

THE ROLES AND RELATIONS BETWEEN SEA AND DRY PORTS IN THE LOGISTICS CHAIN

Dr. Abdulla Wanis Tabet

Dr. Mousa Saleh Sharedy

Assistant Professor, the higher institute of marine science technologies-Khoms –Libya

Assistant Professor, the higher institute of marine science technologies-Sabratha –Libya

nouraw@gmail.com

mshredi79@gmail.com

ABSTRACT:

This paper aims to describe roles and relations between sea port and dry port (DP) within logistic chain using descriptive and panel research approaches. In so doing, the author reviews number of related academic literature that contain keywords related to DP, sea port and logistics chain without any time restrictions. The study summarizes that the term sea port is clear and well known, while DP is an emergence and modern concept. Moreover, although DP can facilitate cargo/freight flows between sea port and inland nodes, an implementation of DP concept in an existing transport system or network generates the problem of locating DP terminals, allocation of container flows and environmental issues as well. The study proves that the logistics chain required to be evolved with the global development and changes of maritime transport pattern in order to keep the competitive of port or terminals.

Keywords: Sea Port, Dry Port, Inland Terminal, Supply Chain, Logistics.

المستخلص

تهدف هذه الورقة لشرح دور كل من الميناء البحري والميناء الجاف والعلاقة بينهما ضمن السلسلة اللوجستية، وقد أستخدم الباحثان المنهج الوصفي لدراسة الحالة مع الاستعانة ببيانات لوجية، ولتحقيق أهداف الدراسة استعرض الباحثان عدداً من الأدبيات العالمية ذات الصلة بموضوع الدراسة وبدون أي حدود زمنية ، وتم استخدام كلمات مفتاحية مثل ميناء جاف وميناء بحري وسلسلة لوجستية. لقد خلصت الدراسة الى أن مصطلح ميناء بحري هو مصطلح شائع ولايكتنفه الغموض، وفي المقابل فأن مصطلح ميناء جاف هو مصطلح ناشئ، كما خلصت الدراسة ايضاً الى أنه على الرغم من ان الميناء الجاف يُسهل عمليات تدفق السلع بين الميناء البحري والمحطات بالبر إلا أن تطبيقه في نظام أو شبكة نقل قائمة سيسبب صعوبات ومشاكل منها صعوبة تحديد مواقع المحطات، وتخصيص تدفقات الحاويات، فضلاً عن المشاكل البيئية.

إجمالاً، لقد أثبتت الدراسة أن سلاسل الإمداد اللوجستي يجب أن تتطور مع التطورات العالمية والتغيرات في أنماط النقل البحري للحفاظ على القدرة التنافسية للموانئ.

كلمات مفتاحية: ميناء بحري، ميناء جاف، محطات بالبر، سلاسل امداد، لوجستيات.

1- INTRODUCTION

Transport is the second largest category of commercial services after the tourism sector. However, transport infrastructure facilitates global trade development and maritime supply chains are composed of international transport services, ports and terminals as it plays a vital role in logistics and supply chain management (SCM) activities. Transport has a crucial place within international trade, which relies on the movement of goods from one point to another (Haralambides H., 2008).

Furthermore, maritime transport services sector is one of the pillars of the globalized economy, transport also plays a significant role as an agent of the globalization, as it is considered as being one of the four cornerstones of the globalization together with trade liberalization, telecommunications and international standardization (Wanis, A., 2018).

In comparison with other transport modes, the maritime transport is the cheapest but the slowest mode, for instance; ships are capable of carrying as much as half a million tons of cargo each time. Thus, now a days 90% of all the goods and commodities travel by sea. Thus, an increase in sea freight flows generates an almost proportional increase inland freight flow. In line with this growth and to fulfilment of its requirements, the infrastructure of sea ports has been developed

Basically, the global trade passes through multiple routes via multiple transport modes which require number of trans-shipments hubs. In very broad words, the global traded goods depend on logistics which become increasingly complex. Logistics and SCM, however, are integrated among various business functions and progresses, with the aim of minimizing costs, maximizing benefits and profit and thus generating customer satisfaction (Obasi c., et al., 2024).

In addition to this, the global supply chains (SCs) connect markets, labor, and parts with resources, while, SCM is the coordination and organization of a complex network of activities delivering a finished product to the end and right users or customers in the right time. It includes customer satisfaction, customer relations, financial flow and information flow by making logistics functions a more integrated and complex group of activities (Burns, M., 2015).

Sea port or coastal terminal plays a crucial role within the SC, as sea transport represents approximately 90% of the global trade these days. However, sea port as an important

component in the transport system is affected by a wide range of economic, technological and geopolitical developments. In other words, sea ports are functioning as platforms within global CSs and global production networks. Sea ports, however, face number of challenges and difficulties due to a steady increase in the volume of merchandise trade especially containerized cargoes. Moreover, lack of space in sea ports as a result of an evolution of maritime traffic and surface transport means due to insufficient number of access routes to terminals.

