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SUPPLY CHAIN MANAGER COMPETENCIES AND THEIR IMPACT ON SUPPLY CHAIN INTEGRATION

Kamolchanok Suttiwatnaruput[1], Pongsa Pornchaiviseskul[2], Supachai Archiwaranguprok[3],

[1] Professor Dr., Faculty of Commerce and Accountancy, Chulalongkorn University, Thailand

[2] Associate Professor Dr., Faculty of Economics, Chulalongkorn University, Thailand

[3] PhD Candidate in Logistics Management, Chulalongkorn University, Thailand

ABSTRACT: *The level of supply chain professionals' competencies is a crucial factor to enhance a firm's competitiveness. Given the limited interdisciplinary study of supply chain management and human resource management, we provide insights of how supply chain manager competencies can impact the supply chain integration of a firm. Starting by developing a list of competencies, using principle component analysis, we achieve two key competencies; namely Technical Knowledge and Application and Traits and Management Skills. Subsequently, we apply multivariate regression to reveal how the two groups of competencies and a supply chain manager's roles and responsibilities impact differently each dimension of supply chain integration; namely internal integration, supplier integration and customer integration. At a significance level of 0.05, interpretation of regression coefficients reveals that Technical Knowledge and Application impacts internal and customer integration while Traits and Management Skills impacts internal integration. A supply chain manager's roles and responsibilities impact only internal integration. The findings enable concerned parties to implement actions to enrich supply chain managers of today and in the future.*

KEYWORDS: Supply Chain Manager Competencies, Supply Chain Integration, Regression Analysis, Multivariate Analysis

INTRODUCTION

Supply chain excellence in the global marketplace can be achieved through excellence in skills and competencies of the people who manage it (Spekman and Kamauff, 2002, Mangan and Christopher, 2005). Firms can enhance their productivity and profitability through strategic supply chain management. They need to excel today key performance such as on-shelf availability improvement, cost reduction (Butner, 2010, Green Jr. et al., 2008) and sound financial figures. They also need to look ahead to give priorities to additional measures, which become key concerns to stakeholders such as CO2 emission reduction, preservation of energy, and better management of transportation to avoid congestion. Supply chain network failing to synchronize strategies and objectives of the business cannot succeed in being among the top performers. Only with competent supply

chain managers, companies can keep themselves abreast of all the latest development in this field. Therefore, supply chain managers are to equip themselves with appropriate skills, knowledge and competencies.

At present, we inevitably ignore the growing numbers of interactions among firms from simply exchange of information on demand and supply, to a larger scale of serving different markets requirements. Firms having exposure to continual market size increase require their supply chain to be versatile. The whole supply chain network has to be agile in acting rapidly and intelligently in response to dramatic changes to demand and supply, as well as be adaptable to reshape supply when necessary (Lee, 2004). As a consequent, supply chain managers' job becomes increasingly complex, and multi-dimensional (Harvey and Richey, 2001). It is critical that a firm recruit, develop and maintain the right supply chain managers. All supply chain initiatives cannot yield results if a firm does not have correct human resources to manage both internally and externally its counterparts. What are the skills and competencies contributing to each dimension of supply chain integration; namely internal integration, customer integration and supplier integration? While many supply chain researches focus considerably on pure supply chain principles, neglecting human part, we would like to propose an interdisciplinary research on human resource management and supply chain management. We would question what competencies do supply chain managers required to possess and what is their impact on supply chain integration.

LITERATURE REVIEW

Supply Chain Manager Competencies

Comprehensive literature review brings about the understanding of contemporary discussion in the areas of skills and competencies of supply chain managers, which are important sources of qualitative and quantitative questions to be developed further. The review has shown that competencies required by supply chain managers are wider and more varied than those of other category managers.

Christopher (2004) states that supply chain managers need to possess T-shape skills profiles along with the evolvement of major business transformations. Current supply chain environment has changed from supplier to customer centric. Customers' requirement becomes a key driver to firms in developing their market strategy instead of pushing products out without evaluating the consequences, such as increase in inventory. Unlike previous transactional approach, firms have to build relationships with all key players (Barnesl and Liao, 2012) with a good understanding of the whole chain cost. For all these transactions, Christopher (2004) has identified skills to perform the job (vertical bar) for supply chain managers. For example, they need to understand the market well with good customer insights. With their ability to manage complexity and change, firms can achieve a higher level of flexibility and agility. Supply chain managers should make adequate use of information technology to capture real demand from customers while sharing it to their counterparts. If firms focus on customer retention, they need to ensure their supply chain

managers capitalize the ability to define, to measure and to manage service requirements by market segments. Cost-wise, it is crucial to know wider definition of supply chain cost structure by implementing indicators to follow them as firms cannot render service to customers at any cost (Butner, 2010). They also have to facilitate good teamwork cross-functionally and sustain a good relationship with all players (Kayakutlu and Buyukozkan, 2010, Zhao et al., 2011) throughout the supply chain network with win-win orientation. On a horizontal bar, supply chain managers should possess a wide knowledge of such related areas as business process engineering, marketing understanding, information technology, cost-to-serve indicators, and relationship management for a more effective connection with other disciplines.

