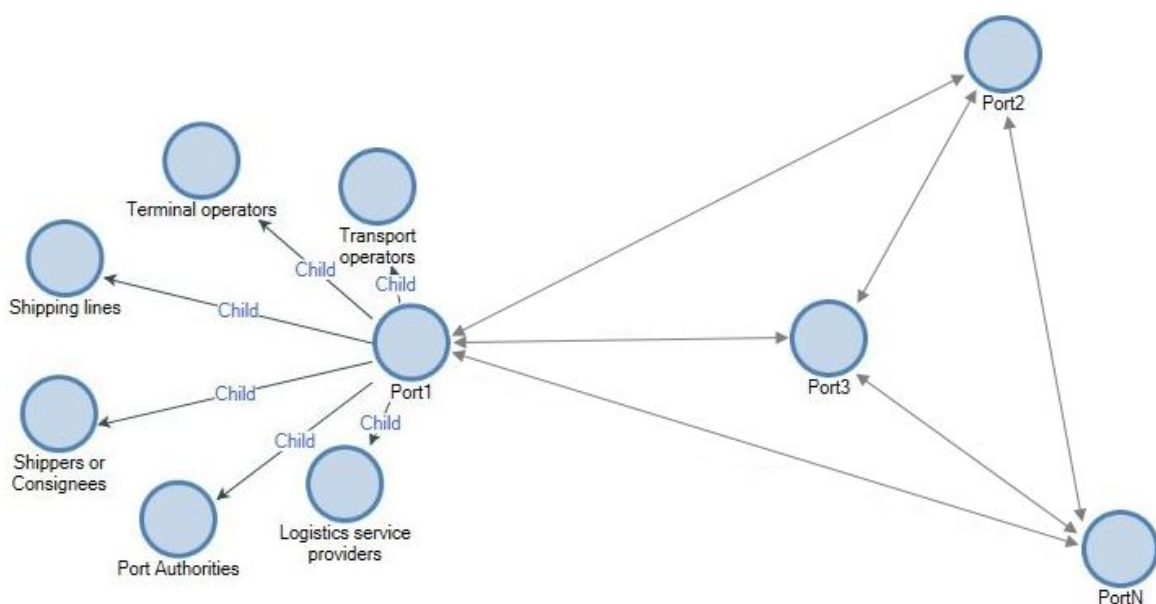


Figure 2. Actors (Partner) integration in the port sector

#### 4. A conceptual framework for port logistics integration

This section is aimed at developing a conceptual framework for port logistics integration. The framework indicates key influential factors as well as current challenges in port logistics integration. Such a conceptual framework is needed for various reasons such as extend previous studies and fill the gap, develop logistics integration framework for seaport industry and identify challenges in port logistics.

This section explains the process of developing a conceptual framework for this study. Literature review in logistics integration in general contexts shows the gap between mentioned factors. In this

section, the key factors regarding port logistics integration are going to discuss briefly. Based on Tseng, Yue [13] definition of a logistics system, it comprises three main sections: logistics information systems, operations and physical activities and logistics infrastructures and resources. Efficient collaboration between these main areas will lead to an integrated logistics system. Dominant studies in logistics integration in the port sector focused on operations and information parts of a logistics system and resources and infrastructures have not been studied as indicators of integrated logistics system in the port sector [26, 33, 36, 38, 43].

This section has covered this gap in logistics literature consider all the measures. Seven main factors have been recognised in the literature review:

- Information and communication integration,
- Value-added services,
- Processes and operations,
- Logistics integration practices
- Organisational activities,
- Institutional support,
- Resource sharing

First four factors have been used in previous studies in port logistics integration and this study developed those factors based on recent

developments in literature and practical environment. Based on the literature gap, which is mentioned earlier, the contribution of this study is adding logistics infrastructure factor (organisational activities, institutional support and resource sharing) which has rarely been studied in port logistics integration studies. Table 1 shows detailed information about each proposed factor, subfactors/variables, references and definition and description.

