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The Influence of Supply Chain Integration on Supply Chain Performances

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Abstract

Integration in the shipping industry is increasingly viewed as a significant strategy to achieve responsiveness and efficiency in the transport chain. Previous research work has proposed numerous supply chain integration practices (SCIPs) for firms to achieve desired performances. However, not all practices can be directly translated into realizable benefits. It is contested that SCIPs must be industry-specific (relevant) and feasible to implement. Hence the objectives of this paper are to, firstly, select the best subset of SCI variables which explains for performance in the container shipping industry and secondly, examine the possibility of cumulative capabilities between internal and external SCI. The methodology of this research combined both qualitative and quantitative approach. Structured face-to-face interviews were first conducted on eight individuals of managerial position from the shipping industry. Thereafter, a survey was administered on 1937 maritime firms. The collected data was analysed using multiple regression technique on SPSS. The results showed that the container shipping industry is more integrated internally than externally. However, variables relating to external integration provide greater explanation for driving supply chain performances (SCPs) in the industry. It was also found that there are limited cumulative capabilities between similar variables presented in internal and external integration. This paper has contributed to the literature by establishing the link between SCI and SCP. In addition, the proposed framework in this paper could support management decisions in achieving greater performances. Future research includes expanding the current framework to incorporate other aspect of performances (i.e. financial and other non-financial performances).

Keywords: supply chain management, internal integration, external integration, container shipping industry, supply chain performance

1. Introduction

The maritime supply chain has received increasing attention in response to global outsourcing and lean logistics initiatives (Huemer, 2012, Fransoo and Lee, 2008). In today's global market, competition is between supply chains and the success of an organization is correlated with its ability to integrate its activities with partners (Ramberg et al., 2002). The increasing demand for reliability, visibility and integrated logistics service has compelled maritime actors which primarily include shipping lines, port operators and logistic service providers to integrate their services in a coordinated and synchronized manner (Evangelista and Morvillo, 2000). For the past decade, shipping lines have undergone both vertical and horizontal integration primarily through merger and acquisition in an attempt to achieve greater controllability over the supply chain (Panayides, 2006). However, despite major consolidation, the maritime industry has experienced limited success in integrating its supply chain (Power, 2005); Global trading is quoted as an awkward flow of paper and misinformation (Kilgore, 2006). In addition, literature tends to focus on examining the consequences of SCI rather than its antecedents (Ho et al., 2002, Vijayasarathy, 2010).

While there is consistent evidence that firms which achieve the highest degree of integration with their partners had the strongest association with performance (Frohlich and Westbrook, 2001), true integration is often hampered by barriers relating to trust, incompatible goals and objectives, incompatible information systems, and multifaceted issues that exist at operational level (Carter et al., 2009, Fawcett and Magnan, 2009). Furthermore, complete end-to-end integration is often not envisaged by firms and the concept of SCI has been narrowly defined to a specific function of the supply chain (Fawcett and Magnan, 2002).

Although studies relating to SCI in the maritime industry have been extensive, the relationship between SCI and performance has not been clearly established (Panayides et al., 2012). Therefore, the objectives of this paper are (1) to select the best subset of predictor variables, relating to internal and external supply chain integration, which explains for performance in the container shipping industry, and (2) examine for the presence of cumulative capabilities between internal and external supply chain integration.

The remaining of this paper is structured as follows. First, a literature review on the concept of SCI, its relevant constructs, and its application to the container shipping industry was performed. Subsequently, the research methodology was covered, followed by the formal model building process to select the best subset of variables that best explains for SCI in the container shipping industry. Thereafter, results from regression analysis were presented and discussed in the Results and Discussion section. Finally, the paper concludes by providing a summary of the paper, its implications and recommendations for future research work.

