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Container interchange: The 6 R model approach

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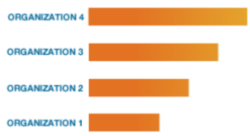

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Container Interchange: the 6 R Model Approach

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Abstract— **The effectiveness and efficiency of container shipping service predominantly depends on the carriers' ability to identify, satisfy and anticipate exporters' demand for containers profitably, better than the competitors in a social responsible manner. The 'Container Interchange Matrix' (6 R model) would provide an effective guidance to carriers in the container inventory management decision making process. Carriers can simulate their individual cases using this model and administer the container exchange mechanism thus strike the right balance between the exporters' demand and the carriers' ability to supply.**

Keywords—Container; 6 R model; maritime; exporter; carriers

I. INTRODUCTION

Container Shipping Lines (CSL) continue to face serious challenges due to container inventory imbalance (CII) since invent of containers. This is primarily caused by the variations of worldwide trade distribution patterns. With the introduction of multiple types and sizes of containers that were developed to 'best suit' the variety of cargos container inventory (CI) became more complex thus problems it created. However, this is an additional service component relevant only to container shipping. In contrast carriers (i.e. break bulk, bulk, tanker etc.) could offer services if the ships/space are available. Container shipping has a fundamental difference compared with other shipping types. Ship space (slots) and containers are complimentary to each other without which the "Container shipping service" cannot be rendered to its customers unless both components are available simultaneously at a given location. This is a unique feature in container shipping and it makes huge disadvantage to carriers managing their container supply chain unlike in other ship types.

The world shipping fleet is mainly comprised of oil tanker bulk carrier general cargo ships, container ships, gas carrier, chemical tanker, offshore, ferry and passenger ships. The influence of container shipping industry on the global supply chain is gradually increasing. The percentage share of container shipping shows a sharp growth in the global supply chain. According to Maritime Review 2016 from 1980 to 2016 the container share in the world fleet by ship type has increased from 1.6 % to 13.5 %.

The containers added an additional cost to carriers and there are 5 key components in the total cost namely, Capital (32%); Repair and refurbishment (25%); Imbalance (22%); Clearing and maintenance (11%); Insurance (10%) (Alderton, 2004). Accordingly, research and development in each area would be highly beneficial to the industry. Apart from the direct cost of empty container repositions it also increases the carbon footprint through excessive transport (Edirisinghe, Zhihong, & Wijeratne, 2016(a))

A balanced inventory may be realized only when the exporters' demand for containers are equal to the laden containers imported into the country. This equality in gross number of containers is not sufficient to have a 'balanced' container inventory. It should satisfy the criterion of 'right type' and 'right size' of containers. Essentially, the quantity of right type and size of container imported should be equal to the demand of its exports. In certain cases, the 'right quality' of containers also matters because, cargos that are sensitive in nature need certain ambitious standards of quality as prerequisite of stuffing such exports. For example, a container that is imported with construction materials may not necessarily be suitable to load an export shipment of tea or garments. Thus, the mere 'seaworthiness' of containers is not sufficient to determine a balanced CI. Even if all the conditions are balanced the 'right' CI should be available at the right time and right location. Accordingly, it is very unlikely that carriers always have 'balanced' CI given the above circumstances and CII usually become a common phenomenon in the container liner shipping industry. The container imbalance primarily occurs due to recurring variance consequent to the trade imbalance that the carriers have no control of. Fundamentally, interchange between those who have excess and those who have shortages at a specific location is the simplest way of balancing container inventories (Edirisinghe, et al., 2015). Researchers noted that there are provisions in certain joint agreement between container carriers allowing them to exchange containers but the resistance particularly from shipping agents have impede carriers' right of taking the commercial advantages of collaboration.

The primary objective of the research is to define a systematic approach namely, the 6 R model. It consists 6 components that help carriers evaluate container exchange possibilities and align the exporters demand with carriers' ability to supply. The overall outcome of CE minimizes container imbalance thus reduce transportation cost. Therefore, the paper also evaluates and discuss as to what extent the container exchange method is feasible.

II. Literature Review

A. *Diachronic and Synchronic views of CII*

Container handling within the chain may be completed in numerous ways including the use of shipping agents (González-Torre et al.,2013). The "box to slot" ratio, which measures the number of containers versus the spaces on container ships, considered at present is 2-to-1 (Weinschenk, 2012). This combined offer of shipping service created a never-ending problem in the container shipping industry. As a matter of fact, the derived demand characteristics in terms of economics primarily made the shipping business a complex one. Carrying capacity of shipping firms positively affects their firms' performances (Lun and Browne, 2009). Initially the combination of the ship and the cargo to be transported were the prerequisites to give a birth to a shipping business. In the post containerization era the combination of the ship, containers and the cargo became essential components in shipping. This situation leads to an imbalance of container inventories in many ports and the CII play a leading role in sustainability of services.