Fundamentally, logistics is about movement and storage of goods from the point of origin to the point of destination in the right time. The sea port, however, is considered as a center of the logistics activities. According to (Hlali and Wanis, 2021), the logistics chain, however, matches to sea / inland port(s) activities of which a part rises of turnover is connected with the port(s), logistics chain control requires a good control of the different flows. Fig -1 shows the information, physical and financial flows in logistics chain.

So far, as a main component of global logistics system, the maritime logistics can play a key role in developing a strong global supply chain system through a smooth operation of maritime transport operations.

Before the containerization revolution in later 1950s, sea ports or coastal terminals have always been the only gateway (nodes) for the international commercial trade. It has a positive impact on ports and liner shipping in three aspects: cargo safety and security, transport speed and transport connectivity. Although these advantages, (Mohammad, 2022) claimed that there is a steady increasing congestion and bottle-neck in sea port yards and gates.

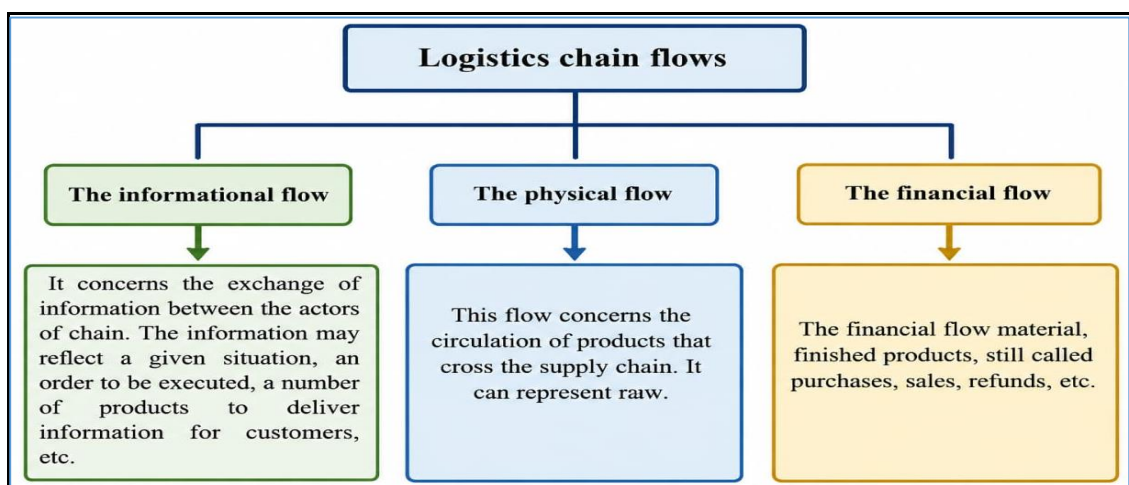


Figure (1) Logistics chain flow

(Source: Hlali and Wanis, 2021)

He added, over time, “DP” expression is the most frequently used instead of the inland terminals/nodes expression. Fig -2 displays the maritime logistics which consist of shipping activities, freight forward activities and operation of ports from any kind.

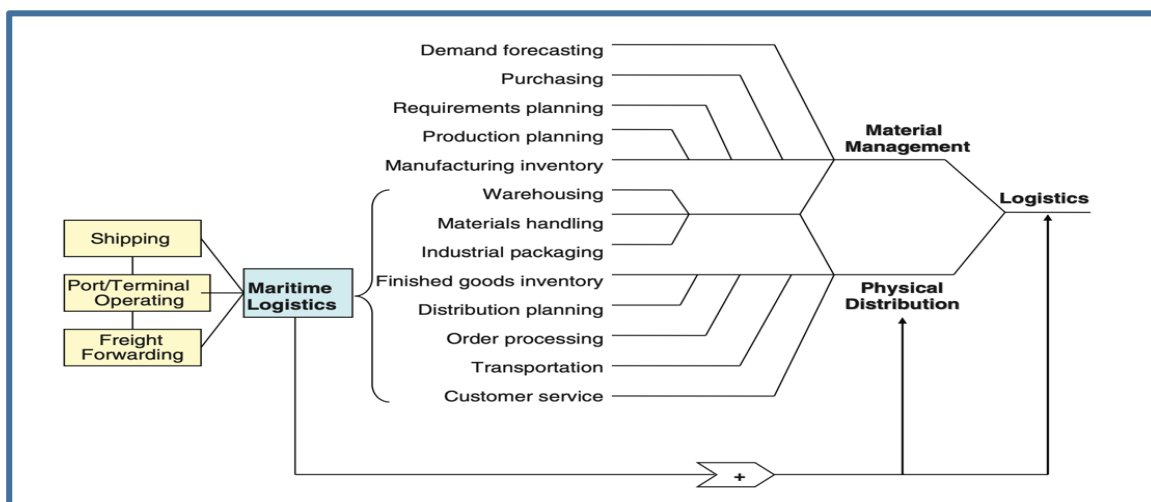


Figure (2) The relationship between maritime logistics and the logistics system as a whole

(Source: Mohammad, 2022)

So far, in order to achieve study aims, this study is motivated to narrow the research gap by answering the following research questions:

Q1- what is the role of sea port and DP independently?

