Container Inventory Management: Factors influencing Container Interchange

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ABSTRACT

Efficient and effective management of empty containers and empty container repositioning is an important issue in the liner shipping industry. Many alliance agreements of carriers have provisions to interchange containers but not practiced in real life scenario. It is hard to find any previous literature on container exchange except the technical details of alliance agreements. The researchers reiterate the conditions provided in carriers' alliance agreements to interchange containers and in principle recommend container interchange as an efficient and effective container inventory management mechanism. Accordingly, the research attempts to find the factors that influence container interchange between carriers. The research was conducted in Sri Lanka. Researchers believe that the sample is adequate because 16 container carriers in the world top 20 list presently call port of Colombo in Sri Lanka. A series of interviews followed by a questionnaire survey have been carried out and data were analysed mainly using Chi-Square Tests. This would lead to understand the critical factors that influence container exchange and thereby develop efficient, sustainable and effective mechanism for container inventory management through container interchange. The study concluded that five factors namely, operational, legal, branding, benefits, and feasibility may influence the container interchange by carriers. There were two limitations noted in the research; the reluctance to provide information pertaining to container inventory by carriers; and the common dislike of carriers to participate in surveys due to their busy work schedules. These findings would help practitioners to expedite the process of developing a user-friendly container interchange system. In addition, this research will fill the serious gap in the present literature on container exchange and provide an incentive to further research on this topic. The container imbalance is a global issue and finding an efficient and effective solution is vital.

Key words: container, inventory, management, shipping, maritime, exchange

INTRODUCTION

Container inventory management (CIM) is a highly complicated issue due the high volatality of the container demand and supply. Shipping is not a direct demand , but a derived demand of the international trade. Theerfore carriers are faced with a dilema to strike a blance between the demand and suppy. The present CIM solution are reative rather than proactive. The need for an effective CIM comes in to play under such market conditions. The total existing fully cellular[1] fleet as at 29th August 2016 (all sizes / all positions) stands at 6,082 fully cellular ships for 20,707,620 TEU (Alphaliner, 2016).

'Container' means, an article of transport equipment of a permanent character and accordingly strong enough to be suitable for repeated use (ICSC, 1972) or any type of container, transportable tank or flat, swap body, or any similar unit load used to consolidate goods, and any equipment ancillary to such unit load (United Nations, 2009). Container ships and containers are supplementary to each other thus Container Shipping Lines (CSL) cannot transport cargo if containers are not available. Containers[2] are capable of transporting efficiently over long distances, and facilitate multimodal transport without intermediate reloading at any mid points. The very common method the carriers apply in balancing the supply and demand is reposition of excess containers to where those are deficit. However this is a costly excersice. Efficient and effective management of empty containers (Song & Carter, 2009) and empty container repositioning is an important issue (Dong, et al., 2013) in the liner[3] shipping industry. In the global context of container traffic, the largest share of containers is in the status of repositioning (Karmelić, et al., 2012). Generally, container shipping companies reposition empty containers from surplus ports to deficit ports. As a result, obviously, there is a cost involved in balancing the container fleet by respective shipping lines. According to Kamelic, et al.(2012) estimated empty container repositioning costs alone accounted for USD 20 billion on the global level in 2002. Management of empty containers not only create an economic effect, but it also has an environmental impact (Song & Carter, 2009) because the ever-increasing empty container movements will also increase

[1] Cellular fleet – the fleet of Container vessels

[2] Container - A truck trailer body that can be detached from the chassis for loading into a vessel, a rail car or stacked in a container depot. Containers may be ventilated, insulated, refrigerated, flat rack, vehicle rack, open top, bulk liquid or equipped with interior devices. A container may be 20 feet, 40 feet, 45 feet, 48 feet or 53 feet in length, 8'0" or 8'6" in width, and 8'6" or 9'6" in height.

[3] A liner service is a fleet of ships, with a common ownership or management, which provide a fixed service, at regular intervals, between named ports, and offer transport to any goods in the catchment area served by those ports and ready for transit by their sailing dates (Stopford, 2009).

fuel consumption, congestion and emissions thus the pressure being placed on the shipping industry over carbon emissions (BMI, 2012).