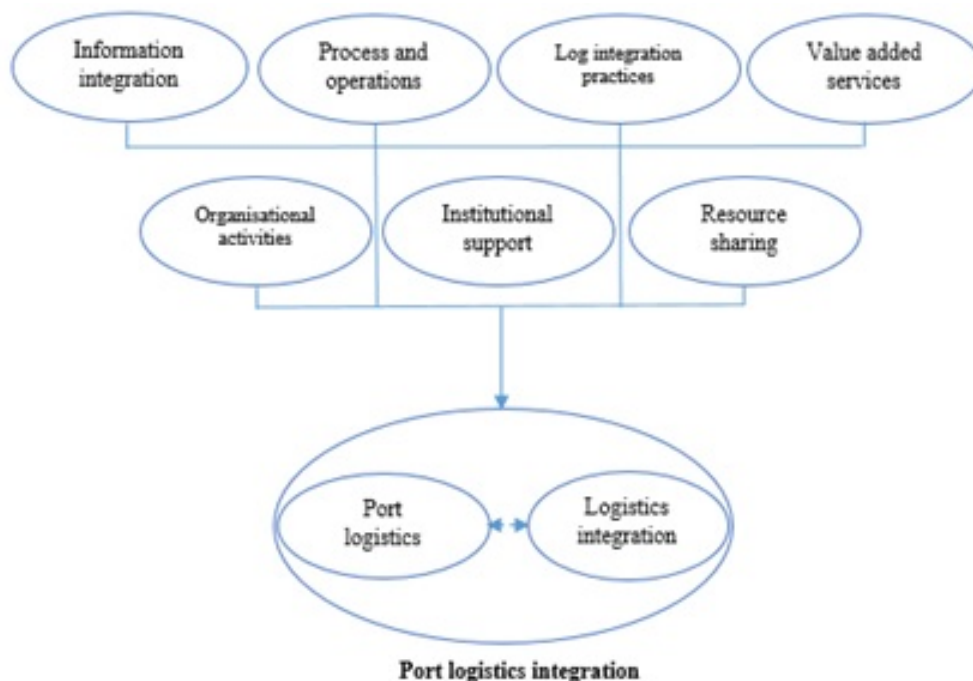


Figure 3. The conceptual framework of the study

Table 1. Factors and dimensions defines port logistics integration

Dimension	Variables	Authors	Description
<b>Information and Communication Integration</b>	Information technology use	[44, 45] [46]	Newly updated tools, facilities and technologies which are used or going to be used in a specific context such as global digital trading network, IT-based alarm and notification systems, Vessel traffic services (VTSS), Innovative logistics technologies, warehouse management system

			(WMS)
	Information attributes	[45, 47] [48]	Forms and types, availability and quality. Forms are related to the type or mode in which information can be delivered to its users such as accuracy, usefulness, reliability and completeness
	Information sharing practices	[45, 49-57]	Overlapping practices for sharing the same information (e.g. timetables) are in use such as traditional methods, advanced communication methods (EDI, ERP, and intranet), face-to-face interactions
	Collaborative functions	[45] [58, 59]	Information sharing itself could not be enough and some socio-technical factors should be included in it. Integration of information sharing with intensives and decision-making, measurement system integration and function process alignment should be joint
<b>Value-added services</b>	Inventory management, distribution centre and warehousing facilities ,pre-assembly, manufacturing, packaging, maintenance and repair facilities, convey cargo through diversified routes/modes, quick decisions regarding changing design processes, postponement, reverse logistics activities,	[26, 33, 37, 60, 61] [62-66] [30] [40] [31] [67] [68] [69] [70] [60, 71]	Activities along the supply chain, which designed to increase partners efficiency and effectiveness and final customers satisfaction.
<b>Process and Operations</b>	Modal shift level, intelligent clearance, Ships connectivity/operability with inland transportation, Joint transport planning Standard , quality service level, improve the security of transport, relationship with SC partners, Schedule transfer times	[36, 72] [73] [74] [75] [24, 26, 33, 37, 76-79]	Coordinating activities in the hinterland to achieve integrated logistics system such as multimodal transport and physical movement of cargoes
<b>Logistics Practices</b>	Evaluating alternative routes, Collaboration with channel members, Benchmark logistics management options, Integrated promotion activities, Identifying least-cost options,	[26, 31, 32, 80-83]	Integrated activities, processes and procedures firm's boundaries activities, which leads to the performance of the firm
<b>Organisational Activities</b>	- Sharing risks, costs and rewards, - Create/maintain long-term relationships with partners - Joint search for end-customer	[22] [44, 84-90] [60, 91]	Constant connections and apparent relationships among all supply chain partners

	satisfaction		
	- Encouraging teamwork		
	- Establish common performance indicators		
<b>Institutional Support</b>	- Financial support for logistics providers	[84] [12, 92] [86, 87, 93-95] [96-99]	Number of forces through relevant institutions, which affect a firm's relationships with its partners social, economic and political factors include governmental policies, financial institutions and educational
	- Approving business loans/microcredit facilities		
	- Facilitating leases		
	- Assessing inter-relationships among logistics functions		
	- Providing vocational education		
	- Organising, inviting and assisting participation in seminars, conferences		
<b>Resource Sharing</b>	- Involve the supply chain members in the decision-making process	[1, 19, 22, 89, 100-107] [108] [109]	Collaboration based on trust and the dependence between supply chain partners
	- Search for an optimal subcontracting		
	- Design and joint development of packaging		
	- Reduce costs and ensure quality		
	- Use of common containers, packaging and transportation		
	- Search for optimisation in the procurement and distribution of materials		

