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2013

Lam, J. S. L. (2013). Benefits and barriers of supply chain integration: empirical analysis of liner shipping. *International Journal of Shipping and Transport Logistics*, 5(1), 13-30.

<https://hdl.handle.net/10356/100015>

<https://doi.org/10.1504/IJSTL.2013.050553>

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[doi:<http://dx.doi.org/10.1504/IJSTL.2013.050553>].

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Benefits and Barriers of Supply Chain Integration: Empirical Analysis of Liner Shipping

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Abstract

This paper aims to analyse the level of supply chain integration in liner shipping and test its relationship with supply chain value. It also aims to examine the barriers and problems to establish and maintain a partnership or collaboration among the members in a supply chain. Recommendations will be given on how to overcome these obstacles. Empirical investigation was conducted via semi-structured interviews which targeted professionals from the top thirty shipping lines. We estimate ordered probit/ logit models to examine the relationship between the level of integration with supply chain members and the supply chain value, and find a positive relationship. Customer service and inventory management are the two most significant areas in affecting supply chain value. Findings reveal that individualism is a major obstacle to supply chain integration. The paper presents an original modelling approach and an empirical investigation based on theoretic foundation in estimating the effects of supply chain integration with the focus on shipping.

Keywords: Supply chain integration, supply chain value, shipping lines, container shipping, shipper, terminal operator, partnership

1. Introduction

Seaborne trade serves as the backbone of economic development. Shipping acts as a key trade facilitator in providing low-cost and efficient transport. Manufacturers and traders in global supply chains depend on maritime transport services both in inbound and outbound logistics. Containerisation has been responsible for integration within the transport chain since its advent in the mid-1960s. In recent years, the maritime industry is progressing towards lower degree of fragmentation. Different forms of integration started to take place. More market players in the supply chain work together to smoothen cargo and information flows (Lam and Van de Voorde, 2011). The shipping sector is not only seen as to handle physical transport, but to deliver supply chain performance (Lai et al., 2004). While benefits can be brought, there are barriers to supply chain integration (SCI) in practice. Here SCI refers to integration of supply chain partners and processes in the supply chain which is a higher degree of partnership than transactional arrangements of a contractual nature, though SCI in this study is not a legally binding term and includes partnership without equity acquisition. In ocean shipment, shippers, carriers and port/terminal operators are major members in the chain. This paper focuses on liner shipping and presents the empirical analysis of SCI done on shipping lines, which are positioned in the middle of the other two major players concerned.

After a thorough literature search, we find that publications in managing maritime transport as an integrated chain are increasing but limited to date, despite the importance of this research topic. Hence, the study investigates into maritime transport from the integrated supply chain perspective, which is a relatively new and multidisciplinary subject. To our knowledge, there are very few papers which empirically investigate this topic. Even for wider supply chain management (SCM) literature, there are not many papers which carry out empirical studies of relations between SCI and performance (Fabbe-Costes and Jahre, 2007). This study attempts to fill the identified gaps in the literature. Specifically, the paper aims to analyse the level of SCI in liner shipping and test its relationship with supply chain value. It also aims to provide recommendations for overcoming obstacles to integration.

The next section presents the literature review and conceptual development which lead to the hypotheses that are tested. Section 3 explains the research methodology and then the empirical results are discussed in section 4. Section 5 presents the qualitative analysis on the barriers to SCI and the recommendations. The last section concludes with suggestions on future research direction.

2. Literature Review and Conceptual Development

2.1 Benefits of supply chain integration

There has been a growing consensus concerning the strategic importance of SCI from late 1980s (Bowersox et al., 1989; McGinnis and Kohn, 1990). SCI is a central theme in supply chain management. Mentzer et al. (2001) define SCM as “the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole”. It is stated that inter-firm coordination along the supply chain is an integral part of SCM. Similar claims are echoed by other researchers. It is necessary to have effective linkages with the external operations of channel members in the supply chain (Lee, 2000). Coordination among the various firms in the supply chain is the key to the effective implementation of SCM (Frohlich and Westbrook, 2001).

SCI's objective is to provide maximum value to its customers (Bowersox et al., 1999). Weng (1995) demonstrates that with supplier-buyer integrated supply chain, companies can attain higher profits than those with low level of integration. Vickery et al. (2003) find positive direct relationships between SCI and customer service, which then indirectly contributes to financial matrices including return on assets and return on sales. The results find that supply chain collaboration is helpful in enhancing company's financial performance. Other studies claim that integration of the supply chain has become an important way for the industry to gain competitive advantages (Bowersox et al. 1989; Kim, 2009). The topic of SCI has been so prevalent that three comprehensive literature reviews are available in recent years. Power (2005) review and organise the studies from years 1990 to 2001 in three aspects, namely, integration of core processes; strategy and planning; and implementation issues. Both Fabbe-Costes and Jahre (2007) and Van der Vaart and Van Donk (2008) analyse the papers investigating the relationship between SCI and performance conducted in 2000 to 2006, while the latter focuses on those survey-based researches.