Q2- what is the relationship between those kinds of ports and logistics chain?

The rest of this paper is organized as follows: after this introductory section, the next section will review the related literature. Section Three is devoted to describe the used methodology, while study outcomes provided in the Section Four. Study conclusion is furnished in the Fifth and final section.

2- LITERATURE REVIEW

Literature review constitutes one specific stage within scientific research process. It is a vital feature of the academic research, as knowledge advancement must be built on the prior existing works. It aims to present and evaluate the body of literature, as well as to recognize the potential research gap(s). In this research, the review relied on online available literature. In this regard, activities of maritime transport have direct and positive relations with the global economy performance and world trade volume (Kothari, 2004). According to (Notteboom et al., 2013) that concept of logistics was first introduced in the early 1960s. It aims to minimize firms' costs and maximize customer satisfaction.

However, logistics is a part of SCM as it plans, implements, and controls the efficient and effective forward and opposed flow as well as cargo storage, services and the related information between points of origin and destination.

In addition, maritime transport emphasizes individual functions relating to sea transport while maritime logistics which is a system which encompasses all the activities involved in both maritime transport and logistics management. As a systematic entity of the logistics integration, it is largely concerned with an efficient and effective flow of the entirety through logistics system .

Moreover, function of transport in the maritime logistics system is to carry and handle cargo through the ocean and broadly connect transportation connections between the sender and recipient of the goods. In Indonesia, as many as 88% of goods transported between regions use sea transportation services Table-1 clarifies the main differences between concepts and roles of maritime logistics and maritime transport (Amin, 2025).

Table-1 Differences between of maritime logistics and maritime transport concepts and roles

Maritime Logistics	Maritime transport
The process of planning, implementing and managing the movement of goods and information which is involved in the ocean carriage.	The process of carrying and handling goods/ cargoes across the oceans.
Maritime logistics is concerned with not only individual functions relating to sea transport, but also an effective logistics flow as a systematic entity of the logistics integration system.	Maritime transport emphasizes individual functions relating to sea transport and each function pursues its own aims or competitiveness.
Activities: contracting, shipping, sea voyage, moving cargo, and loading/unloading (discharging).	Activities: contracting, shipping, sea voyage, moving cargo, and loading/unloading (discharging).

(Source: Khaslavskaya, and Roso,, 2020)

Although there is no consensus on DP and inland terminals terminologies, the first study concerning inland terminals and DP date back to 1984. In this way, (Jaržemskis and Vasiliauskas, 2007) studied DPs using a systematic literature review (SLR) approach. They found DP and inland terminals concepts have been evident within academia as the numbers of publications have grown every year. However, among number of DP definitions the most widely used, the definition was suggested by (Amin , 2025) who

describes DP as “a port situated in the hinterland servicing an industrial/commercial region connected with one or several sea ports with high-capacity transport means, where customers can leave/pick up their standardized units as if directly to a sea port.”

In the same way, DP is an intermodal facility or a kind of transport hubs that helps facilitate hinterland transport including; depositing, transferring, assembling, and controlling cargo flow. In other words, DP can facilitate more feasible and efficient combinations of sea cargo flows and inland flows especially with rail and truck combinations and through providing value-added services offerings at nodes for both; domestic or transit goods (Roso et al., 2009). They differ in site and position, purpose and task, ownership and management structure, and launching processes. Although this, DP are distinguished from conventional inland terminals by the services offered at DP, as well as by their function.

Notteboom et al., (2020) stated that, although there are no two DPs are the same, the DPs exist in very different forms and arrangements under the different terms around the globe. Added to this, an establishment of DP brings number of advantages to sea ports, shippers, environment, railway companies and society as shown in the Table-2

Table-2 Advantages of DPs

DP advantages	
Sea ports	Reduce congestion and bottle neck at access points, Facilitate inventory management, Positive influence on the cost of storage, Increase the storage capacity of goods, and Facilitate and increase the speed of services.
Shippers	Reduce transportation cost, Reduce storage costs, and Facilitate access to sea ports
Environment	Reduction of influence of CO ₂ caused by emissions from trucks
Society	Reduction of traffic congestion, Develop commercial transport flows, More benefits for landlocked countries, and More jobs in areas near DP.
Railway companies	Diversification of the commercial offer.