Containerization has made a notable change globally in the system of freight transport. World Shipping Council, (2015) estimates that containerships would carry about 60% of the value of goods shipped via sea. From 1981 to 2009, global transport of containerized cargo increased approximately 3.3 times faster than the world's GDP (UNCTAD secretariat, 2011). Therefore, the CII which is part and partial of container shipping also symultaneosly grew along with these effective shipping volumes. The total existing fully cellular[1] fleet as at 30th September 2015 (all sizes / all positions) stands at 5,150 fully cellular ships for 19,669,661 TEU (Alphaliner, 2015). The CII however created highly ineffective shipping volume namely, empty container reposition (MTY Repo). While the effective shipping volumes generate income that is collected from exporters the carriers have to bear the entire cost of MTY Repo in order to keep the services alive. According to Kamelic, et al.(2012) estimated empty container repositioning costs alone accounted for USD 20 billion on the global level in 2002. Chiang (2013) of Drewry Maritime Advisors reveals that empty container volumes remain stable ranging from 18% to 22% between 1990 and 2011. The most widespread practice by carriers is to move empty containers from where they are in excess to where they are deficit. Worldwide about twenty percent of total container flows at sea are empty and the costs of repositioning are about USD 400 per container (Brito and Konings,2013); USD 395 (Yen, 1994) and the estimated empty container repositioning cost accounted for USD 20 billion on the global level in 2002 (Kamelic,et al.2012). Yen (1994) estimated the proportion of container repositioning cost as a percentage of average freight rates.

[1] Cellular fleet – the fleet of Container vessels

Table 1: Percent of Container Positioning Cost to Average 1991 Freight Rates

	Eastbound	Westbound
Far East – North America	3.7%	4.2%
North America- North Europe	8.9%	9.5%
North Europe – Far East	10.5%	4.1%

Source: Yen (1994)

Apart from the MTY Repo 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 has 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, SeaCube 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).

However, none of these solutions come in handy free of charge. Therefore, it is quite logical to say that all the costs associated with CII are invariably reflected in the freight rates thus consumers of internationally traded goods are the ultimate payers of these costs. This reality suggests that finding an effective solution to container imbalance not only importnant to the shipping industry but also crtical to every human being who have become part and partial of globalization.

If the CII is minimized the need for MTY Repo,Leasing, and Purchasing also will be minimized. propotionatly because majority of containers will be on move with freighted cargo. In dealing with empty containers, the handling of uncertainty, particularly of demand, can be a major problem (Epstein, et al., 2012). Bose, et al. (2012) identifies Containers availability as one of the criteria that determine the service quality of ocean container carriers. Each year, about 2 to 2.5 million TEUs worth of containers are manufactured; the clear majority of them in China, taking advantage of its containerized export surplus (Rodrigue, 2013).

B. Collaboration among carriers

Collaboration is not a new strategy to the CSL. Many CSL pool ship space (slots) to achieve the economies of scale advantages since they realized that benefits supersede the potential marketing disadvantages they perceive in slot exchange. However, exchange of containers is still not evident in the industry and carriers do not pool their containers and interchange. However, on the other hand the respondents perceive a 'win-win' situation through collaboration as it reduces costs of individual CSL and beneficial to the industry. An effective Container Inventory Management (CIM) should be able to provide most effective and efficient mechanism that balances between the empty container demands from exporters and the carriers' ability to supply.

Supply chain Collaboration is becoming a vitally important strategy to achieve competitive advantage, and to develop core capabilities (Kumar and Banerjee, 2012). High and wasteful costs of container repositioning containers was the motivation that pushed liner carriers towards strategic alliances to share the use of containers (Yen, 1994). Inter firm cooperation is a source of competitive advantage (Solesvik & Encheva, 2010) and is realized either vertically (between firms within the supply chain) or horizontally (between firms which are not members of the same supply chain). (Solesvik & Encheva, 2010). As cited in Lai, et al., (2010) CSL choose to collaborate with other actors in the container transport chain to reposition MTYs by examining their production costs and characteristics of the service (Lopez 2003). Multiple and conflicting objectives usually need to be considered in designing a real-life logistics network (Zhou, et al., 2011). Alliances facilitate the respective partners to deliver comprehensive solutions to their issues thorough collaboration. For two parties of an exchange relationship, higher levels of trust can lead to better interactions and trust is a key factor affecting their supply chain partnerships (Wu et al., 2012). CSL presently mitigate the impact of CI imbalance primarily through internal controls. For example, some CSL (principals) penalize their regional offices or agents for any idle containers remain in their respective territories (Edirisinghe, et al., 2015). Song & Carter (2009) in their study proposed external container sharing as a strategic option. It refers to pooling container fleets among different ocean carriers. Edirisinghe, et al., (2015) in their game theoritic approach study consider 'many-player transferable utility (TU) game' where players (shipping lines) can use mutually beneficial strategies. However, it is important to ensure that the costs incurred in the coalition will be fairly allocated to participating companies in the coalition (Cheng, et al., 2013). Some benefits from joining the chain are difficult to quantify in monetary terms (Chiadamrong & Wajcharapornjinda, 2012).