The distance and complexity of sourcing materials and delivering products increase the need for integrative SCM as businesses grow beyond serving its immediate environment. Shipping is a vital component in global SCM. The positive results suggested by the previous studies in SCI lead us to the proposition on the favourable outcomes brought by integration in liner shipping with supply chain members.

2.2 Areas and scope of supply chain integration

SCI involves information sharing, planning, coordinating and controlling materials, parts and finished goods at the strategic, tactical and operational levels (Stevens, 1989). Comprehensive collaboration among supply chain members mean that they work together at the three levels. An integrated approach in trans-ocean transport can offer economies in the following aspects: cost; supply chain capacity; management; equipment inventory owning, holding and use; information and communication systems; and facility requirements (Frankel, 1999). Regarding the areas for supply chain members to collaborate in, we firstly consider the transportation function and freight handling since it is the primary purpose for the existence of shipping lines and terminal operators. Handling freight movement along the supply chain, i.e. product flow, is one of the three fundamental activities in SCM. Transportation related attributes such as freight rate, cargo care, transit time, service frequency and reliability are often found to be significant (Brooks, 1993; Kent and Parker, 1999; Lam, 2010). Furthermore, both front-end and back-end activities should be considered in SCI. Customer service and quality are major concerns for shippers and the primary value sought by many shippers has shifted from price to quality service performance (Gibson et al., 1993; Lagoudis et al., 2006). The bottom line for shippers is the need for information about services, shipments, bookings and documents (Durvasula et al., 2000 and 2004). Performance on important service attributes indicated by Lu (2003a) such as accurate documentation and availability of cargo space would be improved with closer collaboration among the supply chain members in shipping. Hence, customer service, inventory management and order processing are also included as areas of SCI.

The basis of the variables included in the empirical test is formulated accordingly, as shown in table 1 having 12 cells with examples of the cell activities. Table 1 represents the four areas of activities, i.e. customer service, inventory management, transportation and order processing; and the three dimensions of scope, i.e. strategic, tactical and operational.

Insert table 1

2.3 Carrier-shipper integration

Carrier is the focal firm in the empirical test of this study. Carrier-shipper integration is under a broader topic of customer integration. SCI includes customer integration, supplier integration, information sharing and strategic planning among others. Stank et al. (2001) show that customer integration is the most important type of SCI in influencing logistical service's competitive performance. Customer integration derives from coordination with critical SC customers (Flynn et al., 2010), where information sharing, coordination and synchronization of processes with the customers are critical activities (Zhao et al., 2008). Relationship commitment plays an important role in customer integration. Morgan and Hunt (1994) demonstrate that relationship commitment positively influences acquiescence and cooperation and negatively influences propensity to leave. Chen and Paulraj (2004) also claim that relationship commitment facilitates supply chain members to integrate with their major customers' business processes and goals.

It is beneficial for a firm to establish closer collaboration with its major customers as it is an effective means to retain the business. For liner shipping companies, the main source of revenue is through the sale of slots on the vessels. Brooks (1993) suggests that shipper-liner partnership with full monitoring systems is an attractive strategy for service differentiation, especially for those carriers with access to capital and marketing expertise. Lu's (2003a) survey results show that the relative importance of service attributes differs between shippers' and maritime firms' viewpoint. In another study, Lu (2003b) investigates the impact of carrier service attributes on shipper-carrier partnering relationships. The survey on shippers finds out that timing related service factor is the most significant in affecting shippers' satisfaction from such partnership. However, these two studies represent Taiwan based shippers which exhibit a rather low partnering relationship with carriers. Our study has used an international sample which enhances external validity. Also, a survey with carriers can complement the viewpoint from shippers.

2.4 Carrier-terminal operator integration

While shippers are the customers of shipping lines, port/ terminal operators are their suppliers. In a broader field of supplier integration, studies claim that cost benefits can be obtained and firms are easier to adapt to uncertainty. Supplier integration is a hybrid governance mechanism that uses relational tactics and is more favourable in conditions of high operational or technological uncertainty, where firms are hesitant to invest in vertical integration or fixed commitments (Rindfleisch and Heide, 1997; Boon-itt and Wong, 2011). Integrated suppliers offer economies of scope in a variety of ways including product and process development and lower administrative costs (Handfield and Ragatz, 1999). Supplier integration initiatives such as third-party logistics are emerging, in which networks of companies can create cost benefits through scale economies (Das et al., 2006). Studies also suggest that the commitment of suppliers can enable the buyer firms to pursue their strategic purchasing initiatives and attain better performance (Carr and Pearson 2002; Chen and Paulraj, 2004). Furthermore, supplier integration can enhance responsiveness, flexibility and timesaving capabilities, which then translate into supply chain value (Frazier, 1999).