From the society point of view, the consequences (i.e. cost and environmental hazards) of the container fleet imbalance are ultimately borne by Exporters, Importers, Consumers, Traders and even other players in the cargo supply chain of international trade inadvertently. Given the nature of commercial shipping business carriers always have the liberty to recover the additional costs as a part of the freight. Leading carriers have already implemented Container Imbalance Surcharge adding a direct cost to the consumer. Maersk Line, (2013) advised their customers that the equipment imbalance surcharge was implemented due to an increasingly severe equipment imbalance at Toronto container yards, leading to significantly higher empty repositioning costs. Therefore, finding a solution to mitigate such impact would benefit primary shippers, consignees and shipping lines and then countries, regions and whole world at macro level.

The growing container inventory imbalance (CII) creates substantial additional expenses as well as environmental issues globally. Although the carriers identified the container exchange as a solution to the CII it has failed in its implementation. Therefore, main objective of the research is to explore the potential factors that influence container interchange by carriers. Other objectives include,

1. To find the impact of operational implications on container interchange
2. To understand the perceived legal implications on container interchange
3. To identify the potential negative impacts on marketing and brand name have an impact on container interchange
4. To find if the unavailability of mechanism that quantify financial and non-financial benefits have an impact on container interchange
5. To investigate the carriers' presumption about the feasibility to interchange has an impact on container interchange
6. To study the if revealing confidential data to competitor lines have an impact on container interchange
7. To understand the carriers' reluctance to associate with competitor lines have an impact on container interchange

This would help carriers develop a user friendly, effective, and efficient container interchange system and solve container inventory imbalance problem. And given the complexity of the issue the findings of the research will encourage further research on this subject.

LITERATURE REVIEW

It is hard to find any previous literature that specifically discusses the container exchange. However, it would be necessary to understand the general background of container shipping; root cause of CII; and other solutions for CII. World's very first all-container ship "Gateway city" was found in 1950 (Cudahy, 2006) and containerization was commercially implemented in the US in the mid 1950s (Bernhofen, et al., 2013) and is the driver of the twentieth century economic globalization and world container port throughput increased by an estimated 3.8 per cent to 601.8 million 20-foot equivalent units (TEUs) in 2012 (UNCTAD, 2013). Technically, containers are governed by the ISO (the International Standards Organization) and the CSC (the Container Safety Convention). In 1968, the ISO defined a container as an 'article of transport equipment'(Alderton, 2004). The system, that proved its potential as an increasingly efficient and swift method of transport, led to greatly reduced transport costs, and supported a vast increase in international trade. A considerable amount of investments has been made in purchasing containers and vessels and building port infrastructures. (Dong, et al., 2013) Container ports provide the primary interface where physical exchange between buyers and sellers of containerized shipping capacity can be consolidated and realized (Yapa & Notteboomа, 2011). The container fleet size and the complexity of the container shipping network (Dong, et al., 2013) have increased dramatically bringing more challenges to the operation of the container shipping system. Cross-border transportation is an engine to promote the foreign trade (Zhihong & Qi, 2012). As the inventory grow bigger; the more inventory issues started appearing. This obviously opened the eyes of maritime experts and many researchers have been conducted in last few decades. Containers are usually supplied to exporters for stuffing of cargo at respective ports by the agents of carriers (Some exporters have their own container fleet for private use and this study does not consider their practices). One of the most striking developments in the global economy since World War II has been the tremendous growth in international trade (Bernhofen, et al., 2013). Shipping is a business that grew up with the world economy ,exploring and exploiting the ebb and flow of trade (Stopford, 2009). From 1981 to 2009, global transport of containerized cargo increased approximately 3.3 times faster than the world's GDP (UNCTAD secretariat, 2011). Commercial traffic never seems to be in balance (YUR & Esmer, 2011).

The root cause of CII

The CII is primarily caused due the quantity variation of the two type of global container movements. The key movents of containers are liiustraed in firure 1.