Interchange of containers among carriers can be implemented through alliances between carriers. The strategic alliance is one of the most important types of relationship or partnership due to the high degree of commitment and influence over the other party that is involved (Olavarrieta & Ellinger, 1997) and offers significant value creation opportunities (Ritala, 2009). There are alliances among CSL already in place evidencing the acceptance of collaborative approach in the shipping industry. As explained elsewhere the ship space and containers are decisive components in the container liner service. In an innovative approach CSL presently share (interchange) ship space with competitors. To obtain the economies of scale advantage CSL used to form consortia and share the ship space[2]. CSL have been exchanging ship space successfully for more than two decades now although they are reluctant to treat containers in the same manner. The container carriers have been successfully exchanging the ships' space (slots) for almost two decades now (Edirisinghe, Zhihong, & Wijeratne, 2016). Accordingly, the researchers propose that there is no apparent logic in refusing same mechanism for containers since carriers continue to interchange ship space (slots) very successfully.

According to industry experts there has been a resistance during the initial stages of sharing ships space between carriers particularly from the shipping agents as they perceived it as a huge marketing disadvantage. Later, carriers realized that the financial benefits they derived (given the economies of scale of bigger ships) could never be achieved working in isolation. This reality made a complete change in the container liner shipping industry. Therefore, introducing container exchange mechanism in liner shipping industry is very important. Edirisinghe, et al., (2015) reveals in a paper on this topic that nearly 60% of respondents in their study had agreed that sharing of containers with fellow operators could minimize the cost associated with empty container repositioning.

Researchers also notice some corelation between stot sharing and shipping consortia. Except for some ad hoc cases usually carriers exchange slots only between the members of respective consortia. Therefore, it would be advisable to exchange containers between the members of these existing consoria. FMC (2012) provides a summary of alliance agreements that existed in the Transpacific Trade for 2006 through 2010. Accordingly, seventeen mega carriers had entered into allinace agreements that facilitates equipment interchange. These carriers in fact represent approximately 82 percent of the total container trade. In otherwords, the cotainer exchange mechanism has been accepted by majority of leading carriers that control more than eighty percent of container industry.

Table 2: Carrier Agreements that allow members to exchange equipment

(a) TA-16 Carrier Agreements Active in the US/North Europe Trade for 2006 through 2010

[2] The "Product" component in container shipping comprises 'ship space' and 'containers'

Number	Name	Members
11375	Trans-Atlantic Conference Agreement	ACL, Maersk, MSC, NYK, OOCL
11280	Star West Joint Service Agreement	Albion, Overseas
11854	Greensea Inc. Joint Service Agreement	Green Chartering,
11982	Evergreen Line Joint Service Agreement	Evergreen, Hatsu, Italia
11602	The Grand Alliance Agreement II	HL, NYK, OOCL
11960	New World Alliance Agreement	APL, Hyundai, MOL
10955	ACL/H-L Reciprocal Space Charter and Sailing Agreement	ACL, HL
11415	MPA Space Charter and Sailing Agreement	ACL, MSC
11705	Grand Alliance-CP Ships Atlantic Agreement	CP, HL, NYK, OOCL, PO
11794	The COSCON/KL/YMUK/ Hanjin Worldwide Slot Allocation and Sailing Agreement	Cosco, HJ, KL, YM
11867	Norasia/GSL Round the World Service Agreement	Gold, Norasia
	CMA CGM/CSCL/ELJSA Cross Space Charter,	
11955	Sailing, and Cooperative Working Agreement	China, CMA, Evergreen
11912	Dole-HSud Space Charter and Sailing Agreement	Dole, HSud
11927	Italia, Hatsu	

(b) TP-16 Carrier Agreements in The Transpacific Trade For 2006 Through 2010

Number	Name	Members
11602	The Grand Alliance II	NYK, OOCL, HL
11435	APL/HLAG Space Charter Agreement	APL, HL
11794	COSCO/KL/YMUK/ HANJIN/Senator Worldwide Slot Allocation & Sailing Agreement	K-Line, Yang Ming, Hanjin, COSCO
11885	CMA CGM/MSC Reciprocal Space Charter, Sailing And Cooperative Working Agreement	CMA CGM, MSC
11940	Cross Space Charter, Sailing and Cooperative Working Agreement	CMA CGM, Maruba, China Shipping
11948	CMA CGM/CSCL Cross Space Charter, Sailing And CWA-Central China/US West Coast, Yang Tse/ AAC2 Service	China Shipping, CMA CGM

Source: Federal Maritime (2012)

The prospective outcome of container sharing may realize in two ways (i.e., quantitative and qualitative). In quantitative terms, it reduces the cost of transporting empty containers. Collaboration would improve the service quality through catering exporters' demands promptly and reliably (Edirisinghe, et al., 2015). However, the paradox continues as there is no evident in the industry about container exchange between these carriers.