In the context of containerized shipment, the reasons for carriers' involvement in terminal operations are found to be largely linked to cost and technical efficiencies. Carrier-terminal operator integration can enhance efficiency in the management of shipping lines' global supply chains, achieving greater flexibility and reliability, shorter turnaround times and cost savings (De Souza et al., 2003; Midoro et al., 2005). Carriers are able to gain control of more links in the supply chain, providing economies of scope for door-to-door services. Their interest in terminal operations is traffic dependent (Slack and Fremont, 2005), and thereby high throughput volume

meets the mutual benefits of carriers and terminal operators. This presents an opportunity for terminal operators to increase market share as carrier-terminal operator integration is a means to bind shipping companies to terminals, secure more investment and obtain a guaranteed source of cargo (Heaver et al., 2001).

2.5 Role of mutual dependence and trust in supply chain integration

Practically, supply chain members have to know the essential factors in cultivating and maintaining SCI. Any collaboration should be built on mutual dependence. From each supply chain member's perspective, the business with other parties in the supply chain should be, or at least perceived as, important to the firm. Kumar (1996) refers supply chain relationships of which the parties come together and exchange information and inputs in both directions as reciprocal interdependence which involves relationship commitment (Zhao et. al., 2008). It is more likely to result in decisions that maximise supply chain profitability since the decisions have to take the objectives of both parties into consideration.

Communication and trust are key ingredients for sustainable SCI (Narasimhan and Kim, 2002; Panayides and Lun, 2009). Communication cultivates collaboration by aligning perceptions and expectations on the joint effort. Timely communication fosters trust by enhancing understanding and assisting in resolving conflicts. This is especially important when a high number of supply chain members are involved. In an empirical study, Panayides and So (2005) show that relationship orientation has a positive effect on key organisational capabilities, like organisational learning and innovation, promoting an improvement in supply chain effectiveness and performance. The study points out that a strong relationship between the logistics service provider and the client can increase integration, and consequently enhance the supply chain performance. No research has been undertaken in this aspect for shipping. Hence, interviews with shipping lines were conducted in our study to explore how these social issues influence SCI in shipping.

2.6 Hypotheses

Based on a comprehensive literature review as shown above, we propose that maritime supply chains should aim for better synchronisation and ultimately for value maximisation. For commercial setting, supply chain value means supply chain surplus, which is the difference between the revenue generated from the customer and the overall cost across the supply chain (Nagurney, 2006; Chopra and Meindl, 2007). The following notations are used in this paper.

Z: supply chain value

Y: level of integration with supply chain member(s) of each cell in table 1

i: focal firm (liner in the empirical test)

d: symbol for downstream supply chain member(s), i.e. shipper in the empirical test

u: symbol for upstream supply chain member(s), i.e. port/ terminal operator in the empirical test

$Y_{mni d}$: integration level of firm i with supply chain member d in each cell mn

$Y_{mni u}$: integration level of firm i with supply chain member u in each cell mn

This study attempts to test two statements hypothesing a positive association between the level of integration with the supply chain members and the supply chain value in shipping. Developing from literature in customer and supplier integration, this study categorises supply chain members into both downstream partners and upstream partners, thus having $Y_{mni d}$ and $Y_{mni u}$ as independent variables and Z as dependent variable. It is worth noting that relatively few papers examined both downstream and upstream relationships (Van der Vaart and Van Donk, 2008). SCM literature suggests that greater benefits can be obtained with higher level of integrated upstream and

downstream coordination (Frohlich and Westbrook, 2001; Lau and Yam, 2007). Droge et al. (2004) prove that external integration with suppliers and customers has a direct positive effect on market share. Thus we set two hypotheses as:

- *Hypothesis 1: The higher the level of integration between liners and major shippers (Y_{mnid}), the higher the supply chain value (Z).*
- *Hypothesis 2: The higher the level of integration between liners and major port/terminal operators (Y_{mniu}), the higher the supply chain value (Z).*

3. Research Methodology

Theoretically, management, economics, marketing and supply chain concepts and theories are examined, as shown above and in the discussion section. Empirically, semi-structured interviews were conducted in 2007 and 2008 with professionals from the top thirty shipping lines in the world, based on Alphaliner (2007). The liner business is highly concentrated (Lam et. al., 2007). Based on the slot capacity deployed in terms of TEU, the top thirty carriers accounted for a market share of 85.6%. With this high market share, the views from this group are considered representative of the major players in the liner industry. Two management executives in charge of supply chain solutions from different regional offices in each company were randomly selected and approached for an interview. Fifty three usable samples representing a response rate of 88% were obtained after multiple attempts. Table 2 shows that the responses are quite evenly distributed among the three tiers in terms of company size. The interviewees represented their business unit and considered the major supply chains involved when they responded. A pilot survey with six different samples has been run before the actual field work.