2.0 Literature Review

2.1 Supply Chain Integration

Supply chain integration is defined as the concept that links the operating side of a business with its suppliers and customers, ideally in a seamless chain of product and information flows (Lummus and Vokurka, 1999). In simple terms, integration can be described as a function of cooperation and assertiveness between two entities (Thomas, 2006). Cooperation refers to the agreement of both parties in support of each other's objectives while assertiveness corresponds to the amount of effort extended by each party to achieve its own goals.

A more holistic definition was adopted by Vijayasarathy (2010) who defined SCI as the adoption and use of collaborative and coordinating structures, processes, technologies and practices among supply chain partners for building and maintaining a seamless conduit for the precise and timely flow of information and materials. Subsequently, Huo (2012) defined SCI as the degree to which a firm can strategically collaborate with its supply chain partners and cooperatively manage intra- and inter-organisational processes to achieve effective and efficient flows of products, services, information, money, and decisions to provide the maximum value to the final customer with low costs and high speed.

Several authors have recognized integration as a fundamental principle of Supply Chain Management (SCM) and have summarized four schools of thought on SCI which are shown in Table 1 below. Most studies, to-date, have incorporated all perspective in their assessment of SCI. This includes functional, logistical, information, and process integration.

Table 1: Schools of Thought on Supply Chain Integration

No	School of Thought	Perspective
1	Functional Chain Awareness	Internal and external functional integration
2	Linkage or Logistics	Logistics Integration
3	Information	Intra and Inter-company information integration
4	Integration or process	Business process integration

Source: Cigolini, Cozzi, & Perona (2004)

2.1.2 Constructs of Supply Chain Integration

It has been established in the previous sections that SCI consists of two major dimensions; internal and external integration. A review of the past research work has suggested several constructs and measurement items that represent internal and external integration. These key constructs and measures are summarised in Table 2 below.

Table 2 - Constructs and Measures for Internal and External Integration

Internal Constructs	**Measures**	**Supporting Literature**
1. Cross-Functional Unification	Balancing various functional trade-offs to optimize supply chain Clear delineating of roles and responsibilities of each function	Stevens (1989) Ellinger (2000) Lambert and Cooper (2000) Gimenez and Ventura (2005) Lin and Chen (2008) Teixeira et al.(2008)
2. Information Integration	Investing in information system to improve accessibility, accuracy and timeliness of information Integrating information system to ensure compatibility of software	Bowersox, et al (2000) Lee (2000) Fawcett, Magnan, & McCarter (2008) Vickery, Jayaram, Droge, & Calantone (2003) Stank & Goldsby (2000) Stank, Keller, & Closs (2001)
3. Performance Integration	Aligning of functional goals with organisation and supply chain goals Using performance as a basis for rewards to minimise functional conflicts	Lee (2000) Carter, et al (2009) Fawcett & Magnan (2009) Stank & Goldsby (2000) Stank, Keller, & Closs (2001)
External Constructs	**Measures**	
1. Coordination	Recognising and concerting joint strategies to match logistical demands of end-customer Sharing information pertaining to cost, demand forecast and capacity Implementing incentive schemes to optimise total supply chain profits and to meet customer demands Extending organization capability and knowledge to facilitate continuous improvement	Bowersox, et al (2000) Simatupang, et al (2002) Tongzon, Chang, & Lee (2009) Frohlich (2002) Hung, Ho, Jou, & Tai
2. Information Integration	Investing in information systems to improve accessibility, accuracy and timeliness of information Integrating with partner's information system to ensure compatibility	Bowersox, et al (2000) Lee (2000) Fawcett, Magnan, & McCarter (2008) Vickery, Jayaram, Droge, & Calantone (2003) Stank & Goldsby (2000)

		Stank, Keller, & Closs (2001)
3. Relationship Integration	Valuing the input of partners in providing quality services that suit supply chain needs Investing in partner's equipment, capacity and personnel to support customer relationship Build long-term relationships by entering into contracts (example: slot-sharing, alliances, service contracts)	Kwon & Suh (2004) Vijayasarathy (2010) Bowersox, et al (2000) Boon-itt & Pongpanarat (2011)
4. Performance Integration	Measuring partner's performance by using a customer-centric performance metric that is mutually agreed by both parties Using performance as a basis for rewards to align interests	Bowersox, et al (2000) Neely (2008) Campbell & Sankaran (2005)

Source: Author (2013)

2.1.3 Measuring Integration in the Maritime Supply Chain

While existing framework for measuring SCI has been extensively developed in the literature, studies that relate to the maritime industry are few and are deficient in several ways.