III. Research Method

The demand for containers is controlled by exporters while carriers administrate the supply side through various CIM mechanisms. Therefore, the data collection approach of the study has been two-fold to make equal emphasis on both demand and supply criteria. Accordingly, the perception of container carriers and the views of the exporters were obtained separately using two questionnaires. In the questionnaire survey, the respondents marked their preferences under wide scales of score ranging from -5 to +5 namely, "Extremely Disagreed" to "Extremely Agreed".

An opinion survey was conducted using two questionnaires namely, A and B. Questionnaire A was distributed to 110 shipping agents in Sri Lanka. Out of them, 31 respondents did not respond. However, the response rate (72%) was acceptable according to key informants given such industry norms as some agents were not allowed to reveal any data due to confidentiality nature. Questionnaire B was sent to 320 employees in cargo exporting companies out of which 264 respondents (82.5%) participated in the survey. Structural Equation Modelling and Stated Preference Method were mainly used in data analysis.

The research has predominantly focused its attention on 6 key components in CIM namely, Quantity; Quality; Size; Type; Location; and Time. The effective and efficient CIM could be derived if carriers supply the right size and type of containers that conforms to the right quality offered in right quantities to the exporters at the right location and at the right time. The container interchange mechanism is expected to deliver effective solutions during this never-ending battle between carriers and exporters.

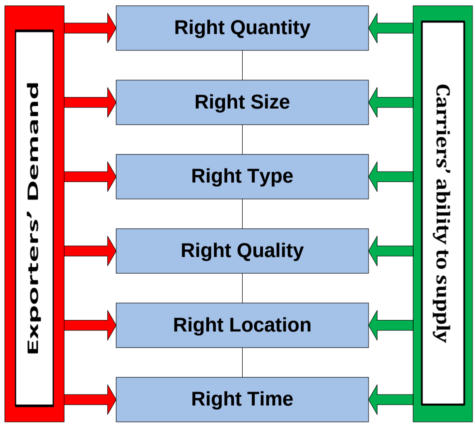

Fig.1: Key components that may influence carriers to interchange containers (6 R model)

IV. RESULTS AND DISCUSSION

Striking the right balance between the exporters' demand and the carriers' ability to supply containers is the main challenge the carriers are faced with. The study identifies six components that influence Container Inventory Management (CIM). Key aspects that need to be considered in CIM is graphically explained in figure 1. This illustration gives sufficient insights to three inherent characteristics of containers [i.e. types (GP, HC, OT, FR, RF etc.); sizes (20', 40', 45' etc.); and quality (to meet with minimum cargo worthiness[3] levels). Once the container inventory is sufficiently met with above factors, there are three conditions that should satisfy to fulfil customer expectation completely. Containers should be made available at a specific location at a pre-determined time and in required quantities.

A. *Evaluating whether the container intercannge is a realistic approach*

The study hypothesizes that container inventory imbalance could be minimized through collaboration among carriers thus the container interchange between carriers is a feasible solution to the problem. However, shipping industry generally perceives that there is no room for exchange because all carriers experience similar market trends or seasonal variation at a given time in respective locations. This could be true in certain situations but not always. In other words, some countries have more exports than imports thus such ports are eternally deficit and vice versa. Since shipping is a derived demand of international trading all the carriers operating in a country should (arguably) face equal impact of the trade imbalance. Therefore, all carriers in a country should be either deficit, balanced, or excess according to the argument. For example, almost all carriers have surplus of 20'GP containers throughout the year in Sri Lanka. Accordingly, the market condition is not conducive to interchange 20'GP containers. However, this is not the case for 40'GP as it is plainly visible in the below test case.

Table 3: Container imbalance of 23 leading carriers in Sri Lanka in 2013 (only 40' GP)

Month	Status	Outcome*	Month	Status	Outcome *
JAN	Excess	557	JUL	Excess	619
	Shortage	346		Shortage	215
FEB	Excess	286	AUG	Excess	697
	Shortage	369		Shortage	491
MAR	Excess	477	SEP	Excess	441
	Shortage	672		Shortage	458
APR	Excess	650	OCT	Excess	121
	Shortage	235		Shortage	562
MAY	Excess	585	NOV	Excess	334
	Shortage	338		Shortage	499
JUN	Excess	399	DEC	Excess	419
	Shortage	163		Shortage	443

* Outcome refers to the container volume after adding monthly imbalance of top 23 carriers

The figures speak for themselves that there is an opportunity in every month because in a collaborative arrangement the shortages could have been replenished by excess containers in each month.