(Source: Lamii, 2020)

As main component of waterway transport system, the sea ports/terminals are found along coastline while DP is located remotely from seas and oceans but with a direct access to them, and in comparison with sea ports characteristics, DP has three basic characteristics including; an intermodal terminal, connection with a port terminal through a high capacity

corridor and an array of logistics activities, while development of inter-modalism concept requires consideration of three of its attributes: transport links, transport nodes, and provision of efficient services (Notteboom et al., 2017).

Regarding regulations and policies controlled the DP, as shown in Fig-3, there is a lack of clear policies and institutional arrangements, or competing interests among actors can pose severe threats to the selection of locations for sea and DPs.

Moreover, digitization of transport documents and veterinary certificates and acceptance of digital documentation at DP always are considered as a key challenge for logistical operation. In contrast, there is coordination between DP and sea port can be impeded due to lack of regulations, or due to various difficulties in sea port operation which might be enhanced by DP utilization.

In terms of types and functions of DPs, as inland nodes, it may; close (satellite terminals), mid- range (trans-loading terminal) and distant DPs (load centers). Broadly speaking, the close DPs or satellite terminals are located close to sea ports and less than 50 km. They act as extensions of sea ports. A mid-range DPs or trans-loading terminal is set in the middle point between a sea port and its end market between 50 and 500 km, while distant DPs or load centers are situated in the proximity of the end markets of 500 km or more (Nguyen and Notteboom, 2019).

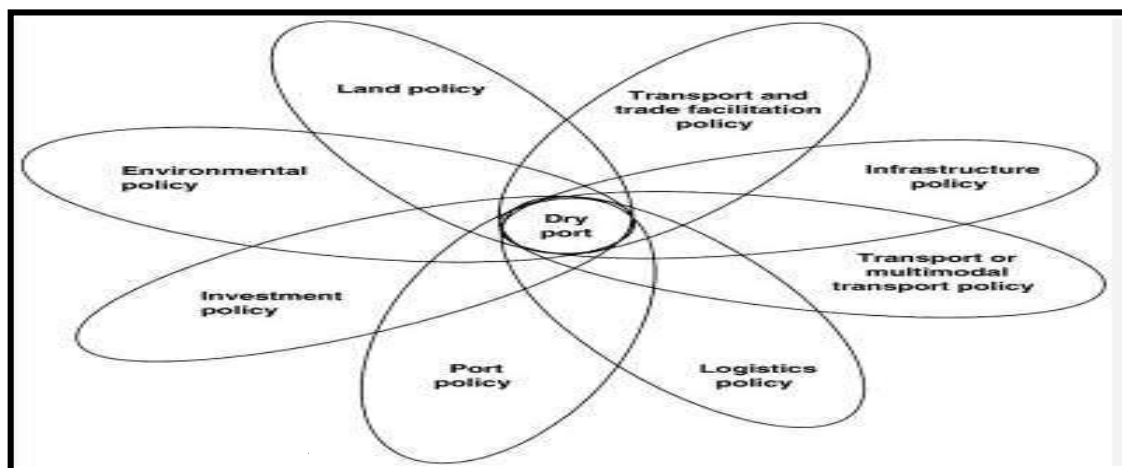


Figure (3) Policies and regulations related to DPs

(Source: Saha and Khali, 2025)

On the other hand, Roso (2007) claimed that DPs can play a vital role in economic corridors development. As shown in Fig-4 that DP is developed to serve economic zones, such as export-based industrial areas or import-based markets. In other words, DP can

serve as important logistics hubs for industrial zones and contribute to regional economic development increase market share and promote regional integration and development.

