

Operational Infrastructure Enhancing the Supply Chain Management

Panyaluck Udomleartprasert
Computer and Engineering Management
Assumption University
Thailand
Panyaluck_u@yahoo.com

Chamnong Jungthirapanich
Computer and Engineering Management
Assumption University
Thailand
Chamnong_jng@au.edu

Abstract

The widespread implementation of supply chain management induced company to move beyond the national boarder and enticed the global competition in business. It has been proven that the supply chain management enhances the improvement in terms of cost reduction and other competitiveness. Applying supply chain management on overall organizations, companies generally considered themselves successful in managing their supply chains. However, while they have achieved the improvement in organizational performance, they have not reached the magnitude of improvements or the desired results ascribed to supply chain management [12,38,39]. Supply chain concerns and problems were first studied in the year 2002. The results showed that the most concerned items were Supply Chain Coherence such as lack of cooperation among supply chain members, Information Capability such as lack of sophisticated information system, and Geographical Proximity such as customer and supplier geographical distances. All of these concerns, related to some basic infrastructures of the company, the supply chain knowledge and operational skill before implementation [38,39,41], affected the effectiveness of supply chain practices and performances.

In this research, we study the infrastructures that enhance the success of supply chain implementation, which influence the supply chain and organization performance. In this work, the author adopts 3 categories of infrastructure as the critical success factors of supply chain implementation. Man is defined as people's skills and education. Machines or tools are defined as supporting items for instance software and tools. Management refers to the supporting factors that drive the man or employee to work according to the strategies. The EQS is used to analyze the data collection. Total 114 data were completed and the result shows the significant related of operational infrastructures and success of supply chain management

1. Introduction

Supply chain management addresses the fundamental business of supplying to meet demand in a complex and uncertain world. Supply chain management emerged in the early 1980s due to the rapidly changing and business competition environments in various industries. In order to improve the overall performance towards the ultimate consumer in the marketplace, supply chain management is a consequence of the cooperation between and across

companies' business activities in marketing channels. The significance of supply chain management has been substantial importance since the early 1990s, although the approach or the concept was introduced back in the early 1980s. Supply Chain Management is an influential ingredient in today's literature and thinking in the field of logistics [1,18,38]. Supply chain management is delivering major economic benefits to business as diverse as manufacturing, retailers, Service Company, etc. The competition has become fierce as companies can go beyond national borders. However, the organization realized that the most immediately benefits that businesses can expected from strategic supply chain management are lowered inventory risks and costs, along with reduction in warehousing, distribution, transportation costs, etc. Over the time, firms will also experience sustainable cost savings through increased productivity and streamlined business processes in procurement and purchasing order fulfillment, accounts receivable and payable, and exception management. Subtler benefits can include accelerated product delivery times, more efficient product development efforts, and lower product manufacturing costs. In the long term, the most significant benefits to businesses with advanced supply chain management capabilities will be dramatically improved customer responsiveness, increased flexibility for changing market conditions, improved customer service and satisfaction, increased customer retention, and more effective marketing [7,19,27,32].

However, most of companies implemented the supply chain management can not reap the supply chain benefits expected. The supply chain concerns and obstacles were first studied in year 2002. The results shown that the most concerns items are Supply Chain Coherence such as lack of cooperation among supply chain members, Information Capability such as lack of sophisticated information system, and Geographical Proximity such as customer and supplier geographical distances. All of these concerns impact to the effectiveness of supply chain practices and performances[39]. Most of the concerns and problems are some basic infrastructures of the company as well as the supply chain knowledge or operational before implementation [18,33,39]. The information exchange is consistently mentioned as a key requirement of successful supply chain management implementation, the main premise of supply chain management is that the sharing of information and the coordination of strategies among firms in a supply chain can both reduce total logistics costs and enhance value

delivered to the customer, which can lead to sustainable competitive advantage for the firm [7,13,34]. The organization characteristics, larger organizations tend to be more diverse and complex and the increased availability of resources can lead to more risk taking by management because potential failure is less hazardous to the health of large organization. Some researches found that the larger organizations adopt more innovations [13]. The management commitment is the key critical factor in supply chain implementation, the budget, vision, information are all derived from the management through the employees. As the above basic infrastructures required, we study the critical operational infrastructures enhancing the supply chain practices and performances. The existing researches on supply chain management pay scant directly about the infrastructures of supply chain management and practices. The literature review of Journal of Business Logistics and Journal of Supply Chain Management from 1970 - 2003, there were no evidence about the studying of the infrastructures enhancing the supply chain practices. In this work, the author adopted the 3 categories of infrastructure of the critical success factors in supply chain implementation. Man is defined as the operational staff worker's knowledge, experiences or etc. Machine is defined as a operating tools for supply chain managing. Management is defined as the commitment from the top level in order to support the supply chain activities and implementations. The supply chain management in this paper, we define the two layers of management. The first layer is the infrastructures level which we define the man, machine and management as the basic infrastructures. Another layer is the supply chain level which we classify as a supply chain practice and a supply chain performance. The research model developed from the Croteau's research model. This research model studies the relationship between basic supply chain infrastructures and the supply chain practices and performances. The research objective is to validate the infrastructures related to the supply chain practices and performance by using the structural equation modeling with - EQS technique.