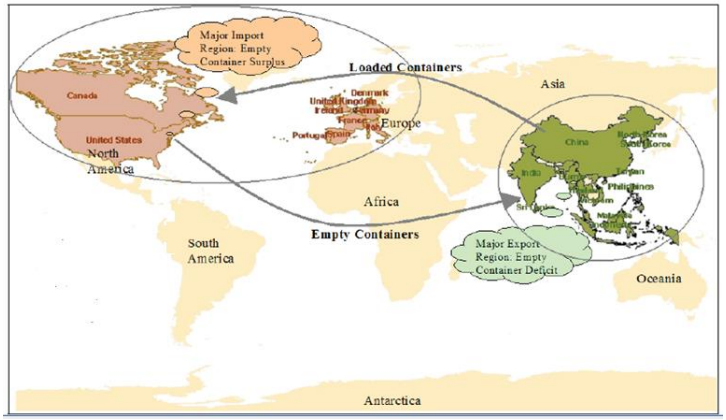

Figure1: Current Practice in Global Container supply chain, Source :(Mittal, 2008)

Because of the trade and weight imbalance, transpacific carriers need to return substantial numbers of empty containers back to Asia (FMC, 2012). Container liner shipping not only suffers from lower volumes, but also has to endure cheaper freight rates (Mason & Nair, 2013).

Very rarely the shipping lines have a well-balanced container inventory due to many practical reasons such as international trade patterns and the consequence of imbalances in the worldwide trade distribution (Karmelić, et al., 2012), uncertainties of customer demands, widespread allocation of container ports and customers, and the dynamic nature and increased complexity of the container shipping (Dong, et al., 2013) and the type of commodities to be moved etc.

Some Container Shipping Lines (CSL) experience a deficit of containers while others are faced with an excess inventory at a given location at a particular time leading to many complications for both parties. Exporters have limited patience and container shipping is a highly competitive sector. Therefore, unmet demands within a given period due to insufficient empty containers will be lost (Dong, et al., 2013). Different repositioning policy may incur significantly different operational cost. (Dong, et al., 2013). This includes Port Handling Costs (PHC), Slot fee for the sea passage, land transport costs, ground rent and handing costs at CFS etc. in addition to those direct costs, the cost of ware and tare, and

cleaning etc. are also to be considered. It is needless to say that these costs would eventually result in higher transport charges to shippers and consignees thus high commodity prices owing to the additional costs that will be incorporated in the freight rates[4] by CSL. As explained elsewhere, the container imbalance is widening as the trade grow year by year. The figure 2 explains the global container market demand growth and figure 3 provides the container supply including the estimate until 2017.

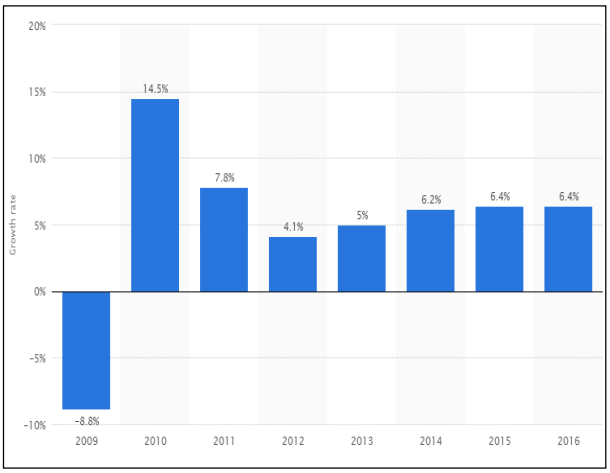

Figure 2: Projected global container market demand growth from 2009 to 2016

(Source: www.stati sta.com, 2014)

BIMCO continues to expect the container shipping industry to steer itself along the lines of the "new normal", where a demand growth of 5-6% must be matched by an equivalent supply growth. There will be no more double-digit growth figures as in the past decades. For 2014, the fleet is expected to grow by 5.2% – a low level not seen for 15 years. (www.bimco.org, 2014)