Mangan and Christopher (2005), through their triangulated research approach to capture the views of education and training providers, program participants, and corporate, identifies key knowledge areas and competencies/skills comprising three board categories of general knowledge, logistics/supply chain management specific, and competencies/skills. Murphy and Poist (1994) suggest that senior-level logistics managers need to have management skills, logistics skills, and business skills. In addition to good communication skill in all interactions of supply chain managers, Gammerlard and Larson (2001) have postulated a three-factor model of SCM skill areas for executive development. It composes of interpersonal/managerial skills, quantitative/technology skills, and supply chain management skills. Razzaque and Bin Sirat (2001) conclude that high rating on general business administration and information system in their research reflects the logistics executives' awareness of the need to be generalists rather than specialists. The ability of firms to identify and maintain an adequate number of qualified global managers (Harvey and Richey, 2001) helps them to compete in the global marketplace.

How can firms be assured that there are not any gaps between current and required competencies of their supply chain managers? Defining required competencies for recruitment and selection process (Hoek et al., 2002, Keller and Ozment, 2009) is as crucial as identifying the gap to improve training system, performance evaluation, development plan and career growth for each person. Mangan and Christopher (2005) find that, in many developing countries, a large proportion of relatively young and inexperienced supply chain managers require coaching and development. Competency model should be adopted to identify important skills and knowledge, both general and specific, to be attained so as to improve the efficiency of their supply chain managers, and consequently supporting the excellence of the firms (Razzaque and Bin Sirat, 2001).

A Supply Chain Manager's Roles and Responsibilities

Supply chain managers play a tremendous impact on the success of an organization. They vary in groups and reflect different origins of the functional areas of their works. Some originally have backgrounds in real logistics and supply chain fields, while some used to hold responsibilities in transportation, procurement, information system or even in finance (Sutton, 1993, Mangan and Christopher, 2005). When it comes into business, supply chain managers engage in every aspect of the organization's activities from material planning to purchasing and storage, from production to distribution and customer services. Roles and

responsibilities of a supply chain manager differ by the level of strategic or operational dimension they have taken. Novicevic et al. (2000) explain transforming roles of managers in supply chain networks composing of internal orientation and rate of environmental change. The former considers whether it is cross-functional or functional, and the latter whether it is stable or unstable. Findings of Sandberg and Abrahamsson (2009) categorize management's roles in the form of four archetypes. They are the supply chain thinker, the relationship manager, the controller and the organizer of the future. All of them are not exclusively independent from each other, but complementary.

Supply Chain Integration

Lambert (2001) and Flynn et al. (2010) have defined supply chain management as key business processes integration from end users through original suppliers in order to optimize the flows of products, services information and money, which benefit customers in term of low cost and high speed. Academics and managers recently have been paying greater attention to the degree of integration on how supply chain partners from manufacturers to intra- and inter-firm processes collaborate among themselves. Supply chain integration is a necessary step for business performance improvement in a market competition (Michael et al., 2010).

Many researchers have attempted to find what influences supply chain integration and relationship among internal integration, external integration, and business performance (Harley and Beaulieu, 2009). A holistic view of supply chain has shifted paradigmatic role from the initial focus of a single firm to include a broader scope of overall performance, to which requires an adaptation of a systematic approach (Shepherd and Gunter, 2006). Some researchers specifically examine the intensity of supply chain integration. Some identify factors that facilitate and inhibit integration. Some propose the linkage of integration and performance.

Rozensweig et al. (2003) discover that supply chain integration intensity leads to an increase in competitive capabilities and business performance improvement. Firms with the highest integration with suppliers and customers have the highest level of financial, non-financial and operational performance (Vachon and Beaulieu, 2009, Frohlich and Westbook, 2011) whereas the interaction of internal and external integration, related to time-based performance, significantly relates to both market share and financial performance after controlling for all other effects (Cornelia et al., 2004).