Insert table 2

In choosing a suitable data collection method, we have considered issues such as research objective, problem definition, research settings and constraints. Compared to one-way communication which requires respondents to complete a survey form, content validity is enhanced in a two-way communication environment, where the definitions and concepts can be clarified for each respondent. This is important for the current study as the research topic is rather new. Also, utilising a uniform instrument for data on Z, Y_{mnid} and Y_{mniu} as well as open-ended dialogue allows us to collect data and information for both quantitative and qualitative analyses. There is no missing data which is another advantage achieved by conducting interviews. This paper focuses on liner shipping and presents the empirical analysis of SCI done on shipping lines, which are positioned in the middle of the other two major players in maritime supply chains, namely shippers and terminal operators. In order to gather a balanced view, interviews were also performed with three global shippers and two global terminal operators in 2009 to verify the survey results. Survey instruments, results and liners' opinion were discussed with these interviewees. They confirmed that the results are valid and also shared their opinion and practice in supply chain integration.

To test the hypotheses, ordered probit/ logit models are specified in which a single ordinal dependent variable (Z) is linearly related to the metric/ non-metric independent variables. The model can analyse the probabilities of observing the various choices of the dependent variable in response to the independent variables (Greene, 2008). A constant term is not separately identified in ordered probit/ logit models (Greene, 2008; Washington et al., 2003). Z was given by survey respondents as perceived supply chain value based on their financial estimation. The answer is a

proxy to supply chain profit as defined by Chopra and Meindl (2007) which is not directly observable due to data availability in industry practice and confidentiality. The answer can be regarded as ordinal realisations of the underlying continuous variable. The measurement scale is an ordered response scale: from not high at all to very high. Nine available ordered choices coded from 1 (lowest) to 9 (highest) are given for more precise estimation (Winship and Mare, 1984). We aim to estimate a model for strategic, tactical and operational management respectively. This allows deriving results for each level, performing comparison and drawing greater insights. The interviewees also validated that our model should include the three levels of management and the four areas of activities (table 1), as they are all important and should not be skipped.

4. Results and Discussion

4.1 Level of integration with major shippers

The respondents from shipping lines were asked to indicate to what extent the company engaged their major shippers as supply chain partners in the cell activities (i.e. variables Y_{mid}) by a continuum numerical scale. 1 denoted “not at all”, 5 denoted “very large extent”. Respondents could choose any value between the two extremes. Referring to table 3, the most engaged cell activity with the major shippers was Y31D, representing customer service at operational level, with the mean score of 3.87. It was followed by Y33D, representing transportation at operational level, scoring 3.80 and Y34D, representing order processing at operational level, scoring 3.71. Cell Y12D, denoting inventory at strategic level, had the lowest score (2.89). The standard deviations of Y_{mid} were rather high, which means that the level of integration with the major shippers varied a lot across different liners. Upon closer investigation, it is found that the integration level differed with firm size having much higher mean for the first tier liners (4.19), followed by second (3.53) and third tier (2.67) respectively. This suggests that larger liner companies are more forward looking in customer integration.

As major shippers are liners’ important customers, it is not surprising to see that they were most engaged in customer service at operational level. This cell activity is basic and essential for retaining customers. As can be seen from table 3, the top three cell activities are all at the operational level. The results suggest that the respondent companies engaged the major shippers more at this level. This is somewhat expected as it is easier to work with supply chain partners in day-to-day operations. The level of commitment is lower than the tactical and strategic levels.

Insert table 3

There is no distinct pattern on which area of cell activity was more engaged. But inventory was the least engaged area. As told by some interviewees, shippers may not be willing to collaborate in this area because they do not see the benefit of doing so. To be more specific, shippers often bear lower cost when they control the inventory in their own way without considering the effects on the whole supply chain. The reluctance from shippers could explain why cells Y12D, Y22D and Y32D indicated lower level of integration. It was especially true for the strategic level, whose score was lower than the medium level (2.89).