2. Literature Review

The supply chain company comprises geographically dispersed facilities where raw materials, intermediate products, or finished products are acquired, transformed, stored, sold and transported to the customers. These activities are the connected facilities along the products flow. The facilities may be operated by the company or vendors, customers, third-party providers, or other firms which the company has business arrangements. The company's goal is to add value to the products through the supply chain and transport them to geographically dispersed markets in the correct quantities.

In the 1950s and 1960s, most manufacturers emphasized on the mass production to minimize the unit cost of production, with the low product flexibility. The information sharing to supplier or partnership was

considered risky. In the period, there was a little to find the cooperative and strategic buyer-supplier partnership and it is rare to find the supply chain organization [38].

In the early of 1970s, the emphasis of competitive strategy was shifted from productivity and mass production to quality emphasis and cycle time reduction [4,5,11,38]. The material requirement planning (MRP) was developed and managers realized the impact of huge WIP inventories on manufacturing cost as well as the product quality, product development and delivery lead-time [1,2,21,28]. All of above inconsistency performance of the supplier or partnership direct and indirect effected to the company in term of the cost, customer satisfaction and management issue. In this period, manufactures resorted to new material management concepts to improve the company performance.

In the 1980s, the global competition forced world-class organization to offer low-cost, high quality and reliable products with the greater design flexibility. The JIT was developed to support and improve the manufacturing efficiency and cycle time [8,15,27,37,38] as well as minimize and manage the inventory. In this period, the buyer-supplier relationship was accountability. The supply chain concept emerged as the experiment in manufacturing. Additional, the procurement professional, logistics experts carried the further step in order to incorporate the physical distribution, transportation and warehousing functions [37].

The evolution of supply chain management continued into the 1990s due to the intense of global competition. The higher demanding from customer to get the product, service at the right time in the lowest cost, the organization or manufacturing realized to improve the overall organization efficiency as well as the efficiency of their partnerships both customer and supplier. The long term and closely working relationships are developed to keep the competitiveness within the chain. In this period, the supply chain management was continued from 1980s and further extended best practices in managing corporate resources to include strategic suppliers and logistics function.

In the end of 1990s to 2000s, several developments in material management were emerged. MRPII and ERP were developed as a tool in managing the material. The advanced supply chain management and logistics were studied to improve the efficiency of process such as the lean logistics, agile supply chain, etc. Currently the supply chain is the new business process management in almost organization regardless to the business types or products. The literature review in supply chain management area was conducted in reviewing The Journal of Supply Chain Management since 1993 to 2003. And The Journal of Business Logistics since the Year 1970 to 1997 that analyzed by Stock in 1997 [2]. There are 1589 citations in total.

Table 1. Supply Chain Revolution

Period	Cooperative Characteristics	Authors
1950s–1960s	-Low cooperative strategy between buyer and supplier -Emphasize on the mass production to minimize cost with low product flexibility -No supply chain developed	Tan 2002
1970s	-Emphasize on high quality product -MRP is developed supporting the WIP managing -Initiate the cycle time reduction, accurate lead time delivery, product development concept	Carter et al 1996, Tan 2002
1980s	- High global competition forced - Market need Low cost , High Quality, Reliable , Higher flexibility - JIT developed to minimize and manage the inventory - Realized the buyer and supplier relationship in cooperate management	Tan 2001, Tan 2002
1990s	-Higher demand of quality product, service in the right time at the lowest cost -Partnership management emerged, the long term, partnership relationships, closely working with the supplier was developed - Supply Chain Management was continued from Period 1980s	Inman and Hubler 1992, Morgan and Monczka 1995, Onge St. A. 1996
2000s	- MRPII, ERP were developed to support the material management - Supply Chain Management is the new business process mgt.	Tan 2002, Elmuti 2002, Li 2002.

The most popular topic is the transportation, purchasing & inventory, logistics, information system, channel of distribution, MRP, DRP, JIT& Kanban, location analysis, supplier management, customer service, human resource & organization, supply chain concept, and others respectively. The number of citation VS the subject area is shown in the following table.

Table 2. Literature Review in Supply Chain

Subject Area	No of citation (s)
Transportation	406
Purchasing & Inventory	384
Logistics	184
Information System	163
Channel of Distribution	132
MRP, DRP, JIT, Kanban	71
Location Analysis	59
Supplier Management	50
Customer Service	42
HR and Organization	34
Supply Chain Concept	27
Miscellaneous	19
Packaging	8
Quality	7
Outsourcing	3

From the literature review, there were very rare the supply chain infrastructure topics. This paper focused on the infrastructure factors that impact on the successful supply chain implementation.