From a separate dimension, internal integration directly relates to both business and operational performance while customer integration directly relates to operational performance. However, there is no direct relation of supplier integration to performance, yet its interaction with customer integration relates to operational performance (Flynn et al., 2010). Drogue et al. (2004) postulate positive antecedents of both external and internal integration to time-based performance, namely time-to-market, time-to-product and responsiveness. On a similar notion, Sriram et al. (2010) analyze the antecedents of process

integration and its impact on firm performance, which include information technology, task security, task complexity, end customer orientation.

Braunscheidel et al. (2010) investigate firm culture effect to determine cultural characteristics types that associate with efforts to integrate supply chain and delivery performance. Their findings provide evidence that culture plays an important role in influencing firms to adopt internal and external integration practices. Similar findings from Michael et al. (2010) describe the effects of firm culture to determine the types of cultural characteristics (clan, adhocracy, market, hierarchy) that strongly associate with efforts to integrate the supply chain and delivery performance. Wong and Boon-itt (2008) find an association of supply chain integration and the moderating roles of environmental uncertainty and institutional norm. Results of the test model proposed by Xiande et al. (2010) show that internal integration and relationship commitment independently impact an improvement of external integration. This aligns with the study of Barbara et al. (2009) that performance improvement is more strongly related to internal and customer integration than supplier integration.

CONCEPTUAL MODEL AND HYPOTHESIS

From the literature review, we have not found any researchers exploring the relationship between supply chain managers and supply chain integration with a link of competencies. We consider an interdisciplinary research connecting supply chain and human resource interesting since both of them are key functions of any firms. Therefore, we organize this paper by developing the constructs of supply chain manager competencies from relevant literature and explore their associations with different dimensions of supply chain integration. We also consider a supply chain manager's roles and responsibilities when analyzing competencies and their impact. Figure 1 shows a conceptual model with the following hypothesis.

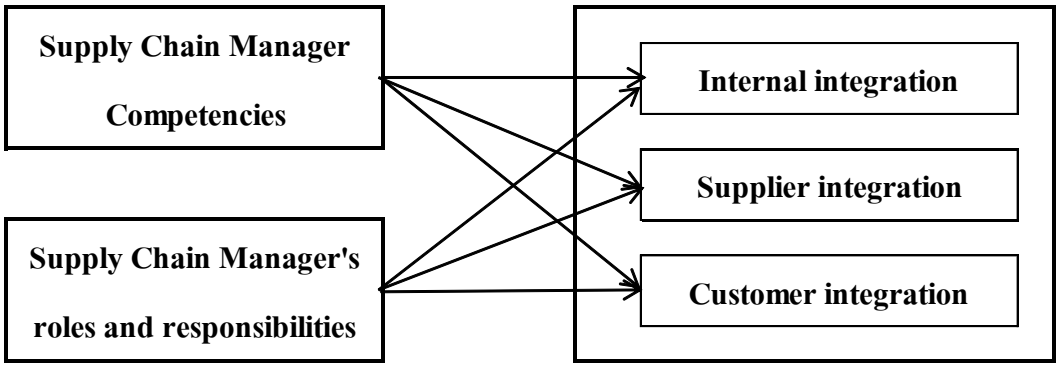

Figure 1: Hypothesized model: relationship among a supply chain managers' roles and responsibilities, competencies and supply chain integration

Hypothesis 1a: Supply chain manager competencies have a positive impact on internal integration

Hypothesis 1b: Supply chain manager competencies have a positive impact on supplier integration

Hypothesis 1c: Supply chain manager competencies have a positive impact on customer integration

Hypothesis 2: Supply chain manager competencies for each supply chain integration dimension are the same

Hypothesis 3a: A supply chain manager's roles and responsibilities have a positive impact on internal integration

Hypothesis 3b: A supply chain manager's roles and responsibilities have a positive impact on supplier integration

Hypothesis 3c: A supply chain manager's roles and responsibilities have a positive impact on customer integration

Hypothesis 4: A supply chain manager's roles and responsibilities for each supply chain integration dimension are the same

DATA COLLECTION AND ANALYSIS METHODOLOTY

Measures and Questionnaire Design

Besides demographic questions, we instruct respondents to make an assessment with the rating scale of 0-99 to describe their roles and responsibilities, supply chain integration level within their firms, current and required supply chain manager competencies. A higher value of the rating indicates a higher level of roles and responsibilities, a higher integration of supply chain, and a higher level of current and required competencies. In the analysis process, we add 0.5 points to each response to avoid having any observations with 0 rating. We transform the dependent variables and the independent variables of a supply chain roles and responsibilities, due to a large scale response, by taking logarithm to improve model fit thus making the variables more normally distributed and more convenient for interpretation.