4.2 Level of integration with major terminal operators

Similarly, data for Y_{niu} was collected. As shown in table 4, the most engaged cell activity with the major terminal operators was Y33U, representing transportation at operational level, with the mean score of 4.05. The relatively consistent scores given by the respondents for this cell were

reflected by the cell's lowest standard deviation (0.77) among Y_{mniu} . Cell Y22U, denoting inventory at tactical level, has the lowest score (3.04). The integration level again varied with firm size having higher mean for the first tier liners (4.12), followed by second (3.44) and third tier companies (3.15), which reveals that larger liners have achieved a higher level of SCI in terms of both upstream and downstream integration.

Insert table 4

Ranks 1, 2 and 4 were cell activities at the operational level. Similar to the last sub-section, it reveals that the respondent companies engaged the major terminal operators more at this level, rather than the tactical and strategic levels. Also similarly, inventory was the least engaged. Collaboration in the inventory area is to a large extent operational and reactive. In general, it is not the shipping lines' and terminal operators' priority in their agenda. This coincides with shippers' low priority put on in this area in terms of collaboration with the shipping lines.

As a whole, SCI with the major terminal operators, as indicated by the total mean score of 3.54, was moderately higher than SCI with the major shippers, as indicated by the total mean score of 3.42. To statistically test whether the two means are significantly different from each other, we performed the Analysis of Variance (ANOVA) test. The F-statistic is 4.1766 and its associated p-value is 0.0412. At 5% level of significance, the two means are significantly different from each other.

4.3 Ordered probit/ logit models and hypothesis testing

After examining the descriptive statistics, this section proceeds to discuss the ordered response models and hypothesis testing. Estimation of parameters was started with all the initial variables Y_{mnid} and Y_{mniu} . Thus 8 variables were included for each model representing the three levels of integration namely strategic, tactical and operational respectively. The quality of the specification was evaluated by utilising diagnostic and specification tests. After an iterative process of estimation, below shows the final ordered probit/ logit models for strategic, tactical and operational factors (see table 1 for the interpretation of variables). The estimation outputs show that the diagnostic statistics are satisfactory, with reasonably high Pseudo R-squared, low information criteria (Akaike, Schwarz and Hannan-Quinn) and highly significant LR statistic (see appendix 1).

Model 1 (ordered probit model for strategic factors):

$$Z = 1.06*Y11D + 0.85*Y11U + 0.46*Y12D + 0.30*Y13D$$

Model 2 (ordered probit model for tactical factors):

$$Z = 1.67*Y21D + 1.07*Y21U + 0.30*Y22D + 0.34*Y22U$$

Model 3 (ordered logit model for operational factors): $Z = 1.91*Y31D + 1.32*Y32U$

As shown in model 1, four variables Y11D, Y11U, Y12D and Y13D are found to be significant. This reveals that integration with shippers, as compared to terminal operators, contributes more to the enhancement of supply chain value from shipping lines' point of view particularly at the strategic level. While integration with terminal operators is considerable as appeared at all levels, the most significant variables are Y11D, Y21D and Y31D which all represent integration with shippers.

In examining hypothesis 1: the higher the level of integration between liners and major shippers (Y_{mnid}), the higher the supply chain value (Z), $Y11D$, $Y12D$, $Y13D$, $Y21D$, $Y22D$ and $Y31D$ are positively related to Z . Thus hypothesis 1 is supported. Particularly, customer service is the most influential area since it appears in all three models and contains the most significant coefficients. Inventory management is the second most important area which appears in both model 1 and model 2. As for hypothesis 2, $Y11U$, $Y21U$, $Y22U$ and $Y32U$ are positively related to Z . Customer service and inventory management are again significant areas in affecting the supply chain value. Hypothesis 2 is also supported.

Based on statistical significance, liner operators should pay particular attention to those cell activities contained in the models since they are the most decisive factors in determining the total supply chain value. Specifically, deployment of resources may favour these cell activities for they can generate higher impact on the supply chain value, i.e. supply chain profitability for commercial firms. This is far more productive than investing in other areas which have negligible contribution. According to the interviews, most respondents recognise the benefits of working more closely with their supply chain partners. Our models may enlighten the firms by suggesting the exact areas of closer collaboration. As examined above, the current industry practice seems to overlook partnering to better manage inventory including on cargo, container and equipment. However, inventory management is found to be significant in influencing supply chain value so maritime supply chain members should devote more efforts in this aspect.

The three levels of management are: strategic, tactical and operational. Strategic and tactical levels involve longer time frame and wider scope of management. The liners should be particularly concerned with the crucial implications of decision making at the strategic and tactical levels for those cell activities in the final models. According to the descriptive statistics of the survey data discussed previously, liners involve shippers and terminal operators as supply chain partners more at the operational level. But the empirical analysis shows that more cells of Y_{mnid} and Y_{mniu} are included in the tactical and strategic levels than the operational level. Hence, integration at higher levels cannot be ignored. Fostering collaboration at the tactical and strategic levels could be the step forward for bringing more benefits for maritime supply chains.