3. Supply Chain Management

3.1 Supply Chain Performance

Managing a supply chain is becoming the important issues for organizations. Several researches mentioned that the competition is no longer between organizations but among supply chains [19]. Wisner and Choon suggested that the intense global competition of the past decade has let organizations to create the cooperative, mutually beneficial partnerships with suppliers, distributors, retailers, and other firms within the supply chain. The objectives of those partnerships are to offer the lower-cost, higher quality products and services with greater design flexibility [3,12,15], cycle time improvement, higher productivity, waste reduction, efficiency of work, and product quality [19,26,27,31]. Supply chain implementation objective is also to achieve the financial and level of firm revenue as to maximize over time ratio of the annual revenue, less operation costs [3,5,36], sales, sales per staff, gross sales, operating income before depreciation, return on assets, net income (Ross 2002), saving, ROE, ROI and margin [1,19,29,33]

Several researchers focused on supply chain performance measurement and firm performance improvement objectives [2,6,8,17,28,29]. In 1995,

Mcmullan studied about the supply chain management practices in Asia Pacific, the researcher investigated the four key areas; management issue, role and responsibilities, competitive strategies and performance management. McMullan [29] also suggested that in order to achieve a competitive advantages, the firm is required to change their organization structures, relationships with supply chain members and performance measurement systems as well as the new information technology to enhance communication throughout the supply chain which will be increased the service levels and reduce the operating costs. Lambert et al described the supply chain is to maximize the profitability at each line, supply chain performance migrates toward management's objectives and maximizes performance[27].

The customer management and satisfaction is the objectives of supply chain implementation [3,14,27,29] in order to deliver the on time delivery product, reduced the customer complaints, provide the inventory accuracy and reduce the total cycle time [29,37]. The supply chain implementation in manufacturing can also reflect to the customer satisfaction by increase sale volume, cost reduction so sell higher margin products, reduce safety stock, improve asset utilization, product development, investment plan, resource effectiveness [16,27,29,]

For the supplier management, many researchers identified that it is the critical success factor in supply chain management [1,7,9,18,23,25]. The objectives expected from the supply chain management program are to acquire the right quality products in the right supplier, time, price and services [10,11,2137]. The impact of supplier selection criteria and supplier involvement can be impacted to the firm performance by reduced the production rework cost, reduced the production costs per unit, decreased the work in progress inventories, material handling and increased the quality of outgoing product and delivery performance from the accuracy in delivery from the supplier [3,12,22,39].

The warehouse and transportation is the one component in supply chain integration, the most common measured in warehouse performance are inventory accuracy, on time delivery, shipping error, warehouse cycle time, etc [16,24,27,32]. Some researchers identified the benefits of supply chain in warehouse and transportation as to lower inventory cost and risk, warehouse cost reduction, cost saving from overtime through increased productivity and streamlined business processes in procurement and purchasing. The logistics system can be saved for the operation cost [19,34] by implementing the freight and transportation management. There are some researchers studied about the third party service provided in helping cost and efficiency improvement.

The warehouse management seems to be related to the Information Technology. Some companies have implemented the software in managing the warehouse and inventory processing, the software in Inventory Management is the most application to supply chain organization [29]. So the Information Technology is one of the key success factors to supply chain management. It

is as the medium for coordination among and within organizations but the larger of IT investment seems not to lead the higher financial performance [22,36]. So the firm should consider the investment level of Information technology in achieve the highest benefit return. Some usage of Information Technology in supply chain such as the Internet which provides the opportunity for demand data and supply capacity data to be visible to all company within the chain [21,35]. Other applications of Information Technology in supply chain management concerned in usage of Warehousing management, fleet management, facility network planning, MRP II, Barcoding, Radio frequency, EDI [4, 29, 26, 27].

Table 3. The Literature Review in the Supply Chain and Firm Performance

Supply Chain Performance	Descriptions	Authors
Financial Performance	The overall profitability or cost reduction after the supply chain implementation in term of ROI, ROE, Profit sharing, etc	Mcmullan 1995, Lee 2002, Elmuti2002, Lambert 2001,
Managerial Performance	The effectiveness and efficiency in overall managing from the first process of purchasing through the final process of transportation and logistics to end customer	Lambert 2001
Competitive Performance	The strength of company in order to win over the competitors	Hewitt 1999,
Customer Relation Performance	The relationship and efficiency in managing to achieve the customer expectation	Hewitt 1999, Elmuiti2002 McMullan1995
Warehouse and Transportation Performance	The effectiveness and efficiency in material from supplier and finished product to customer	Mcmullan, 1995, Tan et al 1998,
Technological Performance	The utilization of technological hardware and software in order to maximize the efficiency and effectiveness in supply chain implementation	Ellram 2002
Supplier Relation Performance	The supplier's consistency in delivering materials, components or products as well as developing the long term partner.	Lambert 2001, Power 2001, Talluri 2002,

From these benefits, the advent of information technology and intense global competition has enticed

many world-class manufacturers, service providers [39,40] adopt an integrated strategic approach to supply chain management. To achieve these benefits, the supply chain strategies were implemented and studied by several researchers in how the practices related to firm performance or individual studied the supply chain practices for implementation.

3.2 Supply Chain Practices

The facing of competitive global market, revolution in manufacturers, downsizing and lean in organization, to achieve the competitive advantage the organization need to adapt and implement some value-adding activities. In order to achieve the financial performance, firm should focus on the profit maximization, cost reduction in manufacturing, operating cost, cost of quality, etc [18, 22]. Some manufacturers are practicing the process cutting by adding some processes to supplier capacity [33] such as the part preparation before production.