The earliest research on measuring SCI for the maritime industry can be traced to Evangelista & Morvillo (2000). The authors used two major dimensions, logistical and inter-organization integration, to access the level of integration in the maritime industry from the shipping line perspective. The degree of logistical integration is defined as firm's involvement in the transportation activities of their vertical partners while inter-organization integration is defined as firm's utilization and involvement in partnership programs.

In another study, a 3x4 matrix model with row presenting management level (operational, tactical, strategic) and column representing shipping line's value chain activities (customer service, inventory, transportation and order processing) is proposed (Lam, 2009). This matrix is then subsequently used to measure shipping line's integration with terminal operators and shippers separately.

For measuring port integration from a supply chain perspective, Panayides and Song (2009) proposed four parameters. They are (1) information and communication systems, (2) value-added services, (3) multimodal systems and operations, and (4) supply chain integration practices. In another framework developed by Tongzon, Chang and Lee (2009), (1) relationship with users, (2) value-added services (3) inter-connecting inter-modal infrastructure and (4) channel integration practices were proposed.

The following gaps in the literature are observed. Firstly, the highlighted studies above have not addressed all integrating constructs in SCM. Studies tend to focus only on coordination and logistical dimensions. For example, study conducted by Evangelista and Morvillo (2000) has not incorporated information and performance dimensions in their framework. Secondly, constructs that were proposed to measure integration are external-oriented. The contributions of internal integration were excluded. Lastly, research has not been inclusive in addressing all major maritime participants. Next, while methodologies that are adopted for supply chain research can be at dyadic level (pairwise relationships), organizational-set (relationships between a focal firm and multiple trading partners) or network level (all relationships among firms in a supply chain level) (Vijayasarathy, 2010), the method that is commonly used in measuring SCI for the maritime supply chain tends to be at dyadic level. Generalised studies that are applicable to the full spectrum of the maritime supply chain have not been conducted.

2.2 Performance

The overall performance of a firm can be evaluated based on its logistical performance, Supply Chain Performance (SCP), and/or financial performance (Lai et al., 2002). Performance, for the transport chain, can be evaluated based on their supply chain performances which include reliability, responsiveness, cost, visibility, and speed (Notteboom and Rodrigue, 2008, Lai et al., 2002, Bowersox et al., 2000). According to Lai, et al. (2002), financial criteria should not be used to assess performance attributing to their narrow focus and failure to consider for the performance of the entire supply chain.

Reliability is characterized as the level of consistency in performing supply chain activities. Responsiveness is measured by the flexibility of the chain to respond to changing needs and demands of the customers. Cost performance relates to the level of proficiency in performing activities efficiently. Visibility is assessed by the transparency of information for making key decisions in planning and operations. Lastly, speed is determined the level of proficiency in delivering services at shorter lead time.

3. Research Methodology

A combination of preliminary interviews followed by surveys was conducted on shippers, shipping lines, third-party logistics service provider and port operators. SPSS was used as the primary data analysis tool.

3.1 Preliminary Interview

The primary purpose of the preliminary interview was to invite interviewees to share their views on the feasibility of the dimensions and measures that characterise SCI and SCP.

Unsolicited e-mails were first sent to ten potential interviewees who were selected from Times online directory (Singapore Shipping Directory). Another five, who were acquainted with the authors were also invited. In total, six of the targeted participants, holding managerial positions, agreed to be interviewed. Two of them were from the container shipping line, the other two were shippers, one was working in the container port while the other is working in a freight forwarding company.