Dependent variables: Dependent variables of the study comprise three dimensions of supply chain integration. Internal integration concerns cross-functional cooperation from incoming to outgoing activities of both operation and supporting teams to ensure smooth information and physical flows, as well as a joint effort of improvement. Supplier integration seeks for shared information between respondents' firms and their suppliers for strategic partnership, enabling both parties to address each other's requirements and constraints for better anticipation. Customer integration aims at responding not only timely but correctly markets' requirement through demand viability and operation flexibility

consideration. Giving an equal weight for different statements rating under the same integration, we derive mean values for the analysis. We then draw different models exclusively for each integration dimension. This is to understand how much effect human resource dimensions can have on the integration level.

Independent Variables: We define the independent variables from respondents' roles and responsibilities as well as their competencies level. The former describes how much involvement of the respondents' job functions within their firms. We give an equal weight to each statement to obtain a mean value of roles and responsibilities independent variable in the model. The latter depicts 20 entries of supply chain manager competencies, covering skills, knowledge and attributes that a supply chain manager should possess. Respondents are to rate their current competencies level as well as required level to perform their jobs. While we analyze a gap of current and required competencies level, we expect multi-collinearity among 20 entries and subsequently perform factor analysis to reduce a number of variables.

Sample and Data Collection

We collect samples of this research from two sources; (1) the Directory of the Logistics Office, the Department of Primary Industry and Mines, the Ministry of Industry, and (2) Linkedin website by searching supply chain professionals in Thailand. We send an on-line questionnaire to 698 target population with a personalized message if they would like to obtain the results of this survey. Eighty-two respondents provide their answers after one month. As we do not request respondents to identify their names in the questionnaire, we send a follow-up e-mail to remind everyone about their participation in this survey. Consequently, we receive 78 additional returns, making a total of 160 responses. The completion rate of 26.8% is a sizable number for empirical studies in operations management. Respondents' profile covers various industries in Thailand, and their work nature varies from a specific to a multiple activity in supply chain.

Table 1 shows a summary of demographic characteristics of the respondents. Half of the respondents work in the company size of less than 500 employees, and the other half more than 500 employees. Work nature of the majority of respondents is logistics management representing 38.8%, followed by those whose work nature covers two scopes representing 21.9%. The key industry is Industrial Goods & Services (32.7%). An average working experience is 10.4

Table 1: Respondents' profile (N=160)

Items	Response	%
Company size		
<500	76	47.5%
500-1,000	26	16.3%
>1,000	58	36.25%
Work nature		
Logistics management	62	38.8%
Customer relation management	10	6.3%
Supplier relation management	25	15.6%
2 areas of responsibilities	35	21.9%
3 areas of responsibilities	28	17.5%
Type of industry		
Industrial goods & services	50	31.25%
Personal & Household Goods	41	25.6%
Automobile & Parts	22	13.75%
Health Care	20	12.5%
Food & Beverage	18	11.25%
Other	9	5.6%

Table 2 presents the descriptive statistical result of the dependent variables. Among the three outcomes, internal integration has the highest mean, followed by supplier integration and customer integration. It is remarkable that respondents consider a substantial level of a cross-functional team to drive process improvement and product development. On improvement areas, customer integration should be addressed since customer involvement in key activities of a firm is weak, specifically in the product development process. Firms seem to act on customer requirement and demand with poor visibility, possibly leading to delivery issues and bullwhip effects throughout supply chain network. The perception of supplier integration of the respondents also reveals a low level of information sharing among firms and suppliers, particularly on the capability of operations flexibility.

Table 2: Supply chain integration (N=160)

Description	Mean	Standard Deviation	Cronbach's alpha
Responsiveness between departments to meet each other requirement	77.91	17.40	0.89
Integration and connections among all internal functions from raw material management through production, distribution and sales	78.19	19.76	0.90
Our organization emphasizes on cross-function team on process improvement and product development	78.84	18.72	0.93
Internal integration	**78.32**	**16.07**	**0.83**
Our organization exchanges information with our major suppliers through information technologies	70.02	24.69	0.95
Our organization has a strategic partnership with our suppliers	70.42	24.24	0.94

Our organization has joint planning with our suppliers to obtain rapid response ordering process, including new product development	71.43	23.16	0.93
Our major suppliers share their capability of operations flexibility	69.23	24.01	0.94
Supplier integration	**70.27**	**21.28**	**0.91**
Our organization exchanges market information with major customers	69.92	23.73	0.93
Our organization shares information to major customers through information technologies on operations flexibility	67.66	24.13	0.92
Our organization has joint planning and forecasting with major customers to anticipate demand visibility	69.83	24.15	0.91
Our customers are involved in our product development process	65.82	28.94	0.93
Customer integration	**68.31**	**21.73**	**0.88**

As seen from Table 3 descriptive statistics of a supply chain manager's roles and responsibilities, meeting customer's demand and future requirement by ensuring operations flexibility ranks first among the six statements. Respondents tend to address operational activities as higher priority than strategic fostering with customers and suppliers, or sustaining firms' competitiveness.