The most practices in customer management are to identify the customer needs, reduce the customer complaints, full score of delivery performance [4,38]. These activities the firm expected the repeated order in long term. In the other hand, firm also need the strongly support by their suppliers. The supplier will be monitored by the firm since the starting of business, many firms implemented the supplier selection program and set up the team to control the supplier performance as well as the reducing incoming inspection lot at firm's receiving, provide the supplier certification for the excellent supplier performance [32, 38, 39,40]. Currently, the suppliers are treated as the partnership in business, some purchasing roles in organization had been changed such as purchasing from individual plant source in low cost items, decentralized the purchasing, annual price negotiation activities [38,39].

The outsourcing is another premise of supply chain management for the cost reduction, the outsourcing can be applied to transportation function, warehousing function or human resource management [19] and Information technology. Some researchers [17,18] identified the information technology that purchasing and supply management use in 6 items. The cost reduction was initiated in the JIT program to keep less inventory and lower risk as well as the transportation which the consolidated and postponement strategy were selected to perform the cost reduction. Generally, the supply chain practices and activities were emphasizing in internal competencies which it requires greater reliance. In an empirical survey, Tan et al 1998 identified 10 SCM practices and showed that some of the practices affected firms' performance. Later in 2002, Tan studied the 25 supply chain practices related to the firm performances and concerned, the result shown that the "determining the customers' future needs" was the most practice items of the survey respondents and it is strongly to customer service and competitive position performance of the firm. The "use of third party SCM specialist" is the lowest activities rating from the survey respondents and no any

relation to the any firm performances [39,40].

3.3 Supply Chain Infrastructures

From the past researches, there were no supply chain infrastructures found in the literature review. In this paper, the researchers define the supply chain infrastructures into 3 parts as the followings

3.3.1 Man Infrastructures

Man infrastructure is defined as capability of people in supply chain organization. In this research, we focus on the followings

- (a) Skill and experience
- (b) Education and training

3.3.2 Machine Infrastructures

Machine infrastructure is defined as the equipment, tools or necessary things to support the supply chain activities. In this research, we focus on the followings

- (a) Equipment, tools, computers, etc
- (b) Software, computer program, MRP, ERP, etc

3.3.3 Management Infrastructures

Management infrastructure is defined as the management vision to the supply chain management and implementation. Due to the supply chain management is required the investment so the budget for the implementation is significant impacted to the overall success. In this research, we focus on the followings

- (a) Management commitment
- (b) Management strategy

In this research, we study the infrastructures that directly impact to the supply chain practices and supply chain management. The research model categorize into multilevel of supply chain. The basic level is the supply chain infrastructure. The intermediate level is the supply chain practices and the supply chain performance is the latest level.

4. Study Tool

The study tools in this research are the Q Methodology in clustering the basic infrastructure as the classified category. The structural equation modeling is used to validate the research result.

4.1 Q Methodology

Q methodology was invented in 1935 by British physicist-psychologist William Stephenson in 1953 and is most often associated with quantitative analysis due to its involvement with factor analysis. Statistical procedures aside, however, what Stephenson was interested in providing was a way to reveal the subjectivity involved in any situation -- e.g., in aesthetic judgment, poetic interpretation, perceptions of organizational role, political attitudes, appraisals of health care, experiences of bereavement, perspectives on life and the cosmos, et cetera ad infinitum. It is life as lived from the standpoint of the person living it that is typically passed over by

quantitative procedures, and it is subjectivity in this sense that Q methodology is designed to examine and that frequently engages the attention of the qualitative researcher interested in more than just life measured by the pound. Q methodology "combines the strengths of both qualitative and quantitative research traditions" and in other respects provides a bridge between the two [27,37]. Some of the quantitative obstacles to the wider use of Q methodology have recently been rendered less daunting by virtue of software packages which have converted to button presses what before were tedious calculations. One such package, Q Method (Atkinson, 1992), is available as freeware from Kent State University's List server, and the way in which Q Method facilitates Q-methodological inquiries, as well as the way in which such inquiries proceed. The formula for calculating the sample kappa (k) is

$$k = \frac{N \sum X_i^2 - (\sum X_i)^2}{N^2 - (\sum X_i)^2} \quad (1)$$

For kappa, no general agreement exists with respect to required scores. Landis and Koch (1977) have provided a more detailed guideline to interpret kappa by associating different values of this index to degree of agreement beyond chance. The following guideline is suggested:

Table 4. Guidelines for Kappa Value

Value of Kappa	Degree of Agreement Beyond Chance
0.76 – 1.00	Excellent
0.40 – 0.75	Fair to Good (Moderate)
0.39 or less	Poor

4.2 Structural Equation Modeling

The growing interest in Structural Equation Modeling (SEM) techniques and recognition of their importance in empirical research, Structural Equation Modeling (SEM) techniques such as LISREL, EQS, Partial Least Squares (PLS) are second generation data analysis techniques that can be used to test the extent to which the research meets recognized standards for high quality statistical analysis. The test is for statistical conclusion validity. Contrary to the first generation statistical tools such as regression, SEM enables researcher to answer a set of interrelated

research questions in Single, Systematic and Comprehensive Analysis by modeling the relationships among multiple independent and dependent constructs simultaneously. This capability for simultaneous analysis differ greatly from most first generation regression model such as linear regression, LOGIT, ANOVA and MANOVA, which can analyze only one layer of linkages between independent and dependent variables at a time. SEM tools are increasingly being used in behavioral science research for the casual modeling of complex, multivariate data sets in which the researcher gathers multiple measures of proposed constructs. Several literatures suggested that SEM has become a tool in validating instruments and testing linkages between constructs. Consistent with [37], the qualifying criteria for the sample were that the article employed either:

- (a) Correlation or statistical manipulation of variables
- (b) Some form of data analysis, even if the data analysis was simply descriptive statistics.