5. Recommendations for Overcoming Barriers of Supply Chain Integration

Based on both theoretical and empirical analyses, SCI in liner shipping can enhance supply chain value. The benefits that could be brought by integration have been discussed. Nevertheless, there are obstacles to integration in practice. By referring to qualitative analysis from interview dialogues, the central issue is the distribution and realisation of benefits. This section discusses these obstacles and provides recommendations on how to overcome them with the goal to facilitate higher integration.

5.1 Distribution of benefits

There are situations where the total supply chain profit can be enhanced by collaboration, but some chain members cannot directly enjoy the benefit. There could be two circumstances making them unwilling to collaborate. First, Z is increased at the expense of some chain members. Due to cost trade-offs, the chain members major in different areas of activities would display characteristics that put them in conflict with each other. Certain decisions may benefit the supply chain as a whole, but some members are actually adversely affected. For example, interviewees told that some shippers exercise just-in-time manufacturing and aim to minimise the level of inventory. Yet, the shipper wants to offer flexibility and responsiveness to its customers. This

decision requires a lean and agile supply chain (Goldsby et al., 2006) characterised by postponement strategy and close collaboration among the chain members. Transport cost would increase but inventory carrying cost saving can balance the effect so that the ultimate result is better. Carriers would welcome this decision from shippers as revenue is increased. Nevertheless, warehouse operators may not react positively as their revenue would be reduced.

Second, the presence of gains that could be achieved might not be sufficient enough as a reason for collaboration as the costs of pursuing these gains by any one party could be substantial and might not be offset by the benefit obtained. These are extra costs expend in SCI which are involved in the flows of information, products and funds between various stages of the chain. For instance, supply chain members may be required to invest more in information technology, which is a key concern of the interviewees, especially carriers and shippers. They may have to develop a common database for sharing information and data which are essential for making decisions affecting the supply chain. They may even have to re-configure their information systems to ensure that they are compatible for smooth information flow. Under either one of these circumstances, some chain members are worse off if the supply chain is more integrated.

Individualism which lies in self interest and goal orientation (Ketkar et al., 2011) is a major obstacle to SCI. If the total supply chain profit is increased when some members are better off but some other members are worse off, it is obvious that those who are worse off have no incentive to collaborate. They will make decisions individually to maximise the firm's own profit, not the total supply chain profit. A mechanism should be created to motivate participation from these firms. Naturally, those other firms which can enjoy greater benefits will take the initiative. We should also note that in some cases even all the chain members can achieve higher individual profits after integration, some chain members may be discontent if they cannot enjoy an equitable share of benefit. The problem deals with the fairness of the division of total profits among the parties involved. The collaboration will tend to be unstable.

Hence, in tackling these obstacles to SCI, there should be a scheme or agreement on distributing the benefits to ensure that all members can gain equitably from the partnership. The problem of incentive could be solved by an agreement to compensate those chain members who are worse off (Ballou et al., 2000). A mutual beneficial pricing policy is another example of enticing integration (Wee and Yang, 2007). Also, the benefit allocated should be reasonable and sufficient to cover the cost of integration. With alignment of interest and recognition of mutual dependence, liner shipping would be able to attain greater SCI in order to obtain win-win benefits for shipping lines, shippers and port/terminal operators.

5.2 Realisation of benefits

Supply chain integration may be a long term process. Partners have to be persistent in building and maintaining the partnership. As discussed previously, partners involve costs of integration which make the collaboration works. Normally, some of the costs are sunk costs at the beginning stage of the partnership (Parayre, 1995; Carr and Pearson, 1999). However, the benefits brought by the partnership can only be realised at a later stage. This means that even the firms can enjoy higher profits in the long run, they may have to bear loss in the short run. Because of this, some firms may wish to stay stagnant instead of taking the risk. This behaviour is reflected by the lower rate of integration at the strategic and tactical levels as discussed above in empirical findings.

In order to alter the sluggish situation, supply chain members have to recognise and focus on the long term supply chain performance and profitability. To this end, it is essential to have top management's support.

5.3 Benefits of individual staff

People in the firm are actors in the integration process. SCI among the firms requires the support of their staff. Hence, other than the incentive at the firm level, we have to consider the incentive at the individual level (Pagell, 2004). The staff of a firm may be resistant to SCI because their performance is evaluated by the traditional method based on the firm's individual key performance indicators and they are rewarded accordingly.