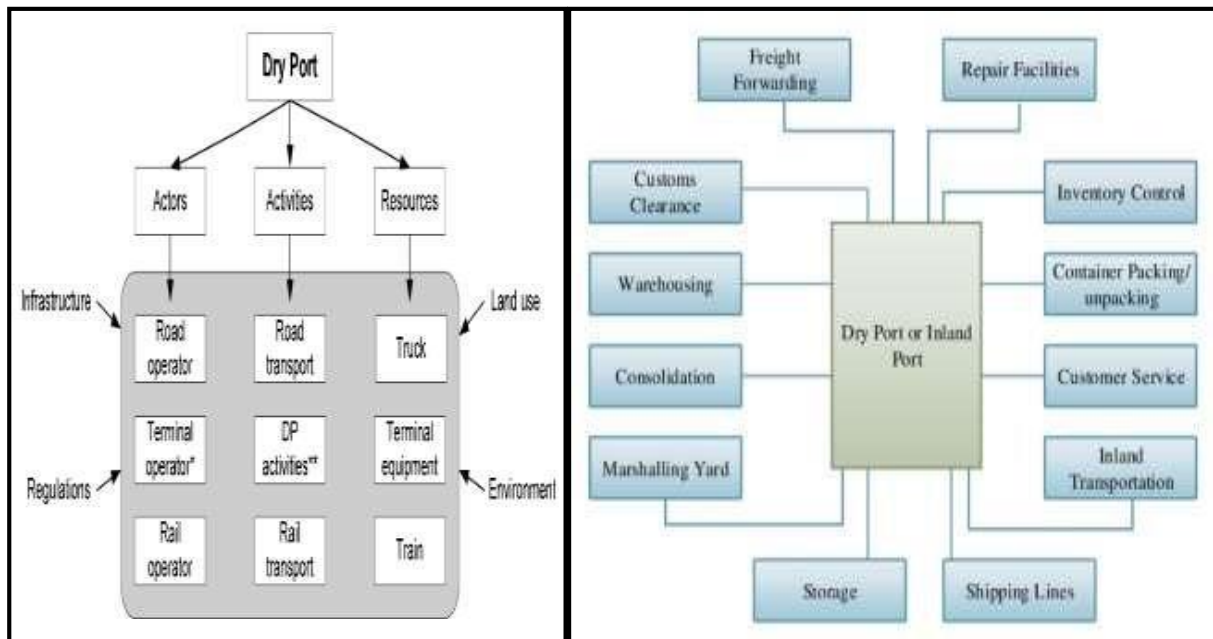


Figure (4) Roles and functions of DP

(Source: Roso, 2007)

On the other hand, Until the 1970s, most studies on sea ports were published in books. They were primarily describing developments and situations in sea ports around the world. This is because the research was hardly grounded in theoretical concepts and did not employ advanced research designs. Since 1973 when Maritime Policy and Management Journal established, the number of port-related papers grew steadily (Mohammad, 2022). In the context of sea port generations, Hlali and Wanis (2021) clarified that sea ports have evolved through several generations. The first generation (until the 1960s), in this generation the role of sea port is an interface between terrestrial and maritime links for goods transport. In the second generation (1960s-1970s) the sea ports constituted a center for transport, industrial and commercial activities.

Broadly speaking, after the introduction of container in 1960s the formation of shipping is highly changed. This development resulted the re-structuring in port systems of the various regions. Liner shipping is cumulated in the major ports and large ships and a requirement of feeder ships to transport commodities from major ports to small ports and feeder services is raised

In the third generation (1980s-2000) sea port role changed to become more integrated with transport systems and first logistics platform and or logistics hub was appeared in this generation. Finally, the fourth generation of sea ports (since 2000) has become logistics networks and term of port community system (PCS) was very common concept. Finally, since 2011, the concept of the fifth generation of sea ports defines the sea port as an integrated and sustainable SC. In this generation, sea port services meet customers and stakeholder s requirements. In other words, the sea port became a community rather than a logistics hub.

In context of SC integration and as shown in Fig-5, the sea port is considered as a sensitive link in the port logistics chain. As a complex system, it plays a crucial role where it handles and transports of goods and containerized cargoes, while sea/dry port performance depends on both; strategic and tactical operational decisions which made by different levels of port managers through logistics chain and global supply chain. (Mohammad, 2022).