From the above table, it is shown that SEM has been used with some frequency for validating instruments and testing linkages between constructs in two of three widely known Information System Journals. In ISR, 45% of the positivist, empirically-based articles used SEM. In MISQ, it was 25%. From the first appearance of SEM in 1990 in the major Information System journals [37], usage had steadily grown. By the mid of 1990s SEM was being used in about 18% of empirical articles across the three journals, with PLS and LISREL being the two most common techniques. Other SEM tools, such as EQS and AMOS, were used less often, but this is most likely because of the slowness of diffusion of innovation and is not a statement about the power or capability of these particular packages [37].

4.3 Research Model and Hypothesis

In this paper, the multilevel supply chain is integrated. The proposed research model is illustrated in Figure 1. From the statement of the problem, do the Man, Machine and Management infrastructure influence the effectiveness of supply chain management? The model is designed to study the supporting of operational infrastructures in term of man, machine and management in supply chain implementation.

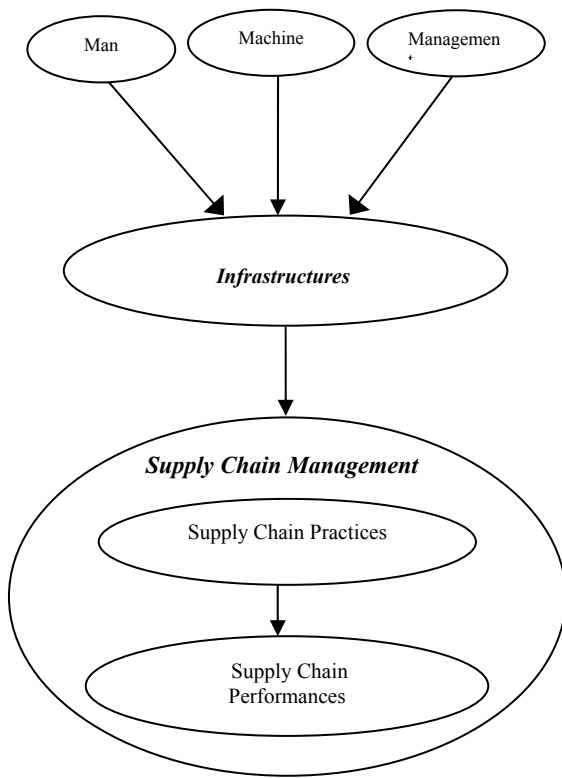


Figure 1. Research Model

The model is analyzed the basic infrastructures need for supply chain activities enhancing the effectiveness of supply chain practices and their performances. The man, machine and management infrastructures are studied the covariation to the supply chain management. From the research model, the hypothesis is established:

H: The higher supply chain infrastructures preparation, the higher effectiveness of supply chain management

We also study the correlation between the infrastructures, supply chain practices and supply chain performances.

4.4 Survey Methodology

A survey instrument in form of a questionnaire was designed based on the integrated model described. The respondents were asked to indicate the level of company practices and performance achievement after supply chain implementation using five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The six infrastructure variables were constructed. The questions about man, machine and management infrastructures were asked to indicate the five-points Likert scale as well as the four group questions of the supply chain practices and performance. This survey data was collected from a single respondent from each target firm, the target respondents are in the purchasing and sale departments because they were assumed to fully involve the company's supply chain activities. The objective in

collecting the single respondent from one firm is to minimize the variation in data bias [41].

The variables were checked the validity by 4 practitioners and academicians, the Q-sort methodology was used to ensure the variables by improving the k values from the first to second rounds. The questionnaire was pre-tested to check the content validity and revised where necessary to ensure the content validity. The surveys were sent refer to the industrial estates list, totally 114 from 986 surveys usable (11.56%). The last wave of surveys received was considered as representative of non-respondents [9]. The 30 survey items were selected for analysis randomly. Each sample was split into two groups on the basis of early and late survey return time, then the t-test were used to analyze. The t-test yielded no statistically significant differences between early and late response groups. The non-affect of non-response bias was recommended. The profile of company and respondents were asked. The firms were mainly from the manufacturing and trading industries. The respondent's profile is shown in Figures 2:

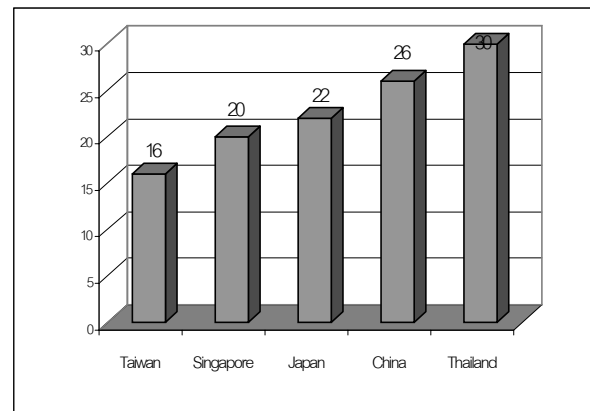


Figure 2. The Respondents' Origin Country

Figure 2 represented the firm's country of origin, they are from Taiwan, Singapore, Japan, China and Thailand, respectively. The Figure 3 shows the driving force of supply chain implementation, the highest driving force is from the customer requirement, cost reduction, delivery management, inventory management accordingly. Figure 4 shows the business function of the respondent. The major business function of supply chain implementation is in electronic industry, plastic industry, trading industry and packaging industry respectively.

4.5 Analysis of the Research Model

The simultaneous estimation methodology is applied to test the measurement and theoretical. All data from 114 firms sampled to obtain the maximum likelihood estimates of the path coefficients (γ), loading (λ), correlations, error variances, and χ^2 goodness of fit test [12]. All of these parameters were derived from the EQS, which it is one program of structural equation modeling program. The advantages of EQS other than other

structural equation modeling are the simpler represented system on two or three sets of parameter metrics. Also, the less limitation in the type of structural coefficients make the EQS easily interpret the statistic result in the small number of variables [12,37].

The reliability, convergent validity, unidimensionality of infrastructure alignment and supply chain practices are analyzed by examining the level of sub model fit and estimated loading [12]. The unidimensional reliability is a model comparison with significant smaller χ^2 in the proposed measurement model with the alternative measurement models. For the model fit is assessed using chi-square statistic estimated for the hypothesized model. However, the χ^2 is sensitive to the sample size so it is a caution to only rely on the χ^2 . The value of χ^2/df can be used to improve this limitation if the ratio is inferior to 5 [12]. In EQS, the Bentler's comparative fit index (CFI) is approached to reflect the fit at all sample sizes. The CFI formula is:

$$CFI = \frac{(\chi^2_{02} - df_0) - (\chi^2_k - df_k)}{(\chi^2_{02} - df_0)} \quad (2)$$

Where χ^2_{02} is the null model and χ^2_k is the hypothesized model. Model fit is acceptable at CFI is higher than 0.90 level. For the structural equation modeling assessed of this model results in Figure 2. A significant value of 112.4 at $df = 53$, $p(0.01)$ is the chi-square result and confirmed fit is the χ^2/df ratio at 2.18, which this $CFI = 0.91$ is adequate supported the unidimensionality of alignment and practices.

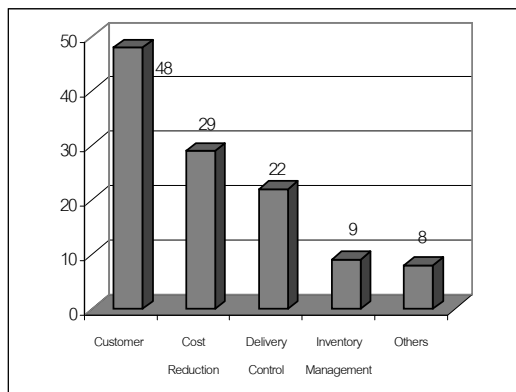


Figure 3. The Supply Chain Driving Forces

For the convergent validity, the underlying construct or trait are described in percentage of variance in term of loading squared. In this model, the loading range is from 0.51 to 0.84. The loading of operational infrastructures Man, Machine and Management are significant in enhancing the supply chain practice. A result higher than 0.5 shown the measurement is captured by the constructed variance [12]. In this model the ρ ranged

from 0.51 - 0.74 that confirmed the reliability of this model. As shown in the Table 5, the correlation ranged from 0.42 to 0.74 at 99% confidence interval. The largest correlation is between the supply chain practice and supply chain performance, the values shown the acceptable discriminant validity.

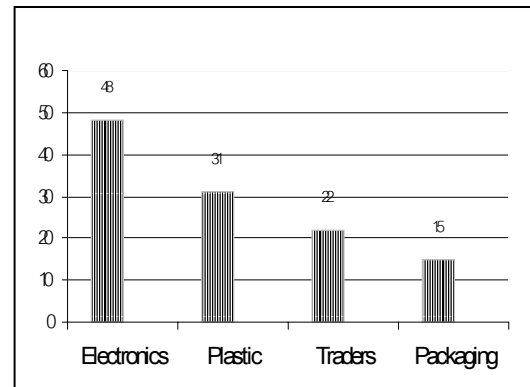


Figure 4. Respondent's Business Function

For the theoretical model, the linked between operational infrastructure to the supply chain practices reflect the terms of competitiveness performance, cost management and inventory control performance. The hypothesis was confirmed by the significant path coefficient of 0.74 at 99% confidence level that enhancing of operational infrastructures of man, machine and management to the supply chain practices support the supply chain performance of organization [12,27,37].

