Container Supply Chain Management: Facts, Problems, Solution

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Abstract—**This paper presents the review of facts, problems, and solution to the container supply chain management. It starts with the important of containerization system as it holds good characteristics of sea transportation. It can transport lot of products while minimize the damage of goods. The history of how maritime route is also described in this paper. It reveals the international trade and geographic are the most important factors in establishing maritime routes since long time ago. Supply chain management of container which is the main carrier in maritime transport is presented and shows that there are four main players in managing the container. After an intensive review of containerization system's problem, the most common problem which all parties has encountered is an imbalance between demand and supply of container. The well-known solution to the problem in container management is optimization technique which aims to minimize operation cost.**

Index Terms—**Container management, Maritime transport, Containerization system, Imbalanced container problem, Port and Container terminal management.**

I. INTRODUCTION

Maritime or Sea transport has supported an international trade since at least two millennia ago [1] because it can carry lots of freight over a long distance. The well known international trade countries using sea transportation in the past are China and Egypt [1], [2] using bulk system. Since 1960s, the efforts has been developed the global trade capability in several ways and containerization has been introduced since then [3]. The containerization system is a revolution of freight transportation and becomes popular in maritime industry. That is because many types of cargo can be loaded into the container and can be connected from production sites to customer sites using intermodal transportation all over the world with the minimum damage [4], [5], [6]. Rate of growth of containerization has increased sharply and has dominated bulk cargo at present. The proportion of bulk cargo per container cargo in maritime transport in 2010 is 36: 64 [7]. Because of high growth in the necessity of container to support intermodal transportation, therefore the main problem for container shipping is about how to properly reposition empty containers while minimizing cost. This paper aims to review fact, problem, and solution of container management in maritime transport. It comprises of 5 sections: (1) introduction states about fact and importance of containerization systems in maritime transport, (2) fact about maritime route, (3) supply chain of container management, (4) review of container management problems and solutions, and (5) conclusion and recommendation.

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II. GEOGRAPHICAL DIVERSIFICATION OF MARITIME ROUTES

In the past, a maritime route was established by using international trade factor [8]. The example of famous routes are Egypt – Sumatra which is a trade connection route between Egypt and Asia, Egypt – European colony which is a trade connection route between Egypt and European countries, and Suez and Panama canal which connect between North America, Europe, and Asia Pacific [9]. At present, globalization has become an important issue and allows a global trade without borders around the world. Therefore, the graphical diversification is another factor that has been taken into consideration in establishing maritime route. In 2010, there are total of 385 maritime service routes around the world [10]. Those routes comprise of three major types of maritime routes: Port-to-port, Pendulum, and Round-the World, which can be explained in Figure 1 and can be roughly shown routes around the world in Figure 2 [8].

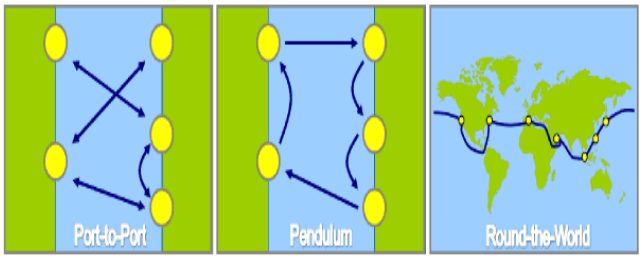

Figure 1: type of maritime routes
Source: http://people.hofstra.edu/geotrans/eng/content.html

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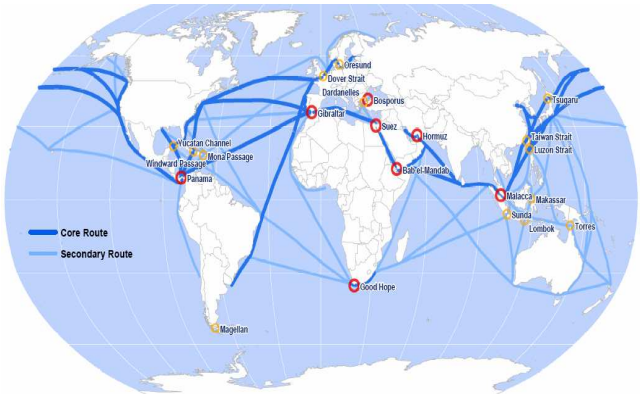

Figure 2: The main maritime routes [8]
Source: http://people.hofstra.edu/geotrans/eng/content.html

III. Supply Chain of Container Management

Maritime transport plays the important role for an export industry, since it carries goods from productions to customers through several mode of transportation. Nowadays, containerization system has become main carrier in maritime transport due to its several merits. When there is demand in exporting product from production site to customers, the demand of container occurs. The information about demand of container will be sent to freight forwarder or shipping company and then forwarded to the owner of the shipping liner company. The container will be allocated by principal. Port or container depot will prepare container as directed by the principal and then ship it to the exporter [11]. Therefore, there are four parties in the supply chain of container – principal, port, container depot, and customer as shown in Figure 3.