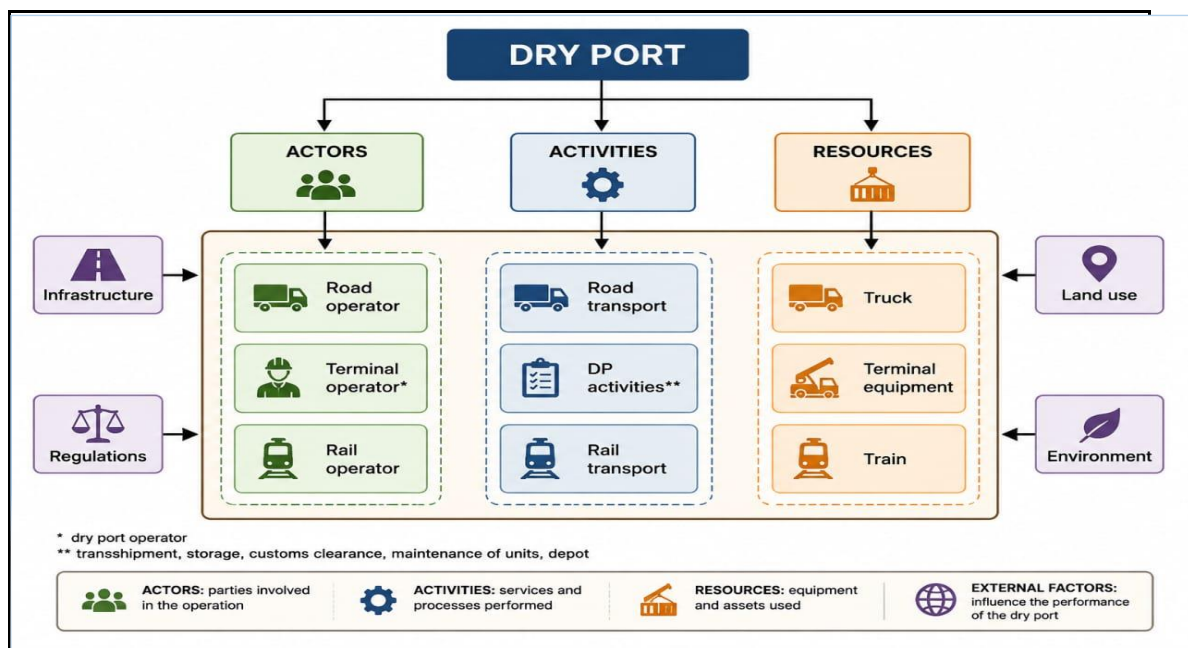


Figure (5) Activities and actors of DP

(Source: Roso, 2007)

Thus, in parallel to developments in international trade, logistics and SCM can rapidly transform and develop businesses. In this way, port efficiency, customs environment, regulatory environment and service sector infrastructure are 4 main indicators for trade facilitation. (Wilson, et al., 2003).

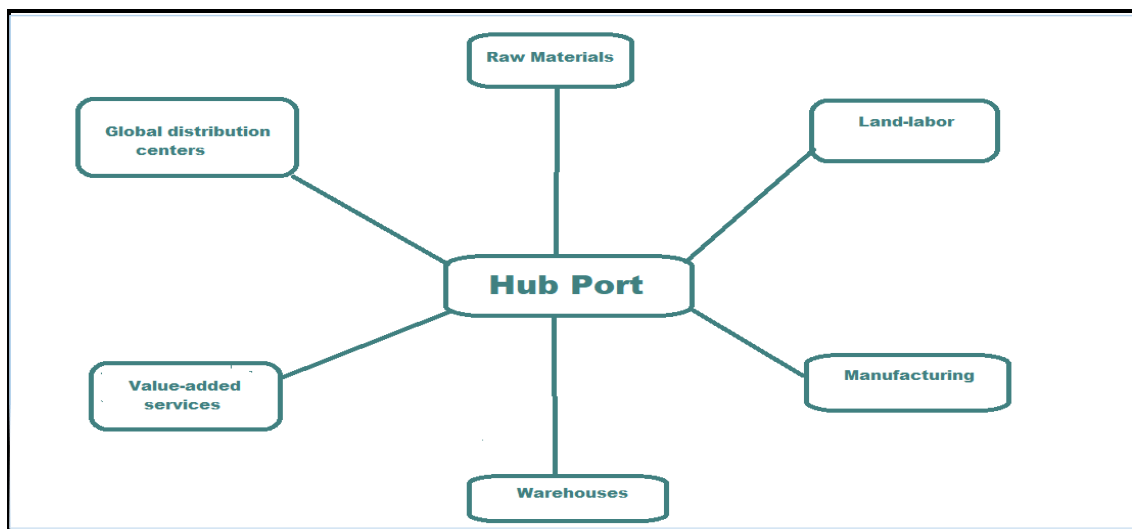


Figure (6) Port integration in the global supply chain (GSC)

(Source: Roso, Woxenius and Lumsden, 2009)

In terms of SC integration, the maritime logistics pass through four layers, Fig-6 proven that whereas the manufacturer as a first party logistics service. (1PL) normally responsible for production and product sales, a second party logistics services (2PL) is intended to provide land/surface transport services. In the same way, whereas a third-party logistics service provider (3PL) usually invests in warehouses and transport assets, a fourth party logistics service provider (4PL) restricts to IT-based supply chain design (Roso and Lumsden, 2009).