Table 3: A supply chain manager's roles and responsibilities (N=160)

Description	Mean	Standard Deviation	Cronbach's alpha
I ensure operations flexibility to meet both current customer's demand and future requirements.	81.34	17.40	0.86
I foster strategic relationship with suppliers and customers.	78.42	18.93	0.85
I am responsible for the company's strategic move to sustain competitive advantage.	73.14	22.32	0.88
I drive operational team to achieve daily and weekly targets.	77.68	23.13	0.87
I personally involve in corrective actions to most problems related to supply chain activities.	78.70	21.06	0.86
I deal with suppliers and/or customers to minimize all possible problems that will obstruct short-medium term supply chain operations	76.49	21.34	0.85
Overall roles and responsibilities	**77.63**	**15.11**	**0.82**

Table 4 describes another set of the independent variables of supply chain manager competencies. Respondents assess Integrity, Post Secondary Education, Customer Focus as the three highest competency level with the mean score higher than 75. When analyzing the gap between current and expected levels, the top three competencies showing the highest gap are International Business Rules & Regulations, Technical Logistics and

Supply Chain Function, and Supply Chain Synchronization. Meeting the international business requirement such as compliance with transportation modes, trade conventions, offshore procurement process, and risk-management is critical to successful establishment of a global footprint. With increasing concern on environment preservation, such laws as Clean Air and Toxic-Substances Control Act imposed by any countries could decrease a firm's international competitiveness if it cannot demonstrate compliance. Supply chain managers have to ensure balance between technical and attitudinal aspects for higher integration. Technical functions deal with supply chain planning and control methods, work flow structures, organization structures, communication infrastructures and product flow facilities structure. (Prajogo and Olhager, 2011, Chow et al., 2008). The ability to manage demand variability and supply patterns by ensuring information visibility across organization promotes synchronization and strengthens a firm's competitiveness. (APICS, 2009).

Table 4: Supply chain manager competencies (N=160)

Description	Current Level			Expected Level			GAP			Rank	Cronbach's
	Rank	Mean	Std. Dev.	Rank	Mean	Std. Dev.	Rank	Mean	Std. Dev.	Change	Alpha (current level)
Interpersonal skills	10	71.93	16.14	8	89.96	9.11	11	18.03	14.58	2.00	0.967
Effective communication	11	71.86	17.05	4	91.09	7.44	9	19.23	15.19	7.00	0.966
Integrity	1	85.42	15.93	1	94.59	7.31	19	9.18	13.41	0.00	0.968
Building effective teams	9	72.23	17.13	2	91.68	8.35	5	19.45	14.51	7.00	0.965
Personal learning & self-development	4	73.11	15.61	6	90.26	8.86	15	17.16	12.20	(2.00)	0.966
Post secondary education	2	79.76	21.21	14	88.16	15.01	20	8.41	14.77	(12.00)	0.969
Math, statistics and analytical thinking	7	72.64	17.42	19	87.22	11.89	18	14.58	11.28	(12.00)	0.967
Supply chain fundamentals	12	71.31	19.29	11	88.59	11.93	14	17.28	13.95	1.00	0.966
Business process knowledge	8	72.34	18.95	7	90.03	10.24	13	17.68	14.43	1.00	0.965
International business rules & regulations	20	62.94	20.88	20	84.55	13.55	1	21.61	16.46	0.00	0.966
Technical logistics/supply chain functions	19	66.33	20.13	18	87.44	11.62	2	21.11	15.88	1.00	0.966
Work processes management	5	72.73	17.34	5	90.41	9.00	12	17.69	14.53	0.00	0.965
Supply chain synchronization	18	67.28	19.59	16	88.05	12.34	3	20.77	16.16	2.00	0.965
Customer focus (internal / external)	3	75.78	17.18	3	91.31	9.14	17	15.53	14.61	0.00	0.965
Supplier management	13	70.03	18.20	10	89.39	9.95	6	19.37	15.83	3.00	0.966
Enabling technology	14	69.92	17.10	12	88.59	9.57	10	18.67	15.14	2.00	0.966
Conflict management	17	67.71	19.14	15	88.15	12.73	4	20.44	15.92	2.00	0.965
Change & complexity management	16	68.58	18.63	17	87.91	11.65	7	19.33	15.35	(1.00)	0.965
Focus on the bottom line (action oriented /results)	6	72.69	18.74	9	89.76	11.24	16	17.08	15.01	(3.00)	0.965
Strategy development & Application	15	69.21	17.56	13	88.45	10.94	8	19.24	14.04	2.00	0.966