## 5. Conceptual and theoretical background

The proposed conceptual framework is built upon a key aspect of two extend theories: supply chain management and resource dependency theory [12]. Supply chain management has been adopted by various fields such as quality revolution, materials management and integrated logistics networks structure, industrial marketing management, the notion of increased focus and industry-specific studies [110]. Logistics integration is an approach based on SCM, which is developed and applied with the purpose of utilising the supply chain in order to afford effective performance and respond to customer needs. Resource dependency theory (RDT) states that firms are dependent on interactions and relationships with other parties. Based on RDT theory, handling the external dependencies and resources (both in physical and skill-based) with supply chain partners can decrease uncertainty. Considering this theory in

logistics and supply chain context, RDT suggests supply chain partners would be dependent and collaborate with each other, it can guarantee greater performance improvements in the long-term period [12]. According to this theory, resource-sharing activities would be one of the crucial practices to achieve an integrated logistics system. The institutional theory is about profound and robust dimensions of social configuration [111]. It is "a widely accepted theoretical posture that emphasizes rational myths, isomorphism, and legitimacy" [112]. This theory also defined as figurative and behavioural systems comprising representational, constitutional, and normative rubrics, together with regularity mechanisms, which describe a common meaning system and give rise to distinctive partners and action routines [113]. In Supply chain and logistics contexts, there is a couple of studies, which emphasise the importance of the institutional environment on supply chain development. In addition, institutional forces (such as government, financial institutions and educational centres) affect



a firm's operational processes through supply chain integration practices. Resource base view is focusing on core assets and capabilities of the firm to sustain and increase its competitive advantage and performance. In other words, successful firms are those can create and apply a bundle of valuable tangible (physical resources, such as equipment and funds) or intangible resources (include all benefits firm gain from its processes and functions, such as reputation, brand, knowledge and organisational culture) in their supply chains, which can be protected from acquisition and imitation [114] [115]. In the supply chain context, it can affect channel integration as well as logistics/supply chain performance [82]. It can also incorporate logistics context by focusing on tangible and intangible resources of the firms in their supply chain and managing the organisational activities between supply chain partners in order to reach an integrated logistics system.

## 6. Discussion

Logistics integration is a crucial element to the transportation and logistics sector especially seaports due to their nodal role in international transport and logistics. A higher level of integration also helps improve the operational efficiency as well as the competitiveness of freight and logistics providers. This further creates positive impacts on other elements of the supply chain and the economy. An efficient shipping system is influential in joining separate activities, as it includes one-third of the logistic costs and considerably affects logistics system performance [13]. A literature review revealed a wide variety of factors and dimensions, which makes it difficult to compare findings and reach a determined framework. There several examples of frameworks and research papers point out in this study in previous sections. Logistics integration in the port sector is presented in different ways. Tseng and Liao [27] focus on information integration, process and operations factors. On the other hand, Song and Panayides [26] create a framework with 7 constructs, namely information and communication technology, relationship with shipping line, value-added service, integration of transport modes, relationship with inland transport operators and channel integration practices and performance. Later they focused their study on four factors: Information and communication systems, Value added services, Multimodal systems and operations

and Supply chain integration practices [33, 37]. However, Bae [43] considered internal and external factors as dimensions of PLI. In another study, Wilmsmeier, Monios [76] more specifically looked at port hinterland integration factors such as modal shift, customs clearance and dwell time, load centre, metropolitan accessibility, rail and road regulation, cargo security and land acquisition.

On the other hand, Resource sharing activities and coordination between resources between supply chain members were one of the main concerns in logistics/ supply chain integration studies [22, 100, 102, 103, 106, 116]. Furthermore, by looking from a strategic perspective to logistics integration managing the relationships among supply chain partners can be classified as organisational integration activities [12, 22, 90]. There is a number of studies mentioning the impacts of different institutions (specifically governmental institutions) on logistics integration in the literature [117] [118]. These scattered examples and lack of consensus on factors lead the study to propose a conceptual framework to bring these ideas together and have comprehensive insight into port logistics integration [22, 119].

## 7. Conclusion

The main aim of the study is to identify influential factors in port logistics integration and contributes to a clarification of the concept of integrated logistics and its factors. Besides, the other purpose of the paper is highlighting the role of internal (e.g., organisational activities, resource sharing) and external (e.g. Institutional support) actors on port logistics integration. This study has a number of theoretical and practical implications. In terms of theoretical implications, the current study proposes a new conceptual framework to analyse port logistics integration. The proposed framework considers the drawbacks and limitations of previous frameworks such as focusing on port supply chain partners rather than functions to identify the level of integration with each partner. A close relationship between supply chain partners and the integration of their functions and activities make integration such an important topic and objective in every system [20]. Moreover, this study considers the developments in each function (such as information integration) in recent literature and proposes a comprehensive framework to fill the gaps.

The main limitation of this study is no primary research has been conducted to validate the conceptual framework. The other limitation is about a large number of studies using the concept of integration and differentiate between these studies and finding a most relative study to logistics integration; specifically, the subtle difference between supply chain integration and logistics integration. For this, the study may not cover all studies out there. However, an organised process has been used to select related journals, papers, reports and books as explained in the methodology section.

Research results and conceptual framework shed the lights on new research areas in terms of port logistics integration outputs. In this regard, several researchers have mentioned the importance of integrated logistics to improve overall efficiency and performance of the logistics chain. In other words, results of the logistics integration should be revealed in the overall performance of the logistics chain. Researchers have agreed on the relationship between logistics integration and its impact on different types of performance for instance: organisational performance [1], logistics performance [80], business performance [120], inbound supply performance [2], operational performance [56], firm performance [16], financial and market performance [18], supply chain performance [121].

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