3.2 Survey

3.2.1 Sampling Methodology

The targeted sectors in the container shipping industry include shipping lines, container ports, 3PL and shippers. Table 3 below summarizes the sampling method and sampling frame for each targeted sector.

Table 3 – Sampling Methodology and Sampling Frame

Sector	Sampling Method	Justification of Method	Sample Size	Directory
Shipping Lines	Top 100 Shipping Lines	Container throughput handled by the top 100 shipping lines constitutes over 90 percent for year 2008. This provides a good representation of the sector.	100	Alpha Liner Container Intelligence
Container Ports	Multi-Stage Sampling	To consider for 1) container throughput and 2) geographical region of the port while conforming to certain degree of randomness in selection. Size of the sample is predetermined by the guidelines prescribed by Gay and Airasian (2003)	179 (approximately 50% of total population in the directory)	Container Intelligence
3PL	Random Sampling	To ensure selected samples are unbiased and represent the entire population	1058 (3% of total population in	FIATA Singapore

			the directories)	Times
Shippers	Random Sampling	To ensure selected samples are unbiased and represent the entire population	273 (50% of total population in the directories)	SCCCI SICCI

Source: Author (2013)

3.2.2 Survey Design

Respondents were required to rate the questions in the survey based on a five-point categorical scale, with one being least and five being most successful, significant or effective. In addition, textbox were inserted at the end of each question to allow respondents to point out considerations that were omitted in this research. Section 1 of the survey provided respondents with some background information on supply chain integration and the research objective. Section 2 covered questions relating to the degree of SCI in the respondent's firm and supply chain. Lastly, Section 3 comprised of demographic questions regarding respondent's company, department, designation, years of experience and their contact information.

3.2.3 Survey Procedure

The survey was specifically addressed to individuals who were holding managerial roles and were from the supply chain, logistics, strategy, or operations department. An initial invitation via electronic mails was first sent to individual to request for their participation in the survey. Participants can either choose to accept or reject the invitation by clicking on the respective URLs in the e-mail. A total of 1937 e-mails were sent and of which, 216 respondents accepted the invitation. Upon acceptance, participants were directed to the webpage on survey monkey to complete the questionnaire. Forty-eight participants completed the survey within two weeks. Thereafter, five reminders at an interval of four weeks generated another 116 completed surveys. In all, 164 responses were received and a response rate of eight percent was achieved. Accordingly, number of responses from the shipping lines, container ports, 3PL, and shippers are 36, 43, 41, and 44 respectively. The survey was conducted from the start of January 2012 to end of June 2012.

4.0 Model Building Process

4.1 Data Preparation

The received data were first screened for missing values and errors. As the online survey website requires respondent to answer every question before submission, no missing values were found. The existing data (n = 164) was randomly divided into two halves for training and validation purpose (Kutner et al., 2004). The training data set is used for the model building process while the validation data set is used solely for validation purpose at the later stage.

4.2. Preliminary Model Investigation

4.2.1. First-Order Regression Model

To address the research question set out in this study, the following first order regression model is developed.

$$Y = \beta_0 + \beta_i X_i + \varepsilon_i \qquad i = 1,2,3,4,5,6,7 \qquad (4.1)$$

Table 4 – First Order Regression Model

Variable	Description	No. of Measurement Items
Y	Supply Chain Performance	5
X_1	Cross-Functional Unification	2
X_2	Internal Information Integration	2
X_3	Internal Performance Integration	2
X_4	Coordination	4
X_5	External Information Integration	2
X_6	Relationship Integration	3
X_7	External Performance Integration	2

Source: Author (2013)