5. Discussion

The tested model shows the significant man, machine and management infrastructures enhancing the supply chain management. The research results indicated the operational infrastructures are highly impact to the supply chain practices that reflect the success in supply chain performance. In this paper the supply chain performance, the inventory control performance is highly significant variable.

For the further research, this model can be analyzed in term of mathematical equation in order to be the indicator of infrastructure preparation before entering the supply chain program as the following;

$$F(x) = \{\text{Man, Machine, Management}\}$$

Where $F(x)$ is the readiness indicator of infrastructure preparation.

The research will be more contribution if linking to the supply chain performance

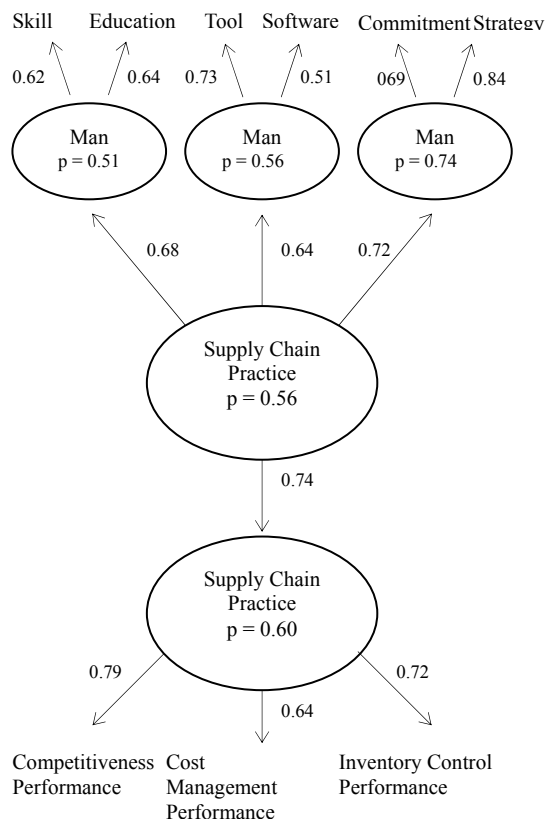


Figure 5. Operational Infrastructures Enhancing Supply Chain Management

Table 5. The Correlation Analysis of the Constructs

	1	2	3	4	5
1. Man	-				
2. Machine	0.46	-			
3. Management	0.51	0.42	-		
4. Supply Chain Practice	0.68	0.64	0.72	-	
5. Supply Chain Performance	0.48	0.49	0.52	0.74	-

References

- [1] Ahuja Saraj, Larson Lars and Motwani Jaideep, Managing a Global Supply Chain Partnership, Logistics Information Management, Volume 11, No. 6 1998, p349 - 354.
- [2] Auskain Richard J., Carter Craig R. and Ketchum Carol L., Purchasing from Minority Business Enterprises: Key Success Factors, The Journal of Supply Chain Management, Winter 1999, p 28- 32.
- [3] Beamon, B.M., Measuring Supply Chain Performance, International Journal of Operations and Production Management, Volume 19, No. 1 1999, p275 - 292.
- [4] Bommer Michael, O'Neil Brian and Treat Shadrach, Strategic Assessment of the Supply Chain Interface: Beverage Industry Case Study, International Journal of Physical Distribution and Logistics Management, Volume 31 No. 1 2001, p11 - 25.
- [5] Boudreau Marie-Claude, Gafen David, Straub Detmar W., Structural Equation Modeling and Regression: Guidelines for Research Practice, Communication of the Association for Information Systems, Volume 4 Article 7 August 2000, p 1-79
- [6] Carter Craig R. and Kaufmann Lutz, International Supply Management Systems - The Impact of Price vs. Non Price Driven Motives in the United States and Germany, The Journal of Supply chain Management, Summer 2002, p4 - 17.
- [7] Carter Craig R., Hendrick Thomas E. and Siferd Sue P., Purchasing' s Involvement in Time-Based Strategies, International Journal of Purchasing and Materials Management, August 1996, p2 - 10.
- [8] Choi Thomas Y. and Rungtusanatham Manus, Comparison of Quality Management Practices: Across the Supply Chain and Industries, The Journal of Supply Chain Management, Winter 1999, p20 - 27
- [9] Chopra Sunil and Meindl Peter, Supply Chain Management: Strategic, Planning and Operations Preice-Hall, New Jersey 2001
- [10] Christopher M. and Jutter U., Developing Strategic Partnership in Supply Chain: A Practitioner Perspective, European Journal of Purchasing and Supply Chain Management, Volume 6, No2, p117 - 127.
- [11] Christopher Martin and Lee Hau L., Supply Chain Confidence - The Key to Effective Supply Chains Through Improved Visibility and Reliability, Global Trade Management - Cranfield University and Stanford University, November 2001.
- [12] Croteau, Anne-Marie, Simons Solomon, Louis Raymond, Francois Bergeron, Organizational and Technological Infrastructures Alignment, IEEE Proceeding of the 34th Hawaii International Conference on System Science 2001, p1-10
- [13] Cutler, Bob D., Christopher R. Moberg, Andrew Gross and Thomas W. Speh, Identifying antecedents of information exchange within supply chains, International Journal of Physical Distribution & Logistics Management, Vol.32 No 9, pp.755-770.
- [14] Daugherty Patricia J., Rogers Dale S. and Stank Theodore P., Benchmarking Programs: Opportunities for Enhancing Performance, Journal of Business Logistics, Volume 16, No.2 1995, p43 - 52.
- [15] Davis Tom, Effective Supply Chain Management, SLOAN Management Review, Summer 1993, p35 - 46
- [16] Ellram L. M., Supply Chain Management: the Industrial Organization Perspective, International Journal of Physical Distribution and Logistics Management, Volume 21 No. 1, p 13 - 22.
- [17] Ellram L. M., The Supplier Selection Decision in Strategic Partnership, Journal of Purchasing and Materials Magament, Fall 1990, p8 - 14.
- [18] Ellram Lisa M and Zsidisin George A., Factors that Drive Purchasing and Supply Management's Use of Information Technology, IEEE Transactions on Engineering Management, Volume 49, No. 3 August 2002, p 269 - 281.