[4] Transport charge applied in the shipping industry

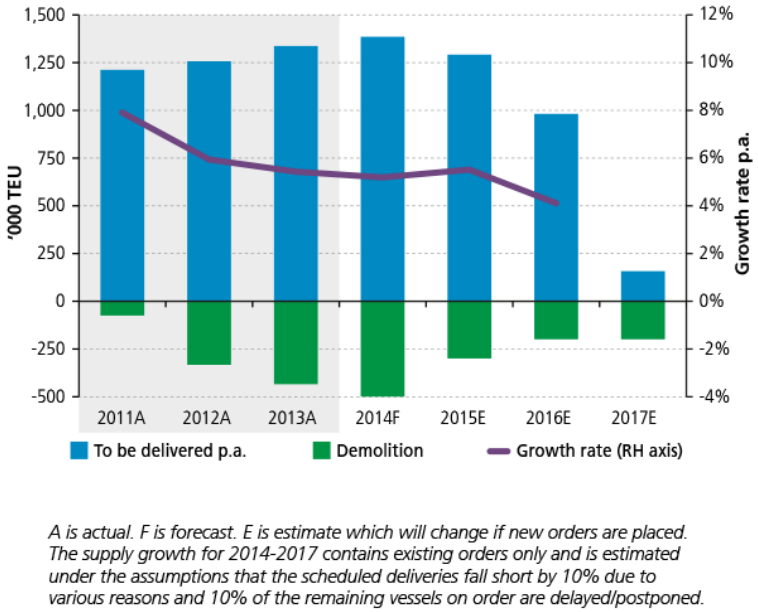

Figure3: Container shipping supply growth

The likelihood of global overcapacity of container ship space continuing into 2014 will result in carriers deepening their push to cut costs, whether by expanding alliances so as to maximize utilization of the largest and most cost-effective ships, by taking measures to make ships more fuel efficient or by reducing ships' time in port so as to maximize opportunities for slow steaming. The overcapacity of ship space would naturally mean surplus of containers globally. It was estimated earlier that container volume is usually more than double of ship space given the weaker strategies of container inventory utilization. Therefore developing strtegies that help increasing the utilization of existing inventories would be vital for the sustainability of container shipping industry.

Apart from the empty container reposition there are two other sources to container supply namely, leasing and purchasing. These sources provide a kind of reactive solution to CII. A considerable amount of investments have been made in purchasing containers and vessels and building port infrastructures (Dong, et al., 2013). The selling price of containers uses the cost-plus pricing model, so any decrease in the price of steel leads directly to a lower selling price (Knowler, 2014). With respect to container leasing, Textainer is currently the industry leader, with approximately 20% of the market share, in terms of total number of containers owned while TAL International Group, Sea Cube Container Leasing, CAI International follow respectively (Pinkasovitch, 2010). Shipping companies heavily depend on leasing containers (Knowler, 2014). Depending on carrier's business strategy, the amount of owned equipment

can vary between 50% and 90%. Several operators, especially the smaller and regional lines rely 100% on rented boxes (Lai, et al., 2010).

Alternative CIM solutions

Developing concepts for collapsible or foldable containers might represent a solution to minimize both regional and international movement. Another application being practiced is a flexible destination port policy. The effectiveness of this method is limited to the relevant line's service routes, container inventory and fleet size. Another study conducted by Francesco, et al., (2009) shows that multi-scenario policies require shipping companies to satisfy empty-container demands for different values that may involve uncertain parameters. Feng & Chang, (2010) have formulated a model that incorporates the expected cost of MTY repositioning subject to constraints of vessel capacity, container demand and MTY supply. In current practice, off-hired empty container movements are often more flexible than those of carrier-owned empty containers (Hanh, 2003). Container leasing is part of a carrier's inventory management strategy. Carriers prefer to lease containers in shortage areas and off-hire them in surplus areas to avoid repositioning costs (Hanh, 2003). Di Francescoa, et al., (ND) propose a mathematical model to minimize the overall cost of managing empty containers using the day as a time-step of a dynamic network over a planning horizon of fifteen days. Rattanawong, et al., (2011) cite 27 papers that attempted to solve the empty container issue. Their paper's analyses are based on the players in the container supply chain, namely, the principal, the port, the customer, and the container depot. The key issues discussed in those papers include imbalances of empty containers, container allocation problems, trade imbalances, uncertain demand on ports, the movement and flow of empty containers, container scheduling problems, distribution planning problems, and fleet management. Chou, et al., (2010) consider the empty container allocation problem by determining the optimal volume of a port's empty containers and repositioning empty containers between ports to meet exporters' demand over time. Olivo, et al., (2005 propose an operational model considering the empty container management as a min cost flow problem whose arcs represent services routes, inventory links and decisions concerning the time and place to lease containers from external sources.