4.2.2. Interactive Model

In addition to the first order variables that were proposed, 3 interactive variables are included in the regression model. Specifically, the model takes into account of the cumulative effect of cross-functional unification and coordination, internal and external information integration, and internal and external integration on supply chain performance. The full regression model, inclusive of interactive variables, is presented below.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_1 X_4 + \beta_9 X_2 X_5 + \beta_{10} X_3 X_7 + \varepsilon \quad (4.2)$$

4.2.3 Outliers

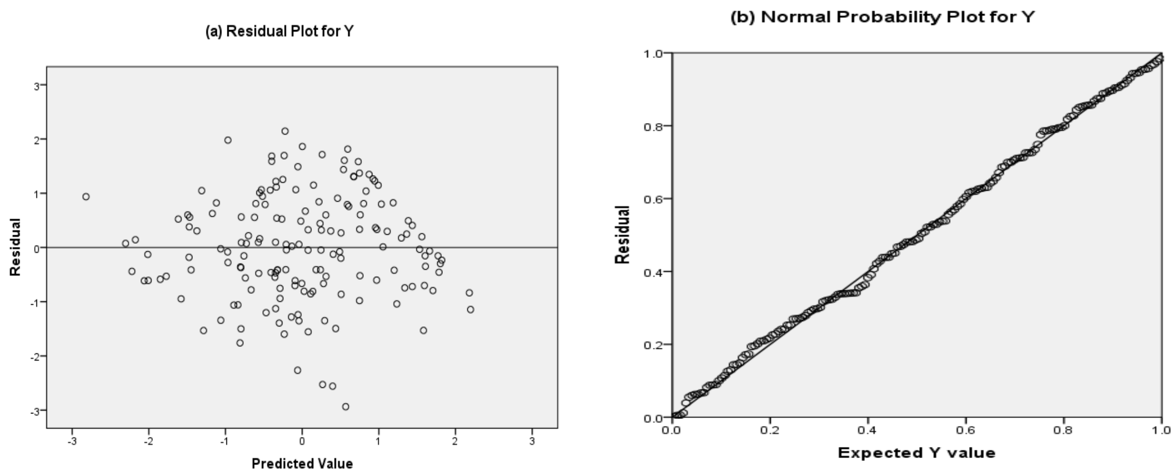
Formal methods were employed to detect for any outliers that would have significant influence on the regression model. This includes the use of DFFITS, Cook's Distance (D_i), and DFBETAS for identifying both x and y outliers. No significant outliers were found based on the general guideline, DFFITS > 1, $D_i > 0.2$, or |DFBETAS| > 1.

4.2.4 Test of Assumptions

Preliminary test for violation of constancy of error, normality, linearity, and independencies of errors was performed. A plot of residuals against the predicted values for the fitted model is shown in Figure 1 (a) below. The plot suggested that non constancy of error was apparent; residuals were observed to be increasing with predicted value in a megaphone shape. The particular violation of non-constancy of error term could potentially affect the estimation of the parameters (i.e. regression coefficient) efficiently with ordinary least square method. This violation will be addressed using weighted least square method upon completion of the model building and selection process. As shown in Figure 1 (b), the probability plot also connotes that the residuals are normally distributed and hence allow reliable interpretation of statistical decisions.

Table 5 below shows the correlation between individual independent variables and the dependent variable. The indexes indicate that each of the independent variables is linearly associated with Y and are significantly at significance level 0.01. Hence, the assumption of linearity is satisfied. As the group of sample data was collected randomly, residuals should be randomly distributed and independent. In addition, Durbin-Watson test (D = 2.115) was performed and the residuals are noted to be uncorrelated at significance level 0.01. Therefore, the assumption of randomness is satisfied.