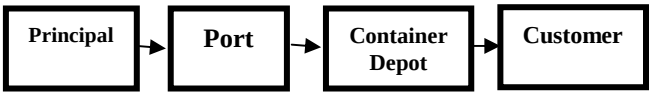

Figure 3: Supply Chain of container management

IV. Review of Container Management Problems and Solutions.

From previous two sections, they have stated that there are efforts to solve the supply chain management of containerization systems in maritime transport. However, there are still problems which can't be solved or can't efficiently solve. After intensively review 27 literatures [12] – [38], the researchers are trying to solve problems of containerization systems in maritime transport in different parts of the world using optimization technique. Ref [12] – [23] are in Asia and ref [24] – [32] are in Europe which both share same problems of imbalance of empty container and fleet management. Ref [33] – [37] are in USA confronts with the congestion of port and insufficient of port infrastructures. Only one paper is a problem in Australia states about inefficient of container distribution [38]. Table I shows the classification of these papers according to the problems associated with main players in container supply chain which are principal, port, container depot, and customer. In addition, Table II reveals the objective function and constraints of an optimization model in [12] – [38].

TABLE I. Associated problem with all players in container supply chain.

Players	Problems
Principal	- Imbalance of empty container [12] - Container allocation problem [18], [28]
Port	- Imbalance of empty container [12], [15], [24], [32], [33], [35] - Container allocation problem [18], [26], [27], [28], [31], [36] - Trade imbalance [13], [30], [33], [34], [35] - Uncertain demand on port [20], [21], [22], [23], [29] - Movement and flow of empty container [14], [16], [19] - Container's scheduling problem [25] - Distribution planning problem [38]
Container Depot	- Imbalance of empty container [12], [15], [17], [24], [27] - Container allocation problem [14], [16], [18], [26], [28], [29], [31], [32] - Fleet management [19] - Uncertain demand on port [20], [21], [22], [23] - Container's scheduling problem [25] - Movement and flow of empty container [36], [37] - Trade imbalance [30], [33], [35] - Distribution planning problem [38]
Customer	- Imbalance of empty container [12], [15], [17] - Container allocation problem [14], [18], [27], [28], [32] - Movement and flow of empty container [16] - Fleet management [19] - Uncertain demand on port [20], [29] - Movement and flow of empty container [36], [37] - Container allocation [36]

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TABLE II. Objective function and constraints used in solving container management problem.

Authors	Objective Function	Constraints
[12]	Minimize holding cost.	Vessel capacity, stochastic demand, container fleet size.
[13]	Minimize operation cost	Volume of containers, vessel capacity.
[14]	Maximize profit	Time schedule of vessel departure,
[15]	Minimize cost	Volume of containers, distance.
[16]	Minimize cost	Volume of containers
[17]	Minimize Operating cost	Volume of containers
[18]	Minimize Operating cost	Volume of containers
[19]	Minimize Operating cost	Volume of containers
[20]	Minimize Operating cost	Volume of container, type and size, demand cost
[21]	Minimize Operating cost	Volume of containers
[22]	Minimize cost	Demand & supply/ flow capacity/ customer's demand
[23]	Minimize cost	Volume of empty containers, integer constraints
[24]	Minimize cost	Volume of containers
[25]	Minimize total cost	Volume of containers
[26]	Minimize cost	O/D distance
[27]	Minimize cost	Network, transportation capacity
[28]	Minimize cost	Vehicle capacity, volume of containers
[29]	Minimize variable cost	Volume of containers, collaborative container-vessel scheduling,
[30]	Minimize cost	Volume of containers,
[31]	Minimize Operating cost	Volume of containers, flow capacity
[32]	Minimize cost	Demand , supply in multi–port
[33]	Minimize cost	Volume of empties
[34]	Minimize cost	Constraints; demand vs. supply/flow capacity/ customer movement.
[35]	Minimize cost	Volume. of containers ,type, demand cost
[36]	Minimize cost	Demand cost, no of container, flow balance
[37]	Minimize cost	Volume of containers,
[38]	Minimize cost	Volume of containers ,type, demand cost

V. CONCLUSION AND RECOMMENDATION OF FUTURE RESEARCH

From all above sections, this paper discovers fact of how important of sea transportation are since long time ago. It also shows the connection of sea transportation to the maritime transport and how the containerization system has existed to serve a maritime transport. The supply chain management of the container systems shows that the main players are principal, port, container depot, and customer. None of these players have no problems. Most common problem is imbalance of empty container. The methodology which is commonly used to solve the problem is optimization technique with objective function of minimizing cost of operations.

Since the authors are now living in Thailand which do not has its own fleet. Therefore, it is not possible that we can efficiently allocate container to support all needs. Hence, the authors have not seen that the relocating of container is the main problem as shown in other papers or researches. The main problem which needs to be solved by the government is how to allocate the limited number of containers to the exporter. This has to be done in order to minimize the opportunity loss which might occur if the exporter is not assigned the container when needed. This future research is considered as new concept in container management and will provide the great contribution for other countries which face the same problem as Thailand.

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Notation

Container Terminal: The area designated for the storage of cargoes in container, usually accessible by truck, railroad and marine transportation.

Maritime transport: Movement of cargo containers interchangeably are operated by shipping liner.

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