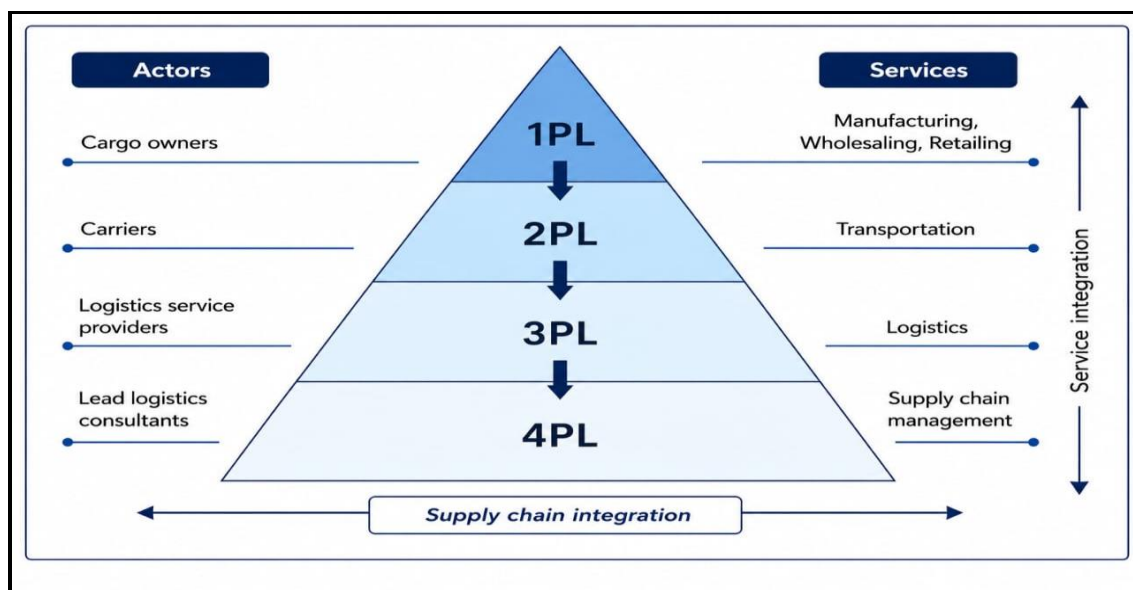


Figure (7) Maritime logistics services

(Source: Roso and Lumsden, 2009)

To sum up, the reviewed literature has investigated the development of DP and sea port concepts, location, roles and relations in respect of SC. Also, it has clarified that interest in the topic has been evident within academia; the number of publications has grown every year since 2009.

METHODOLOGY

Quantitative research method is widely used in the natural and social sciences which dealing in numbers, logic, and an objective stance (Kothari, 2004). Thus, in order to achieve study goals, the study employed descriptive and panel data research approaches through reviewing number of related literature without any time restrictions, because the descriptive research as a quantitative research method is a research method that aims to accurately and systematically describe a population, situation, or phenomenon, as well as using panel data is more appropriate in this sort of scientific research. However, the author used Science Direct, Taylor and Francis and Google Scholar databases and search engines to filter the extant literature related only to sea ports, DPs and maritime logistics concepts.

3- RESULTS AND DISCUSSION

This section provides analysis of the reviewed literature, as well as, to answer research questions. First of all, a DP enables a gateway sea port or airport to shift inland for the shipper to complete all transactions relating to maritime/air transport of the shipment. Regardless of their dimensions, site and specifications, the sea ports are essentially designed to provide shelter to open sea and ocean-going vessels (Roso and Lumsden, 2009). In context of port authorities' role, it can play an important role in the process of inland distribution by applying new innovation for gaining competitive advantages with other national and or regional sea ports throughout SC and networks.

DP or inland terminal as a logistics solution plays a significant role in the transport chain through the important function of “connecting” sea port to its hinterland. Added to this vital role, it can reduce sea port constraints, develop hinterland access and might be economic zone facilitation. In terms of international trade, DP secures inland location for handling, temporary storage, inspection and customs clearance of goods. However, there are numerous factors that affect the location of sea ports are proximity to DPs; connections to other transport modes, development costs, operation costs, transport cost and environmental concerns.

The main features of a DP are: intermodal terminal; situated inland; rail connection to a sea port with scheduled and reliable services; offers services that are available at freight terminals and at sea terminals/ports, for instance; maintenance of containers, container storage, freight forward, road hauling; and customs clearance. Broadly speaking, the DP provides customs clearance and also act as a transfer point of freights from one mode to another transport mode. Moreover, it is an essential node for coastal and landlocked countries that ensures freight flow along SC (Burns, 2015).

DP operations in the landlocked countries, on the other hand, depend on the operation of sea ports located in other counties and the evolution of DPs in landlocked countries is starting to overcome their physical challenges. In other words, the special economic areas and free trade zones as freight hubs should be close to or adjacent to the DP which is providing special tax incentives. Also, the DP in the landlocked states can promote intermodal transport and provide transfer and trans-shipment functions along with customs clearance facilities.

In terms of intermodal transport, the growing containerized transport is the main problems facing sea ports, despite the heavy investments in container terminal capacity, larger flows of containers severely strain sea port operations. Thus, it is important to note that, although the most important benefit of containerization is in the reduction of terminal costs, it was converted from a labour- intensive industry to a capital-intensive industry due to using the advance equipment and technologies. Similarly, although DP should bring numerous benefits to the actors of the transport system, there are numerous impediments to the implementation of DP concept, such as regulations, environment, land use, infrastructure and might sea ports lose a significant portion of their profits (Roso and Lumsden ,2009). To this end, sea ports and terminals constitute the central component of maritime supply chain while the DP concept has changed, over time, from a simple infrastructure exchange point to a real solution for maritime transport. As logistic nodes, the DP is well connected to sea port and located away from the sea, close to land/surface transport means. In case of container terminals, DP helps improve terminal efficiency due to reduction of yard and or gates congestion.