Overall analysis for the year.
Total excess 40'GP containers = 5585
Total deficit 40'GP containers = 4791
Total Imbalance (if not interchanged) = 10376
Total Imbalance if they interchange containers = 794
Reduction in imbalance = 9582 units
Effectiveness of interchange (as a percentage) = 92%

B. *The carriers' perception about container interchange*

Container interchange cannot eliminate CII, but will minimize the number of containers that need reposition instead. There are potential advantages of container interchange namely, reducing container idle time; minimizing storage and excessive cleaning and maintenance costs; reduction of empty reposition cost; cheaper freight rates through effective container utilization; eliminating empty reposition surcharge (ERS); improved customer satisfaction; ability to back load with another carrier; eliminate excessive ware and tare; reduce operational cost; avoid uncompetitive freight rates; reduce customers' dissatisfaction. Similarly, the researchers also identify certain disadvantages of container sharing namely, negative impact on brand name; complications on container insurance; legal implications to carriers; possible advantages to competitors (offeree); and container monitoring and administrative issues. Therefore, it was suggested to respondents that interchange is a satisfactory solution to CII.

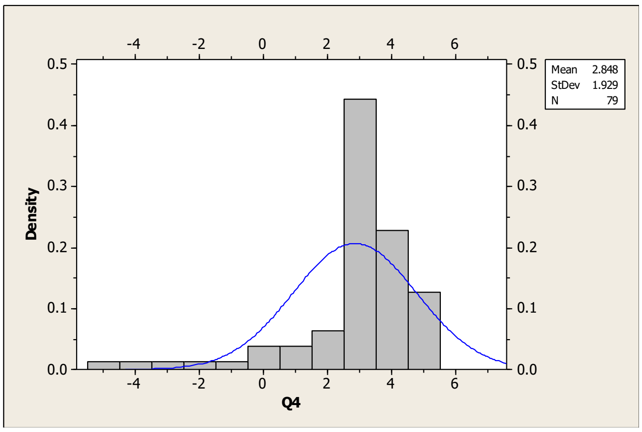

Fig.2: Container interchange is an appropriate solution in conducive market condition

[3] There are certain prerequisite conditions (mainly the interior) and standards of containers in order to be suitable for stuffing of some cargos. For example, odour free, rust free, brand new containers are required for a garment shipment. However, on the other hand an exporter of waste paper may not demand such qualities

Fig. 2 illustrates that 79 respondents have accepted (mean value 2.85) as appropriate solution provided the industry environment is conducive to do so. The industry environment refers to sufficient variations[4] in container inventories maintained by different carriers in each port at a given time that some carriers have excess while others are short of containers. The questionnaire proposed that the expected benefits may supersede the perceived, disadvantages (legal issues; marketing issues, insurance complexities, and inventory control issues, etc.) responses are illustrated in figure 2.

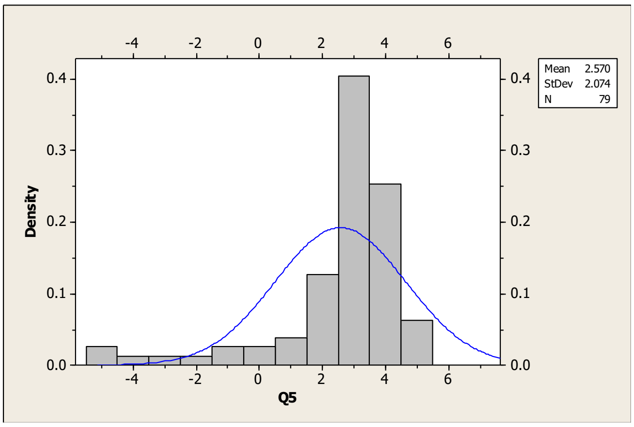

Fig. 3: “Benefits of exchange may supersede its perceived disadvantages”

The graphs in figure 2 and figure 3 are both negatively skewed showing that most of respondents in agreement to this effect (their responses are clustered around 3 and 4 of the scale).

C. *Factors that determines container exchange*

Authors identified ten potential factors that could influence the container exchange mechanism globally. The Q16 to Q25 refer to these factors namely, (i)Back loading through another carrier that lead to future reciprocate gain (Free repo); (ii)Eliminate natural ware and tare caused by long storage; (iii)Reduce operational cost that is caused by empty container transport and port handling(Operational); (iv)Avoid the freight rates become uncompetitive due to excess inventory (Freight Risk); (v)Eliminate Customer attrition due to ERS-Empty Reposition Surcharge; (vi)Reduce customers’ dissatisfaction due to non-availability of containers (Customer care); (vii)Perceived advantages to competitors (offeree) that may be detrimental to the offeror (Risk of Competition); (viii)Additional insurance premiums to cover extended risks of third party containers; (ix)Risk of potential legal implications; and (x)Need for effective and efficient CIM for sustainability of trade respectively. The stated preference analysis of these ten factors are given in table 4.