In contrast, Integrity and Post Secondary Education has the smallest gap between current and expected levels. We need, however, to analyze these competencies with caution as most respondents seem to be positive. Despite their smallest gaps, we still need to reinforce them to achieve even higher competency level. Personal integrity is one of the most desired attributes, and an ingredient of the efficient management system for business success. (Razzaque and Sirat, 2001, Chow et al, 2006, Thai and Cahoon, 2011). Postsecondary education can promote competencies improvement in supply chain management. This is especially when supply chain professionals hold degrees related to supply chain or operations management. (Sauber et al, 2008, APICS, 2009)

The Proposed Model

Factor analysis: As part of a model building, we apply Kaiser-Meyer-Olkin (KMO) and Bartlett's Test to measure the strength of the relationship among twenty variables of supply chain manager competencies. We discover the KMO measure of sampling adequacy at 0.95 indicating that the degree of common variance is marvelous (Kaiser, 1974), whereas the approximate chi-square value obtained from Barlett's test of sphericity is 3183.22 with its associated probability less than 0.01. This significance level is small enough to reject the null hypothesis that the correlation matrix of supply chain manager competencies is an identity matrix.

The test result allows us to conduct a principle component analysis (PCA) from those variables in order to express data in such a way to highlight their similarities and differences, as well as to get a small set of variables, so-called factors (Smith, 2002). After running factor analysis, we perform Varimax rotation to produce orthogonal factors, not correlating to each other. The Keiser test, as a criterion, says that only factors with an eigenvalue of 1 or greater than 1 are meaningful. Therefore, we can obtain two factors namely Technical Knowledge and Application; and Traits and Management Skills. Table 5 displays the factor loading of all competencies which are greater than 0.5 and the cumulative variance is 70.11%.

The result reveals that the first factor with the Eigenvalue of 12.61 has the largest explanatory power of supply chain manager competencies, followed by the second factor whose Eigenvalue shows 1.42. Highly close relationship exists between Technical Knowledge and Application, and Traits and Management Skills at 0.844, reaching the significant level of 0.01. For Technical Knowledge and Application factor, Technical Logistics/Supply Chain Functions, Supply Chain Fundamentals and Strategy Development and Application are the top three competencies with high loading. Similarly, Integrity, Effective Communication and Interpersonal Skills are the top three competencies loading in Traits and Management Skills factor.

Table 5: Factor analysis

	Factor 1	Factor 2
Factor 1: Technical Knowledge and Application (TKA)		
Technical logistics/supply chain functions	0.868	
Supply chain fundamentals	0.846	
Strategy development & Application	0.796	
Enabling technology	0.776	
Personal learning & self-development	0.716	
Math, statistics and analytical thinking	0.696	
International business rules & regulations	0.630	
Supply chain synchronization	0.628	
Business process knowledge	0.607	
Factor 2: Traits and Management Skills (TMS)		
Integrity		0.810
Effective communication		0.796
Interpersonal skills		0.769
Building effective teams		0.749
Work processes management		0.703
Conflict management		0.653
Change & complexity management		0.645
Focus on the bottom line (action oriented /results)		0.641
Post secondary education		0.638
Customer focus (internal / external)		0.635
Supplier management		0.574
Eigenvalues	12.606	1.416
Explained variance (%)	0.630	0.071
Total explained variance (%)	0.630	0.701

Multivariate regression analysis: To test all of the hypotheses, we use multivariate regression for supply chain integration outcomes (internal, supplier and customer) in term of a set of predictor variables (Technical Knowledge and Application, Traits and Management Skills, and a supply chain manager's roles and responsibilities). Prior to the analysis, we take logarithm of dependent variables and independent variables of roles and responsibilities of a supply chain manager. We apply STATA statistical software version 11.0 through `mvreg` procedure to calibrate three distinct models of supply chain integration. Instead of running OLS regression, we apply multivariate regression as it enables us to conduct tests of coefficients across different outcome variables as required by the hypothesis 2 and 4.