Figure 1 (a) & (b) – Residual and Probability Plot



Source: Author (2013)

Table 5 – Correlation between Variable Y and Variables X

Pearson's Correlation	Index
$r_{Y.X_1}$	0.397*
$r_{Y.X_2}$	0.495*
$r_{Y.X_3}$	0.469*
$r_{Y.X_4}$	0.651*
$r_{Y.X_5}$	0.650*
$r_{Y.X_6}$	0.603*
$r_{Y.X_7}$	0.721*
$r_{Y.X_1X_4}$	0.652*
$r_{Y.X_2X_5}$	0.666*
$r_{Y.X_3X_7}$	0.708*

*Note: * correlation is significant at p <0.01*
** t-test is significant at α <0.05*

Source: Author (2013)

4.2.5 Detecting Multi-collinearity and Remedial Actions

The use of the original individual variables presents severe multi-collinearity issues. The high correlation between variables could be attributed to the use of interaction variables. Transformation of the variables is achieved through centralization of each variable by taking the difference between each observation and its expected value (i.e. mean). Table 6 below shows the Variance Inflation Factor (VIF) before and after transformation.

Table 6 – Multi-collinearity Diagnostics Before and After Transformation

Variables	VIF before Transformation	VIF after Transformation
X_1	31.588	1.809
X_2	33.327	1.636
X_3	36.721	2.039
X_4	24.339	1.690
X_5	20.559	1.829
X_6	1.746	1.746
X_7	27.486	2.192
X_1X_4	61.226	1.385
X_2X_5	64.286	1.341
X_3X_7	71.625	1.612

Source: Author (2013)

All VIF readings after transformation did not exceed the general guideline of VIF > 10 (Kutner et al., 2004). In addition, the mean of VIF (i.e. $\overline{VIF}$ = 1.728) is considerably close to one.

4.3 Model Selection and Validation

While the combination approach, utilizing both sequential search method and all possible regression technique, is suggested to be the best model selection approach by Hair et al. (2010), the number of independent variables (i.e. 10) presented in this study would equate to 1024 possible regression models. This would result in unrealistic amount of processing time if all possible subset regression technique is adopted. Therefore, a compromised approach is adopted in this study. First, several regression models are proposed based on statistical or non-statistical consideration. Subsequently, all-possible-regression technique leveraging on six commonly used criteria which include R_p^2, R_a^2, C_p , AIC_p , SBC_p , $PRESS_p$ was applied on each proposed regression model.

Table 7 below presents the outcome of performing model reduction. In all, five alternative models that are worthy for further comparison using all possible regression technique are selected.

Table 7 – Selected Models for All-Possible-Regression Analysis

Model	IV	Parameters (p)	Justification
1	X_3, X_4, X_5, X_7	5	Stepwise Method and Forward Addition
2	$X_1, X_2, X_3, X_4, X_5, X_6, X_7$	8	Past Research Work
3	$X_1, X_2, X_3, X_4, X_6, X_7, X_1X_4$	8	Backward Elimination
4	$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_1X_4$	9	Partial Regression Plot
5	$X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_1X_4, X_2X_5, X_3X_7$	11	Control

Source: Author (2013)

Table 8 - Regression Results for Candidate Models 1 to 5 Based on Model-building and Validation Data Sets

Statistic	Model 1 Training Data Set	Model 1 Training Data Set	Model 2 Training Data Set	Model 2 Training Data Set	Model 3 Training Data Set	Model 3 Training Data Set	Model 4 Training Data Set	Model 4 Training Data Set	Model 5 Training Data Set	Model 5 Training Data Set
p	5	5	8	8	8	8	9	9	11	11
R_p^2	0.681	0.699	0.706	0.774	0.712	0.754	0.723	0.774	0.726	0.779
R_a^2	0.665	0.684	0.678	0.752	0.685	0.730	0.692	0.749	0.687	0.747
C_p	10.548	24.336	10.043	6.537	8.603	13.005	7.759	8.426	11.000	11.000
AIC_p	-111.406	-130.297	-112.137	-147.565	-113.705	-140.561	-114.892	-145.690	-111.830	-143.321
SBC_p	-99.372	-118.264	-92.883	-128.311	-94.451	-121.307	-93.231	-124.029	-85.356	-116.847
$PRESS_p$	21.427	16.794	17.186	13.443	16.860	14.686	16.217	13.734	21.076	14.001
$MSPR$	0.186	-	0.150	-	0.164	-	0.146	-	0.151	-