Table 4: Stated Preference Analysis

Likert Scale	**Q16 Free** Repo	Q22 Risk of Competition	Q21 Customer care	Q25 (Sustainability)	Q24 Legal	Q17 Ware & Tare	Q23 Insurance	Q19 Freight Risk	Q18 Operational	Q20 ERS
5	26	29	25	19	8	7	0	0	0	0
4	37	31	29	24	22	14	18	20	19	9
3	14	15	19	29	28	32	35	32	32	38
2	2	3	3	4	9	12	16	23	19	22
1	0	1	2	1	9	11	5	4	6	8
0	0	0	1	2	3	3	5	0	3	2
Total	79	79	79	79	79	79	79	79	79	79
Top (5 only)	32.91	36.71	31.65	24.05	10.13	8.86	0.00	0.00	0.00	0.00
Top3 (5,4,3)	97.47	94.94	92.41	91.14	73.42	67.09	67.09	65.82	64.56	59.49

Table 4 displays the carriers’ concerns about each concerning factor using the stated preference analysis. Those who responded Agreed (3), Highly Agreed (4), and Extremely Agreed (5) were considered (Top 3) to assess the ranking of carriers’ preference. (Likert scale used in the study consisted -5 to 5). According to above analysis respondents consider Free Repo as top priority because 97% of them belong to the scales of 5, 4, and 3. Carriers perceive that offeror of containers is at disadvantages as it indirectly assists competitors (offeree) when they are in trouble. Therefore, Risk of Competition is another concern by carriers and 95% of respondents placed this component as second priority. Customer care, sustainability, legal implications, container ware and tare, additional insurance premiums, Freight Risk, Operational, ERS recorded percentages of 92, 91, 73, 67, 67, 66, 65, and 60 respectively.

D. *Exporters’ influence in container exchange*

Catering to the exporters’ demand of containers is a complex issue as the carriers required to consider various characteristics (or pre-conditions) of the container inventory. The authors have identified six key components namely, Quantity, Quality, Size, and Type of containers; Location and Time that the containers are required by exporters. The study attempted to understand the general perception of exporters towards container inventory imbalance. Of the total

[4] Several types and sizes of containers

responded, 38% of respondents agreed and 12% marginally agreed that they can shift to another carrier when their regular carrier is short of containers. Rest of exporters extremely Disagreed, highly Disagreed, disagreed, and marginally disagreed at 5%, 20%, 20%, and 5% respectively. According to the overall response exporters agreed to this fact (Mean value 3.20).

Of the total responded, 77% of respondents agreed and 18% extremely agreed that carriers can give a better service to exporters if they exchange containers between carriers. As illustrated in fig. 4 rest of exporters highly agreed, and marginally agreed at 3%, and 2% respectively. (Mean value 3.37).

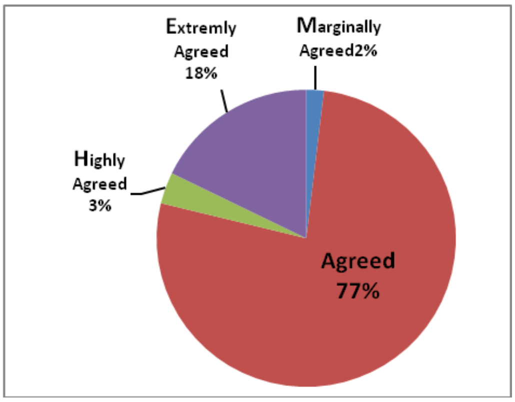

Fig. 4: Exporters view on container exchange

All exporters agree that (Mean value 3.66) they can re-use all the import containers for subsequent exports and save transport cost. Of the total responded, 13% of respondents extremely agreed, 44% highly agreed, 39% Agreed, and 4% marginally agreed to this fact. It is estimated that carriers spent over USD 100 Million yearly in Sri Lanka because container re-position. It was also noted that 44% of respondents agreed while 36% highly agreed that carriers can reduce empty re-position cost. And the resultant lower operational cost may lead to reduction of freight rates if carriers exchange containers. The carriers may reduce the export freight rate from Sri Lanka by USD 47 per TEU if they interchange containers (Edirisinghe & Zhihong, 2016). Also 7% extremely agreed, and 13% marginally agreed on this. (Mean value 3.38).

E. The CIM Mix derived from the 6 R Model

The Structural Equation Modelling (SEM) technique was used to test the 6 R's model. Mac Callum & Austin (2000) suggests that structural equation modelling produces a variety of advantages compared to traditional statistical techniques (as cited in Huurne, 2008). Seven questions in questionnaire B attempted identifying the most crucial factors to exporters in regulating empty container supply through container exchange mechanism by carriers. The purpose of SEM is to examine a set of relationships between one or more independent variables and one or more dependent variables (Veerabramham & Kolla, 2014). On the overall model, six independent variables namely, Time, Quality, Type, Number, Location, Size and the dependent variable Exchange produced an R Square value of 0.623. The overall effect of all variables in ANOVA is statistically significant at P < 0.05. The relationship is graphically shown in Fig 5 with standardized regression weights.