Therefore, establishing a reward system for identifying, measuring and passing the benefits arising from the collaboration to those who contribute to its success will encourage staff participation. The mechanism should create the impetus for self motivation.

6. Conclusions and Suggestions for Future Research

The study has examined the benefits obtainable by liner shipping companies and the barriers to supply chain integration theoretically and empirically. In general, it is found that the level of SCI is positively related to supply chain value. Thus the findings confirm with previous studies in generic supply chain management that higher SCI, in particular customer integration and supplier integration are positively related to supply chain performance. In terms of the areas of activities, customer service, inventory, transportation and order processing are chosen to be included in the empirical test. On the whole, based on ordered probit/ logit analysis, it is apparent that customer service is the most significant area in contributing to the total supply chain value. It may be due to the fact that the customers of the shipping lines (i.e. shippers) are becoming more powerful. Inevitably, the liners have to address this key element of revenue source. Also, by determining customer service levels to meet what the customer desires and is willing to pay, the liners may simultaneously improve service level and reduce cost. Inventory management is another important area. Notably, it is found to be the least engaged area in industry practice. Individualism which lies in self interest and goal orientation is a major obstacle to SCI. Strengthening coordination in inventory management warrants more efforts among the chain members. By improving this aspect, operators are better equipped to meet just-in-time requirements which are prevalent in global supply chain practice. There is also room to reduce storage expense and opportunity cost. In addition to individualism, other barriers of SCI and recommendations have been discussed. These areas present opportunities for future research to advise practitioners on best practices and policy formulation among others.

The paper has presented an original modelling approach and an empirical investigation based on theoretic foundation in estimating the effects of SCI with the focus on shipping. The research makes a significant contribution since it is a comprehensive study adding to the limited prior literature in the research topic related to shipping. Specifically, examining the areas of activities and dimensions of scope in SCI is also an original contribution of the study, which serves as a reference for organisations in formulating collaboration. The findings suggest that there exists a gap between the current industry focus on operational integration with supply chain members and a desirable level of integration to include tactical and strategic factors. With these new insights that were not provided by previous studies, this paper would be an interesting piece of work to various parties such as researchers, managers and market analysts in maritime studies and supply chain management in terms of both research and policy. We recommend referring to table 1 as a guide for planning and design purposes. Firms can devise more detailed guidelines applicable to a particular situation in the maritime supply chain in practice.

We have chosen shipping lines as survey targets which are positioned between upstream and downstream supply chain members. However, the study is subjected to the limitation that other chain members such as shippers and port/terminal operators were not compared by the same empirical instrument, though five interviews with other chain members were conducted to obtain a more balanced view. The modelling approach can be used to analyse the entire chain or any segment of the chain. Empirical investigations can be performed on other chain members in future studies. Also, case studies of successful and unsuccessful SCI of companies may be performed to understand the drivers leading to the outcomes. It could also be useful to undertake research on various formats of partnership by contrasting them with each other. Another suggestion is to investigate if the process of integration would have a tendency to be more prevalent during economic upturns when most companies grow extensively. With this multi-disciplinary study, it is our wish to simulate more maritime and supply chain research to the benefit of industry practice and academic understanding.

Acknowledgements

The author would like to thank Professor Eddy Van de Voorde and Professor Hilde Meersman for their advice which led to the commencement of this research. The anonymous reviewers are acknowledged for their helpful comments and suggestions. Thanks also go to the survey respondents and interviewees for taking their time to participate in the survey. The research was partially funded by NTU SUG M4080118.

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Appendix 1

Table A. Estimation output of Model 1 – Strategic level

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Y11D	1.064315	0.296179	3.593488	0.0002*
Y11U	0.850106	0.235504	3.609737	0.0002*
Y12D	0.464411	0.236335	1.965048	0.0247**
Y13D	0.303247	0.239259	1.267444	0.1025***
Pseudo R-squared	0.452387	Akaike info criterion		2.267866
Schwarz criterion	2.676795	Log likelihood		-49.09846
Hannan-Quinn criter.	2.425120	Restr. log likelihood		-89.65900
LR statistic	81.12109	Avg. log likelihood		-0.926386
Prob(LR statistic)	0.000000			

Table B. Estimation output of Model 2 – Tactical level

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Y21D	1.669905	0.360291	4.634876	0.0000*
Y21U	1.065460	0.277562	3.838634	0.0001*
Y22D	0.296984	0.221125	1.343057	0.0897***
Y22U	0.335897	0.191749	1.751754	0.0399**
Pseudo R-squared	0.524200	Akaike info criterion		2.024897
Schwarz criterion	2.433826	Log likelihood		-42.65977
Hannan-Quinn criter.	2.182151	Restr. log likelihood		-89.65900
LR statistic	93.99845	Avg. log likelihood		-0.804901
Prob(LR statistic)	0.000000			