METHODOLOGY

The research was conducted in Sri Lanka with the intention of generalizing the outcome in the global context. Seventeen of the top twenty CSLs in the world operate regular services in the busiest commercial port in the country, Colombo, primarily because of the strategic geographic location of port of Colombo in Sri Lanka. Approximately 75 percent of the global container capacity is operated (alphaliner.com, 2016) by those top carriers. Therefore, the respondents are expected to be relatively reflective of the general views of the global shipping industry thus the results can be generalized for the benefit of the global shipping community. The study was two folded namely, interviews and questionnaire survey.

Initially the researchers conducted interviews with 15 industry experts based on convenient sampling method. The sample consisted senior managers of shipping lines, members of Ceylon Association of Shipping Agents (CASA) and container freight stations covering the administration, marketing, and container control and vessel operations departments. According to the responses, CSLs have no standard practices or commonly known strategies for CIM. The responses were tabulated,

Accordingly, the researchers introduced a conceptual model considering 7 key factors that influence the container interchange by carriers and are illustrated in figure 4.

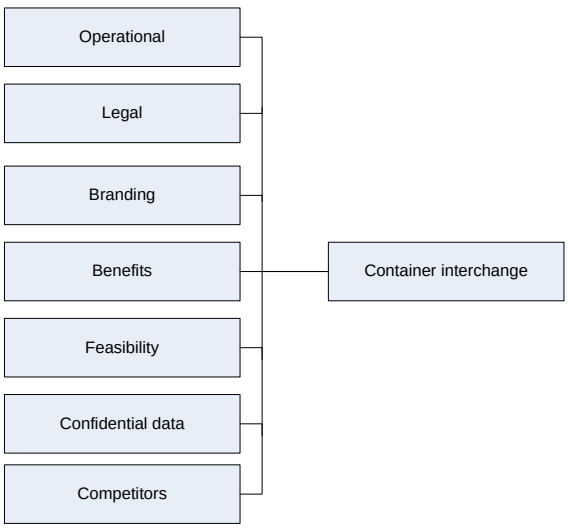

Figure 4: Factors that influence carriers/ decision to interchange containers

Through the interviews it was clearly identified the common factors that a carrier considers in CIM. This helped to inquire further into the general perception of the container controllers of carriers regarding the container exchange mechanism. It also helped in designing a very user friendly questionnaire for the survey. The questionnaire survey was conducted over email; its

goal was to collect specific data covering the entire shipping industry. Researchers invited responses from 90 container shipping industry practitioners based on convenient sampling and received 83 responses. The questionnaire contained only 8 questions and 7 of those being the independent variables according to the conceptual model given in figure 4. This simple questionnaire approach helped getting a highly satisfactory response rate for the study. The likert scale contained 1-5 and respondents were asked to give their preferences.

DATA ANALYSIS AND DISCUSSIONS

There were 82 responses collected from the questionnaire survey. The Cronbach's Alpha value obtained in the data analysis is 0.939. This is a good statistical evidence for the internal consistency of data.

Table 1: Reliability Statistics

Cronbach's Alpha	N of Items
0.939	8

The Pearson Chi-square test was done to analyse the data collected from the questionnaire survey.

Container exchange is a complex operation. There is a fundamental difference between the present slot exchange and proposed container exchange. In a slot exchange, there is no physical component are being exchanged and the exchange is done virtually. The reciprocal part of exchange also performed virtually. However, container exchange has a physical component to play. The most complicated part in container exchange begins when the offeree transport the container to a destination of his choice. Therefore, prior to release of containers the offeror needs to agree on the intended destination of containers. This information should then be processed to determine whether the offeree expects deficit inventories during the time this container reaches its destiny. This provides a simple visualization of the process and surely it does not end there. The reciprocation part will be even more complicated. In this study, it was found in the overall analysis that except for 2, all other 5 variables are significant, Chi-square values ($\chi^{2)}$ and P values (Pr) are tabulated in the Table1 and its practical interpretations are given thereafter.