From the STATA output, as summarized in Table 6, it shows that each of the three univariate models is statistically significant at the alpha level of 0.01. Three predictor variables explain 33%, 22% and 13% of the variance in the equations internal integration, supplier integration, and customer integration respectively. The Breusch-Pagan test is significant with a chi-square of 122.631 and $p < 0.001$, so we conclude that the residuals of supply chain integration variables are not independent of each other.

Table 6: Supply chain integration models fitting with multivariate regression analysis

	Equation	R-square	F	P	
	Internal	0.332	25.809	0.000	
	Supplier	0.220	14.626	0.000	
	Customer	0.134	8.037	0.000	
Measures	Variables	Coeff.	S.E.	t	p>[t]
Internal	Technical knowledge & application	0.010	0.005	2.160	0.032
	Traits & management skills	0.006	0.005	1.290	0.198
	Roles & responsibilities	0.037	0.071	4.320	0.000
	Constant	-0.651	0.199	-3.270	0.001
Supplier	Technical knowledge & application	0.000	0.006	-0.030	0.979
	Traits & management skills	0.021	0.006	3.350	0.001
	Roles & responsibilities	0.098	0.089	1.110	0.268
	Constant	-1.066	0.248	-4.300	0.000
Customer	Technical knowledge & application	0.015	0.007	2.270	0.025
	Traits & management skills	0.002	0.007	0.270	0.790
	Roles & responsibilities	0.054	0.099	0.550	0.583
	Constant	-0.773	0.276	-2.800	0.006

As we build the estimated regressions with logged dependent variable, non-logged independent variables (competency), and logged independent variables (roles and responsibility), we interpret differently the outcomes. At a significant level of 0.05, an increase by one unit of Technical Knowledge and Application level drives an increase of internal integration by 1.0% and customer integration by 1.5%. However, it does not have any impacts on supplier integration. On the contrary, with the same significant level of 0.05, an increase by one unit of Traits and Management Skill level can raise supplier integration level by 2%. As for the logged independent variable, a supply chain manager's roles & responsibilities, we can remark its impact on the internal integration model only. A 1% increase of roles and responsibility of supply chain manager can increase the internal integration level by 0.3%

In order to validate the hypothesized model on the relationship among supply chain manager competencies, a supply chain manager's roles and responsibility, and supply chain integration, we work through both collective variables and individual variable using a `test` procedure. The result of three independent variables as a group in all equations reports a significant level of an F-statistic of 11.26 and $p < 0.001$. It thus confirms fitness of the proposed models with observation data. For each hypothesis, we analyze the findings.

Hypothesis 1 states that supply chain manager competencies have a positive impact on supply chain integration. We analyze two independent variables separately. Technical Knowledge and Application report an F-statistics on the overall models at 4.01 ($p<0.01$), and individually on the internal integration model at 4.68 ($p<0.05$), on the customer integration model at 5.14 ($p<0.05$) and show insignificant statistics on the supplier integration model. Traits and Management Skills reports an F-statistics on the overall model at 5.60 ($p<0.01$) and shows statistically significance on the supplier integration model only ($F = 11.2$, $p<0.01$). The test results support the hypothesis 1 indicating supply chain manager competencies collectively impact all dimensions of supply chain integration. However, individually they have different impact on each integration dimension.

Hypothesis 2 states that supply chain manager competencies for each supply chain integration dimension are the same. We test whether simultaneously coefficients for Technical Knowledge and Application and those for Traits and Managerial Skills are equal, then we conduct a pair-test of each equation. As for Technical Knowledge and Application, the first test yields an F-statistics of 4.24 ($p < 0.05$). By pair, an F-statistics for internal and supplier integration equations is 3.32 ($p > 0.05$), for internal and customer integration equations is 0.55 ($p > 0.05$), and for supplier and customer integration equations is 7.72 ($p < 0.01$). The result is to conclude that coefficients for Technical Knowledge and Application are simultaneously not equal. Pair-wise we cannot reject the null hypothesis that coefficients for internal and supplier integration equations, as well as for internal and customer integration equations are the same due to their associated p-value is insignificant. As for Traits and Management Skills, an F-statistics of collective supply chain integrations reports a value of 6.29 ($p < 0.01$). By pair, an F-statistics for internal and supplier integration equations is 5.69 ($p < 0.05$), for internal and customer integration equations is 0.48 ($p > 0.05$), and for supplier and customer integration equations is 10.99 ($p < 0.01$). Similarly to Technical and Knowledge and Application, the result for Traits and Management Skills is to reject the null hypothesis that coefficients in each equation are equal. However, a test by pair shows significant p-values only in internal and supplier integration equations, and supplier and customer integration equations.