Source: Author (2013)

From Table 8, results provided by the six model selection criteria seem to be in favour of Model 1, 2, and 4. Based on parsimony principle, Model 1 should be chosen as four independent variables are able to explain for approximately 70% of the total variance of the dependent variable (i.e. SCP). In comparison with Model 4, which has the highest number of independent variables, the increase in R-square is marginal. Likewise, the trade-off between the reduction of independent variables and other criterion such as AIC_p, SBC_p, and $PRESS_p$ is minimal. However, it was noted that C_p was unreasonably high in both training and validation data sets. This suggested that the fitted subset regression model is bias and does not provide a good estimation of the population variance. In addition, selecting Model 1 would contradict the findings from past research work where all first-order independent variables are significant in driving performance.

For similar reasons, selection criteria are in favour of Model 4 over Model 3 as C_p for the latter's training data set indicates an unacceptable degree of biasness. In addition, Model 4 offers better accuracy in terms of prediction based on $PRESS_p$ and MSPR in both training and validation data sets.

5. Results and Discussion

As indicated earlier on the issue with violation of constancy of error, weighted least square method is employed to provide the best estimation of the parameters in the finalised regression model (i.e. Model 4). Transformation was executed using weights that are inversely proportional to the variance at each level of independent variables to yield the most precise parameter estimates. Accordingly, Table 9, 10, and 11 below shows the overall model fit, ANNOVA, and parameter (coefficient) estimates using full data set (n = 164) after the transformation.

Table 9 – Model Fit Summary

R Square	Adjusted R Square	Standard Error
0.787	0.776	1.255

Source: Author (2013)

Table 10 – ANOVA Table

	Sum of Squares	df	MS	F (MSR / MSE)	Significance
SSR	905.71	8	113.09	71.75	<0.001
SSE	244.31	155	1.58		
SST	1149.02	163			

Source: Author (2013)

Table 11 – Regression Coefficient Table

I.V	Description	Regression Coefficient	Mean[a]	Standard Deviation	Ranking (Beta-Coefficient)
X_1	Cross-Functional Unification	0.096*	3.80	0.91	8

X_2	Internal Information Integration	0.144**	3.47	0.85	5
X_3	Internal Performance Integration	0.101*	3.80	0.99	7
X_4	Coordination	0.211**	3.58	0.74	2
X_5	External Information Integration	0.185**	3.76	0.76	3
X_6	Relationship Integration	0.156**	3.65	0.77	4
X_7	External Performance Integration	0.337**	3.73	0.76	1
X_1X_4	Cross-Functional Unification and Coordination	0.124**	2.75	0.94	6

Note: [a] min mean = 1 (least extent), max mean = 5(most extent)
** t-test is not significant at α = 0.05*
*** t-test is significant at α = 0.005*

Source: Author (2013)

From Table 9, a generally good model fit is achieved as 78 per-cent of the variance in supply chain performance (i.e. Y) can be explained by the eight variables. The linear regression model is also significant since F-statistics is significant ($p < 0.001$).

With reference to Table 10, all coefficients are significant ($p < 0.005$) except for variables cross functional unification and internal performance integration despite obtaining the highest mean score amongst other predictors. Judging from the mean score obtained for each variables, it can be deduced that the container shipping industry is more integrated internally than externally. This finding is consistent with the evolution theory on SCI proposed by several authors that firms first integrate internally within their supply chain before extending their integration externally with their partners (Stevens, 1989, Frohlich and Westbrook, 2001, Fawcett and Magnan, 2002). However, variables relating to internal integration (X_1, X_2 ,X_3) are inadequate in explaining for supply chain performance in the industry. It was noted that only internal information integration (X_2) has a significant influence on SCP. This result is not surprising since information integration has been the core focus in most internal integration studies and has been identified as the catalyst towards driving efficiency and responsiveness (i.e. performance) in the supply chain. In contrast to several studies which concluded that all three internal-integration-related variables have a significant influence on integration, the differences could be explained by the specific inherent characteristics of the container shipping industry whereby different nodes in the supply chain are highly interdependent on each other for the flow of cargo and information. This places internal integration to be of relatively lesser importance in comparison with other industry (i.e. manufacturing).