- [19] Elmuti Dean, The Perceived Impact of Supply Chain Management on Organizational Effectiveness, *The Journal of Supply Chain Management*, August 2002, p 49 - 57.
- [20] Farris Theodore M. and Hutchison Paul D., Cash to Cash: the New Supply Chain Metric, *International Journal of Physical Distribution and Logistics Management*, Volume 32, No. 4 2002, p288 - 298.
- [21] Fawcett Stanley E., Magnan Gregory M., The Rhetoric and Reality of Supply Chain Integration, *International Journal of Physical Distribution and Logistics Management*, Volume 3, No 5 2002, p339 - 361.
- [22] Ferrin Bruce G. and Plank Richard E., Total Cost of Ownership Models: An Exploratory Study, *The Journal of Supply Chain Management*, Summer 2002, p18 - 29.
- [23] Handfield Robert B., Kannan Vijay R., Tan Keah Choon, Supply Chain Management: Supplier Performance and Firm Performance, *International Journal of Purchasing and Materials Management*, August 1998, p2-9.
- [24] Hewitt F, Information Technology Mediated Business Process Management - Lessons from the Supply Chain, *International Journal of Technology Management*, Volume 17, p 37 - 53.
- [25] Horvath Laura, Insight from Industry, Collaboration: the Key to Value Creation in Supply Chain Management, *An International Journal of Supply Chain Management*, Volume 6, No 5 2001, p205 - 207.
- [26] Inman, R.A. and Hubler J.H., Certify the Process - Not Just the Product, *Production and Inventory Management Journal*, Volume 33, No. 4 1992, p11-14.
- [27] Joreskog, K.G., & Sorbom, D, PRELIS. A program for multivariate data screening and data summarization, Mooresville, IN: Scientific Software.
- [28] Lambert Douglas M. and Pohlen Terrence L., Supply Chain Metrics, *The International Journal of Logistics Management*, Volume 12, No. 1 2001, p1 - 19.
- [29] Lee Calvin B., Demand Chain Optimization - Pitfalls and Key Principles, Nonstop Solution 2002.
- [30] McMullan Amanda, Supply Chain Management Practices in Asia Pacific today, *International Journal of Physical Distribution and Logistics Management*, Volume 26, No. 10 1996, p79 - 95.
- [31] Mehta Sameer G. and Sundaram Meenakshi R., A Comparative Study of Three Different SCM Approaches, *International Journal of Physical Distribution and Logistics Management*, Volume 32, No. 7 2002, p532 - 555.
- [32] Miller Chris A., The Nature and Design of Supply Chain Performance Measurement System – An empirical Study, The Pennsylvania State University, Pennsylvania 2001
- [33] Morgan J. and Monczka R.M., Alliances for New Products, *Purchasing Journal* (118:1), 1995, p103 - 109.
- [34] Onge, St A., New Concepts in Supply Chain Management, *Modern Materials Handling*, Volume 51, No.3 1996, p33.
- [35] Power Damien J., Sohal Amrik S. and Rahman Shams-Ur., Critical Success in Agile Supply Chain Management, *International Journal of Physical Distributors and Logistics Management*, Vol31 No4, 2001, p247-265.
- [36] Stock, et al, Review of Logistics Research 1993 - 1997, *The Journal of Business Logistics*, 1997
- [37] Strub, Detmar W., David Gefen, Marie-Claude Boudreau, SEM and Regression, *AIS V4*, A7 Aug 2002.
- [38] Talluri Srinivas, Enhancing Supply Decisions through the Use of Efficient Marginal Cost Models, *The Journal of Supply Chain Management*, Fall 2002, p4 - 10.
- [39] Tan, K.C., A Framework of Supply Chain Management - Literature, *European Journal of Purchasing and Materials Management*, Volume 34, No. 3 2001 p39-48.
- [40] Tan Keah Choon, Supply Chain Management: Practices, Concerns, and Performance Issues, *The Journal of Supply Chain Management*, Winter 2002, p42-53.
- [41] Udomleartprasert, Panyaluck., Chamnong Jungthirapanice, Aligning the Infrastructure to the Supply chain Management, *IEEE IEMC - 2003*, USA.