Table C. Estimation output of Model 3 – Operational level

Variable	Coefficient	Std. Error	z-Statistic	Prob.
Y31D	1.910730	0.388783	4.914649	0.0000*
Y32U	1.317376	0.353875	3.722718	0.0001*
Pseudo R-squared	0.294859	Akaike info criterion		2.725368
Schwarz criterion	3.059946	Log likelihood		-63.22226
Hannan-Quinn criter.	2.854031	Restr. log likelihood		-89.65900
LR statistic	52.87347	Avg. log likelihood		-1.192873
Prob(LR statistic)	0.000000			

Notes:

* significant at α of 0.01

** significant at α of 0.05

*** significant at α of 0.1

Table 1: Areas and scope of supply chain integration in maritime supply chains

m \ n	Customer service 1	Inventory 2	Transportation 3	Order processing 4
Strategic level 1	11 Setting desirable service level	12 Setting inventory management policies	13 Selecting carriers; Selecting ports of call	14 Determining system design; Order forecasting
Tactical level 2	21 Collecting customers' feedback	22 Determining safety stock level	23 Seasonal capacity adjustments	24 Assessing backorders
Operational level 3	31 Handling customers' requests	32 Replenishment quantities and timing	33 Sea transportation; Loading and unloading	34 Booking; Documentation

Note: m denotes the level of activity, m = 1, 2, 3; n denotes the area of activity, n = 1, 2, 3, 4

Table 2: Respondent profile in terms of liner company size

Rank by TEU capacity	Number	Percent of sample
1 st to 10 th (1 st tier)	16	30.2%
11 th to 20 th (2 nd tier)	18	34.0%
21 st to 30 th (3 rd tier)	19	35.8%

Table 3: Mean scores and ranking indicating the level of integration with major shippers

Rank	Cell	Overall mean	Standard deviation	Mean of 1 st tier liners	Mean of 2 nd tier liners	Mean of 3 rd tier liners
1	Y31D Customer service, Operational	3.87	1.09	4.53	4.03	3.16
2	Y33D Transportation, Operational	3.80	1.01	4.41	4.03	3.08
3	Y34D Order processing, Operational	3.71	1.01	4.41	3.75	3.08
4	Y21D Customer service, Tactical	3.67	1.18	4.59	3.69	2.89
5	Y23D Transportation, Tactical	3.60	1.12	4.22	3.97	2.74
6	Y11D Customer service, Strategic	3.46	1.24	4.41	3.56	2.58
7	Y32D Inventory, Operational	3.41	1.03	4.19	3.31	2.84
8	Y13D Transportation, Strategic	3.34	1.19	4.13	3.81	2.24
9	Y24D Order processing, Tactical	3.23	1.11	4.06	3.22	2.53
10	Y22D Inventory, Tactical	3.06	0.99	3.69	3.03	2.55
11	Y14D Order processing, Strategic	3.01	1.12	3.97	3.00	2.21
12	Y12D Inventory, Strategic	2.89	1.06	3.72	2.94	2.13
Total mean		3.42		4.19	3.53	2.67

Table 4: Mean scores and ranking indicating the level of integration with major terminal operators

Rank	Cell		Overall mean	Standard deviation	Mean of 1 st tier liners	Mean of 2 nd tier liners	Mean of 3 rd tier liners
1	Y33U	Transportation, Operational	4.05	0.77	4.59	3.81	3.82
2	Y31U	Customer service, Operational	3.90	0.87	4.53	3.75	3.50
3	Y23U	Transportation, Tactical	3.80	0.93	4.53	3.69	3.29
4	Y34U	Order processing, Operational	3.70	0.79	4.00	3.78	3.37
5	Y11U	Customer service, Strategic	3.65	0.89	4.34	3.42	3.29
6	Y21U	Customer service, Tactical	3.62	0.96	4.47	3.44	3.08
7	Y13U	Transportation, Strategic	3.48	1.17	4.22	3.42	2.92
8	Y24U	Order processing, Tactical	3.48	0.91	3.88	3.50	3.13
9	Y32U	Inventory, Operational	3.40	0.94	4.00	3.25	3.03
10	Y14U	Order processing, Strategic	3.27	1.00	3.69	3.31	2.90
11	Y12U	Inventory, Strategic	3.10	0.87	3.56	3.06	2.76
12	Y22U	Inventory, Tactical	3.04	1.10	3.66	2.89	2.66
Total mean			3.54		4.12	3.44	3.15