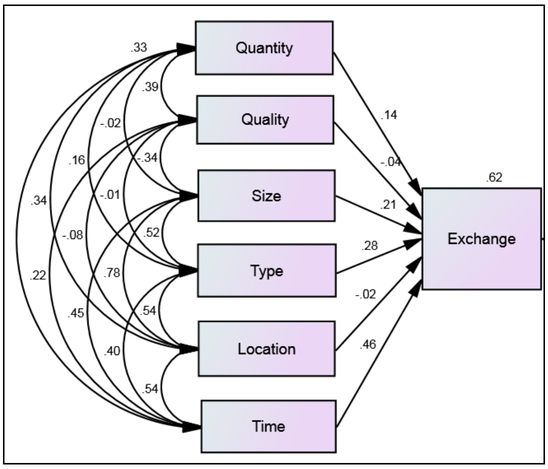

Fig. 5: Standardized Regression Weights

Table 5: standardized regression weights of key determinants of container exchange

Coefficients[a]			
	Beta	t	Sig.
(Constant)		4.329	0.000
Quantity	0.136	2.736	0.007
Quality	-0.040	-0.827	0.409
Size	0.212	2.708	0.007
Type	0.277	5.876	0.000
Location	-0.018	-0.231	0.817
Time	0.456	9.119	0.000
a. Dependent Variable: Exchange			

Table 6: Regression weights of key determinants of container exchange

		Estimate	S.E.	t-statistic	P
Quantity		0.047	0.017	2.768	0.006
Quality		-0.047	0.056	-0.836	0.403
Size		0.147	0.054	2.739	0.006
Type	⇨ Exchange	0.215	0.036	5.944	0.000
Location		-0.013	0.056	-0.234	0.815
Time		0.384	0.042	9.225	0.000

The container carriers should identify, satisfy and anticipate exporters' demand for containers and align their container supply in the most economical manner, better than the competitors with the least negative impact to the environment. Above analysis explain the exporters' point of view that controls the demand side of the empty containers. The balance between that and the carriers' ability to supply the containers is one of the key performance in container shipping service (the other is ship space).

A strategic mix could be derived from the tested 6 R model. Four components namely, Quantity, Size, Type, and Time were found statistically significant and carriers may consider appropriate weights and design the most effective and efficient container inventory management strategy that suits to their organization.

Table 8: The relationships among the independent variables

Variables		Estimate	S.E.	T Statistic	P
Quantity	Location	0.823	0.158	5.222	0.000
Quantity	Type	0.365	0.145	2.522	0.012
Quantity	Quality	0.594	0.100	5.942	0.000
Quality	Location	-0.053	0.044	-1.220	0.223
Size	Time	0.482	0.073	6.642	0.000
Size	Quality	-0.257	0.049	-5.214	0.000
Size	Quantity	-0.064	0.160	-.402	0.688
Size	Type	0.609	0.081	7.515	0.000
Size	Location	0.950	0.095	9.984	0.000
Type	Quality	-0.008	0.042	-.198	0.843
Type	Location	0.584	0.076	7.669	0.000
Time	Location	0.537	0.070	7.661	0.000
Time	Type	0.389	0.064	6.086	0.000
Time	Quantity	0.695	0.138	5.018	0.000
Time	Quality	0.139	0.039	3.527	0.000

In addition to the association between 6 R variables and CIM the study considered the relationships among the independent variables. The correlation coefficients of twelve combinations were statistically significant. Size of containers and the time those are available are statistically significant ($p < 0.05$). Similarly, size and the type, size and quality, as well as size and location are statistically significant with p value at 0.0001. The association between quantity and the type, quality, location was statistically significant ($p < 0.05$). A statistically significant relationship was evident between type of containers and location. Time is another significant factor as previously discussed and it has a statistically significant association with location, type, quantity, and quality at $p < 0.05$. Regression Weights of key determinants of container exchange is illustrated in Table 7. Accordingly, four components namely, Quantity, Size, Type, and Time are statistically significant with $p < 0.05$. The negative relationship of quality and location exhibits that these two components impede the possibility to the exchange mechanism.

When the carriers (or their customers) are highly concerned about the quality of containers it is impossible to depend on another carriers' containers. For example, an exporter of high value fashion garment needs very clean, odor free, brand new containers to stuff the cargo. An exceptional care will be exercised when releasing containers for shipments such exporters. Offering inferior quality containers will create more damage to the long-term business relationship than a cancellation of the booking. Similarly, the location in which the containers are demanded by the exporters is a highly sensitive issue. In most cases carriers compete in various trade lanes.

In a hypothetical situation carrier, A offers a customer a lower freight rate than carrier B. In the present situation carrier, A has no containers but B has surplus inventory. Under normal circumstances this is an opportunity for B to secure the booking even at a higher freight rate if the exporter is not willing to compromise on the delivery date to consignee. The exchange would only reduce the empty reposition cost. Therefore, carrier B will find that exchange produce a negative outcome in this situation.