Regarding answer of the first question: the DP functions are similar to the sea port except for the connection with the sea. However, the DP needs to meet the following standards

in order to be considered an inland terminal: (i) it has a direct connection to the port/s, by road as well as by rail and/or river, (ii) it has a “corridor” with strong transport capacity available, or be positioned on it, (iii) be equipped with suitable structures and machineries, compatible with the reference port/s, and (iv) it can play a collection and distribution role at local and regional level (Roso and Lumsden, 2009).

Regarding answer of the second question: DP plays a significant role in SCM and can mitigates sea port problems as it plays as an inland extension to sea port, but it should be connected strongly to the sea port through a high capacity of transport means. However, implementing sea and DPs is an intensive investment task in which there could be numerous preferences to get funds.

Finally, in case of landlocked states the country's trade passes through the shore side to the sea side access which is mostly governed by a public organization: transport of cargo in transit by the most convenient routes is usually crossing free of fiscal duties. Thus, the landlocked nations have a limited selection or option of sea ports and need to accept other states' decisions on which sea ports will be put at their disposal due to geographic limitation (Yang and Chang, 2019).

To conclude, establishment of DP, on the other hand, is a significant tool for improving the efficiency of intermodal cargo transfers and can increase regional integration and competitiveness levels of landlocked countries. In short, the evolution of DP in the landlocked countries is starting to overcome their physical challenges such as isolation, supply chain-related barriers from the sea ports and high costs of trading with other traders in other parts of the world (UNCRD, 2018).

4- STUDY CONCLUSION AND CLOSING REMARKS

Although the terminology sea port is well known through the academic production, there seems to be no consensus on the DP terminology resulting in a wide range of terms, including DPs, inland terminals, inland ports, inland hubs, inland logistics centers and inland freight villages, this is because it lies in the multiple shapes and forms, purposes and network positions. Although this, the concept of DP has gained significant interest among practitioners and researchers since 2010.

The first reading of results attained from this study that DP is s one of main facilities in multimodal transport networks which helps expand the coverage of sea ports while

providing hinterland access to nearby coastal terminals or DPs facilitate improved logistics solutions for the shippers and ports in the port's hinterland through shifting freight volumes away from sea port yards. Accordingly, although implementation DP concept as a sustainable logistics solution, involves significant investments for the owners, it should be arranged as a joint venture of all beneficiary stakeholders.

The next reading of study results, although the DP role is freight trans-shipment or shifting sea port services to an inland region, its role may include storage and cargo consolidation and customs clearance services. In contrast, sea ports are considered as logistics nodes with a heavy-duty nautical character as it designed to provide facilities and equipment for seagoing vessels including; cargo loading and discharging, livestock and passengers. This means that the DP as an inland element has become crucial in shaping the competitive strategies of sea ports.

DP are differed in site, purpose, maturity level, ownership structure, and origination processes. Although this, DP are distinguished from conventional inland terminals by the services offered at DP, as well as by their function. Moreover, and in terms of port location, the study results reveal that sea port is the source / central point of maritime logistics chain while DP is periphery or boundary in the logistics chain. However, implementation of DP concept in the logistics network must be accompanied by an adequate infrastructure investment and adequate technical- technological and structural changes in its intermodal transport system also.

In keeping with literature review section, the main problem sea port facing today is resulted from the steady growing of containerized transport, this leads to lack of space at sea port terminals and increased bottlenecks in the land-side transport system serving the sea ports [10]. Similarly, DP face the problems are associated with the planning, operation, and regulation of hinterland transportation networks.

Another reading of results attained from this study that with DP implementation, the DP can mitigate sea port's problems and difficulties, such as port congestion which was resulted from numerous surface transport means (trucks and trains).

Although this, using land transport means will increase local pollution and road accidents and there is a necessity to road maintenance. Added to this, DPs in coastal and landlocked

regions may face similar or different operational challenges, depending on their geographic location, transport system and economic development.

The importance of the DP concept is reflected in the fact that it enables sea port especially container terminals to expand their capacity in conditions of space limitations because container logistics has two key problems or concerns: container acquisition and empty container reposition. Thus, by perception of DP concept must first of all be accompanied by adequate infrastructure investments and technical-technological. Second, structural changes of intermodal transport system that should be able to respond to the continual growth in the volume of international trade flows.

Last but not the least, DP contributes positively to the regional economic development as it can serve as important logistics hubs for industrial zones, as well as can promote regional integration and development.

The main contributions of this research can be summarized as follows. First, it provided general knowledge about the terminology of sea ports, dry ports and maritime logistic chain. Second, it clearly distinguishes between DPs and inland ports, maritime logistics chain and logistics chain. Third, it presented function of each element of maritime logistics chain. Fourth, this research aggregating the policies and regulations related to DPs.

It is important to note that this study is only limited to sea port and DP concepts, roles, activities and their relationship within logistic chain

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