Variables relating to external integration have the strongest linear association with supply chain performance. For instance, external performance integration, coordination, external information integration, and relationship integration are ranked first to fourth in terms of beta-coefficient. This indicates that more emphasis should be placed on external integration, primarily through performance integration, to achieve desired SCP. This includes the utilization of customer-centric performance metric which are agreeable by both parties for assessment purpose, and as a basis for rewards and profit-sharing.

From Table 11, there is sufficient evidence to conclude that there is interactive relationship between cross functional unification and coordination (external). It is conceivable to associate that functions which are successful in coordinating with each other would also be successful with coordinating externally with their external counterparts. However, their cumulative contribution towards SCP was marginal and was ranked 6^{th} in terms of explanation towards the variation in SCP.

On the contrary, no similar conclusion can be drawn for the cumulative effects between internal and external information integration, and between internal and external performance integration. The related constructs are concluded to be independent of each other and offer no cumulative contribution to SCP.

6. Conclusion and Recommendation

6.1 Summary

The primary objective of this paper is to select the best subset of predictor variables, relating to internal and external supply chain integration, which explains for performance in the container shipping industry. Attributing to the lack of validation in past research work, this paper also seeks to examine the cumulative capabilities of similar variables found in both internal and external integration. SCI was concluded to be represented by two major components, internal and external integration while SCP, for the container shipping industry, was suggested to be linked with cost, speed, responsiveness, visibility, and reliability. At present studies that link SCI to performance has been deficient in the context of the shipping industry.

The methodology of this paper included both qualitative and quantitative approach. Preliminary interviews were conducted on individuals from shipping line, ports, third-party logistics service providers, and shippers for validation of the constructs and measurement items. Thereafter, 164 survey results were collected and analysed using multiple regression technique with the aid of computer software, SPSS.

It was found that the container shipping industry is more integrated internally than externally. However, variables in external integration were noted to be the main drivers of supply chain performance. External performance integration has the highest influence on performance. This is followed by coordination, external information integration, and relationship integration. Interactive capabilities between similar variables in both internal and external integration are found to be insignificant except for the interaction between cross-function unification and coordination. However, their interactive influence is ranked last amongst other first order variables.

6.2 Academic and Managerial Implication

Academically, this paper has contributed to the lack of SCI studies in the maritime industry. In addition, attempts have been made to establish the link between SCI and performance. In comparison with other existing frameworks that were developed to measure SCI in the maritime industry, the proposed framework in this paper has considered a broader scope which encompass all major nodes in the maritime supply chain and adopted a wider definition of SCI.

From the managerial perspective, maritime firms should continue to focus on integration both internally and externally to achieve greater SCP. Although variables relating to external integration have the strongest association with SCP, it was proposed by several authors that internal integration must be realized for external integration to be effectively implemented. Moreover, performing internal integration activities such as cross-function activities could boost performance directly and indirectly (through coordination).

6.3 Limitation and Recommendation

The scope of this research is limited to the container shipping industry and hence, results should not be viewed as the “true” representation of the maritime supply chain. This paper has not examined the direction (backward or forward) of integration and specifically which node of the maritime supply chain that firms should focus on to maximise their performance.

Lastly, this paper has also not addresses other aspect of performance in its framework. Specifically, financial performances and other non-financial performances such as market share and service quality were not included in this study. Further research in these areas is recommended.

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