Usually the export booking specifies the number of containers (Quantity) including its size (whether 20',40' or 45') and type (i.e. GP, HC, FR, FB, RF, OT[5]). An export booking usually take place after finalizing the date of cargo readiness at exporter's end, expected cargo arrival at destination by consignee, acceptability of freight rates and other commercial considerations. Therefore, the time that the containers (satisfying other characteristics mentioned above) are required by the exporter is crucial. The shipping lines are being service organizations the "perishability' factor pay a key role. In other words, once the ship sail from a port the product (service) offer becomes expired or perished. Therefore, inability to supply right number of right size and right type of containers at the right time will make the containers carriers' service effective and feasible. Above analysis explain the exporters' point of view that controls the demand side of the empty containers. The balance between that and the carriers' ability to supply the containers is one of the key performance in container shipping service (the other is ship space).

V. CONCLUSIONS

Container Inventory Imbalance could be minimized through collaboration among carriers. The collaboration comes into effect in the form of exchanging containers between carriers. Since the ship space and containers are complimentary service components of the container shipping business it is logically appropriate to review the evolution of slot exchange mechanism in the container shipping industry. The slot exchange between competing carriers also came into effect amidst various impediments and challenges. It was argued that loading containers on a competing carrier's vessel has many disadvantages. The negative impact on the brand name, exposing critical marketing information to competitors, service differentiation challenges, legal implications, burden on marketing and sales activities are among the few of hundreds of negatives the carriers and their agents used to highlight opposing this concept. However, these hypothetical arguments have proved futile and the container shipping industry would have faced with deep trouble in the absence of huge scale of economies advantage that they enjoy today through slot exchange. Under these circumstances there are

[5] GP=General Purpose; HC=High Cube; FR=Flat rac: FB=Flat bed; RF=Reefer; OT=Open top

sufficient reasons to argue that similar approach could be workable with respect to containers as well. This would not be a challenging task because almost all major carriers have Carrier Agreements that provide provisions to exchange containers.

One of the key impediments for collaboration thus exchange of containers is the mere negative perception by carriers and their agents. As mentioned earlier this was the case for slots also few years ago until the carriers realized that the positive contribution on scale of economies may supersede all such perceived disadvantages. On the other hand, carriers and their agents hypothetically believe that there is no room for exchange. The key argument in this respect has been that the market behaviour in which all carriers at a location and a given time horizon may affect the same way to all carriers. This may be acceptable for sake of argument as shipping is a derived demand of international trading. The carriers have the task to timely supply the type/size/quantity of containers demanded by exporters. They cannot offer what they have in the inventory. However, the researchers have sufficiently justified using a case study that this argument is not necessarily valid always. The ‘Container Interchange Matrix’ (6 R model) may be an effective tool in the CIM decision making process. Carriers can simulate their individual cases using this model.

Biography

Dr. Lalith Edirisinghe commenced his carrier in 1981 as a Cadet Officer in Merchant Navy. He obtained his PhD, in Transportation planning and Logistics Management from Dalian Maritime University China. He is a researcher in Supply chain management and his innovations include, Container Inventory Management (CIM) Concept Model; Multidimensional CIM Evaluation Country Index; Carriers’ CIM Competence Index; 3F CIM Matrix; Harmonized System Code Process Flowchart. His recent innovation Virtual Container Pool® is a mathematical model submitted in his thesis to Dalian Maritime University. Dr. Edirisinghe is a Chartered Marketer, and Chartered member of Institute of Logistics and Transport (CILT) and a member of Sri Lanka Institute of Marketing. He counts 36 years’ work experience in the fields of maritime; logistics and supply chain management; Customs and border management in both government and private sector organizations.

Prof. Dr. Zhihong Jin: Dean: College of Transportation Management, Dalian Maritime University; Member: Teaching Guiding Committee of Ministry of Education, China; Editorial board: International Journal of Shipping and Transport Logistics; Associate Editor-in-Chief: Journal of Dalian Maritime University. His research interests are logistics system planning and management, transportation planning and management technology, and supply chain design and management. He has published 4 books and more than 160 papers, and obtained 5 projects from National Natural Science Foundation of China (NSFC), 7 projects granted by Ministry of Education of China, Ministry of Transport of China, and Liaoning Province, and 2 international cooperation projects.

Dr. A.W. Wijeratne, having obtained his Doctoral in Mathematics from Harbin Institute of Technology, China in 2008, has been working as a Senior Lecturer in Statistics and Mathematics at Department of Agribusiness Management, Sabaragamuwa University of Sri Lanka. He has published over two dozen of research papers in refereed journals covering a wide range of subject areas. He has been supervising number of doctoral candidates affiliated to reputed national and international universities for last six years. Moreover, he has given his active contribution as a statistician for projects at the national level. His research interest includes mathematical modelling in business, experimental designs and applied statistics.

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