Table 2: Chi-square values and P values

Chi-Square Tests		
	($\chi^{2)}$	Pr
Operational reasons	74.865[a]	0.000
Legal implications	75.469[a]	0.000
Marketing and brand name	75.469[a]	0.000
Benefits of sharing	74.865[a]	0.000
Not viable(Feasibility)	75.469[a]	0.000

A balanced inventory may realise only when the exporters' demand for containers are equal to the laden containers imported into the country which is very unlikely given the above circumstances. Providing containers help increase the utilization rate of containerships. (Rodrigue, 2013) Therefore the right balances of 'Container inventory' at a given location are a vital factor in liner shipping. With respect to deficit ports, container shipping lines (CSL) tend to sail their ships with vacant space. In instances where the number of laden containers imported in to a port is lesser than the number of laden containers the particular CSL exports from that port a 'deficit' exists. The right balance of 'Container inventory[5] at a given location is a vital factor in liner shipping. In addition to passing the part of additional cost incurring owing to having transport empty containers to the customer (i.e. shipper or consignee) as a surcharge, CSL try to mitigate the impact through controls internally. For example, some lines (principals) penalize regional offices and agents for any idle containers remain in their respective territories. As a result, the agents may compel to keep 'lean stocks' which are vulnerable to occurrence of frequent shortages. Therefore, such controls are not effective as the company may lose potential bookings due to shortages at a given location. The first question of the questionnaire refers to the various operational reasons such as container tracking. A strong relationship between the carrier's resistances to container exchange and container tracking was evident. Container tracking is one of the complicated areas pertaining to container inventory. CSL employ substantial resources in order to maintain the inventory visibility at global level as containers move from place to place without any standard

[5] A Container inventory is a collection of containers

schedule. Therefore, keeping a track of all the containers is a difficult task even when it is not shared with another party. The mean was 3 with standard deviation (SD) of 0.78.

The relationship between container sharing and possible legal implications is also significant as illustrated in the table 1. The mean value of this component was 3 with standard deviation of 0.78. Question number 3 suggested that the respondent does not share containers due to its potential negative impact on the brand name. This variable also shows a strong relationship with the mean value of 4.4 and SD of 0.49. One of the key services marketing characteristics plays a direct role with shipping. Due to the perishability[6] factor in liner shipping services the underutilized ship space is lost forever and cannot be reused later. Usually, demands for empty containers and the arrivals of laden containers to be reused will not match (Song & Carter, 2009). Shipping is highly sensitive with respect to timely delivery of cargo thus availability of containers is vital as much as availability of ships. The foreseeable legal concerns are another matter that was raised by many respondents at interviews. Surely, the pressure complying with various legal procedures will be an additional burden to exchange containers. For example, visualize a scenario that carrier B using a container belong to A to stuff exporter x's consignment and loaded on board a ship under carrier C's slot allocation but operated by carrier D under FOB terms in a joint service advertised by carriers C, D, E, and F. The containers have a useful life of about 12 to 15 years (Rodrigue, 2013) and the standard 20-foot container costs about $2,000 to manufacture while 40-footer costs about $3,000. Therefore, a twenty-foot container costs $1.71 per cubic feet to manufacture while a forty-foot container costs $0.80, which underlines the preference for larger volumes as a more effective usage of assets (Rodrigue, 2013). However, according to Alderton, (2004) the life expectancy of a container depends on many factors, but it is approximately 8 years and it frequently needed repairs and maintenance. Therefore, it is obvious they are concerned about the legal aspect particularly when the market is highly volatile. For example, the repercussions are obvious if the interchange has been effective and had alliance members of Hanjin shipping interchanged substantial volumes with them at the time of bankruptcy.

It is evidenced that carriers are reluctant to share containers as there is no mechanism to quantify financial and non-financial benefits of sharing in advance. The relationship between "evaluation of benefits" and the container sharing was statistically significant as the mean value and SD was 4 and 0.78 respectively.