Hypothesis 3 states that a supply chain manager's roles and responsibilities have a positive impact on supply chain integration. A test result indicates that this variable is significant with an F-value of 6.90 ($p<0.001$). After reviewing each equation, we find that a supply chain manager's roles and responsibilities only impact internal integration ($F = 18.7$, $p < 0.001$). Therefore, we only accept the hypothesis 3a and reject the hypothesis 3b and 3c.

Hypothesis 4 states that a supply chain manager's roles and responsibilities for each supply chain integration dimension are the same. With the same procedure conducted in the hypothesis 2, collectively we have to reject the hypothesis since an F-statistics for all equations is 4.16 ($p < 0.05$). However, we find that an F-statistics pair-wise for supplier and customer integration equations is not statistically significant.

MANAGERIAL IMPLICATION AND CONCLUSION

This research shows how we can apply the multivariate regression to an assessment of supply chain integration level impacted by competencies. It is the only study to link how attitudes, knowledge and skills of supply chain managers can predict supply chain integration of any firms. The developed models provide to firms a way for identifying improvement actions of their supply chain professionals on both technical and soft skills. Such identification will guide concerned parties to take appropriate measures in order that required competencies can be achieved and sustained.

The results reveal that competencies listed in Technical Knowledge and Application, Traits and Management Skills, and well as a supply chain manager's roles and responsibilities are obviously complementary in driving a higher level of supply chain integration. They do not, however, render the same impacts. If we consider that overall supply chain integration comprises of three dimensions, including internal, supplier and customer, firms have to evaluate in which integration dimension they need to emphasize to sustain their competitive advantage. For example, firms in the manufacturing environment may have to focus more on supplier and internal integration while logistics service providers have to ensure the management of customer integration. As indicating in the results, Technical Knowledge and Application are significant factors in internal and customer integration dimensions while Traits and Management Skills are crucial in driving supplier integration. When comparing the two groups of supply chain manager competency, we find Technical Knowledge and Application have a higher contribution to supply chain integration. Loading factors show that the top three competencies, among nine of them, are Technical Logistics/Supply Chain Function, Supply Chain Fundamentals, and Strategy Development and Application. Technical Logistics/Supply Chain Function shows as well the second highest gap when compared current and expected level.

Taking into account a supply chain manager's roles and responsibilities as an individual factor, the result shows their influences only on internal integration. This may raise some concerns if we make an interpretation by only the regression result as they seem not impact supplier and customer integration. However, when we analyze in parallel simply with the mean score of the statements describing a supply chain manager's roles and responsibilities, all statements show the level of higher than 75%. As a result, we cannot inevitably consider them important.

In applying the model, firms can establish criteria for recruitment and development of their supply chain managers to meet business requirements. It is crucial to have qualified professionals performing their roles so efficiently that firms integrate well with all stakeholders throughout supply chain network. Similarly, supply chain professionals can refer to the model to identify a competency gap for their personal improvement, consequently increasing their employability level as when compared to those being less competent. Lastly, academic institutes might align their curriculum to foster required technical knowledge on supply chain (Hoek, 2001, Wu et al., 2013) and help students to grow in their career advancement. On a macro level, we might be able to identify

opportunities for partnerships between academic institutions and corporate sectors in developing and delivering knowledge and learning as to equip current and future supply chain managers with appropriate skills and competencies.

LIMITATIONS AND AREAS FOR FURTHER WORKS

Similar to any research, this study may have some shortcomings. The models, despite validity test, may not accurately reflect complete required skills, knowledge and competencies of supply chain managers in all types of industries. Some may consider a group of competencies more important than the others. Nationality and years of experiences of supply chain managers may play an important role in their perceptions of each questionnaire item, thus leading to incomplete analysis. The size of companies and business complexity may also be contributing factors in perception difference of the respondents. Apart from these shortcomings there are potential areas for further works, including adding other variables to verify their impact on supply chain integration. The model can also be diversified on the basis of supply chain manager characteristics in order to verify how competencies change according to their functions. At this stage, number of observations is not large enough to allow this analysis.

Three dimensions of supply chain integration may have different important weight in overall integration. Instead of only analyzing each dimension, an aggregate integration may be interesting as it allows additional aspects of comparisons among firms' and businesses' competencies level. Furthermore, in-depth case studies on best practice of firms' approach to coach and develop supply chain professionals at all levels, from junior to top management as to sustain their competitive edges can be explored. Future research could cover more countries to compare and contrast required competencies. For example, researchers may want to gain more insights by benchmarking supply chain professional development roadmap of each country, especially through cooperation of national firms as to validate its alignment with increasing supply chain complexity in the region.

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