[6] Marketing of liner shipping falls under services marketing thus this characteristic has a huge impact.

The CIM decisions are usually influenced by many factors. These factors include trade imbalances between particular markets in determining liner service; the type of container equipment available in determining container capacities based on the ratio between the number of a carrier's own containers and those to be leased; the optimal leasing arrangement category if containers are leased; the availability of new containers for purchase; optimal repositioning routes; and special empty-container repositioning tariffs and storage tariffs imposed by container terminals and depots etc. However, the possibility of exchanging containers (as they do in slots) never considers by them at present because there is a myopic view in the industry about the reality of container sharing. Many carriers do not even wish to try container sharing because the inventory of all carriers in a particular port at a given time should be either excess of deficit as per their argument. This leads to a significant relationship between reality of container sharing and choosing container exchange as a CIM mechanism. The mean value is 3.8 and the SD is 0.90.

There were two other questions about the perceived impact of marketing reasons except "branding". As mentioned previously, the 2 components that did not show a statistical significance are, (i) confidential data, and (ii) competitors. It was noted that there has been no statistical significance between the container sharing and carriers perception towards the possibility of revealing the offeror's confidential data to competitor lines. Similarly, there is no relationship between container exchange and the carriers' dislike to associate with competitor lines.

The paper has multiple contributions to knowledge; industry; and economy. Firstly, there are quite a few research papers on smart empty container reposition but very few that discuss about the proactive methods of container inventory management. It is almost nothing on container interchange. The concept of container exchange is a long-awaited method to give a kick-start to alliance partners to solve their container inventory imbalance problem through interchange. Shipping alliance are formed to derive the synergy impact to the trade and it gives best results in slot exchange but the specific provisions given to interchange containers are even unheard by many container controllers. These provisions in alliance agreements that are unused for last 20 years will be made used by the carriers with the publicity this work will receive globally. Secondly, CIM is complex subjects even in the current scenario in which the container controllers usually manage the inventory belong to one carrier. However, it is a

known fact that most employees in the shipping industry usually pay a moderate interest to practice academic guidelines. Since the container imbalance problem is making substantial burden on carriers and their customers it is a duty and responsibility of the scholars who can link the academia and practitioners address these type of ever widening industry gaps.

Thirdly this research is an eye opener to the industry. There is no question about the validity or acceptance of the idea of container exchange from the trade because most of alliance agreements have provisions to interchange containers. Therefore, this paper will lead its way to a paradigm shift in container shipping. Providing market awareness about its feasibility and change the carriers' myopic view regarding container interchange is vital in the current scenario. With respect to the impact on economy, the cost of empty container reposition is primarily borne by the respective shipping lines but later it is recovered from the exporters as a higher freight rate and ultimately paid by the consumer of the cargo. Therefore, this helps reduce the consumer goods that are being imported to the country. Since the freight is usually paid in dollars the savings on export freight will have a huge impact on country's economy. The reposition (instead of reusing them in the same port though interchange) of containers adds a huge environmental impact to the world. As stated elsewhere, one exchange reduces reposition of two empty containers. Also, a container reposition is not only polluting the marine environment alone but other environments also through many intermodal transportation activities associated in one container reposition.

CONCLUSIONS AND RECOMENDATIONS

The paper investigated the container influencing factors of container interchange between carriers. The container carriers have been successfully exchanging the ships' space (slots) for almost two decades now. The authors propose that similar approach may help reduce empty reposition cost if carriers extended the similar approach to containers as well. However, in reality carriers do not exchange containers. Based on the statistical analysis it was found that 5 variables namely, operational, legal, branding, benefits, and feasibility may influence carriers' decision with respect to container exchange. it was also revealed that 2 components namely, (i) the risk of revealing marketing information and (ii) the carriers' common objection to associate with competitor lines have no bearing on container exchange.

The authors recommend that; (i) further should be carried out to assess as to what extend these factors may influence the strategies; (ii) the market awareness about the results should

be provided through industry associations such as Ceylon Association of Shipping Agents (CASA); and Sri Lanka Vessel Operations Association.

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