INVESTIGATING THE DETERMINANTS OF GREEN SUPPLY CHAIN MANAGEMENT VALUE CREATION FOR DESIGN SERVICE SUCCESS (The Case of Taiwan High-tech Industry)

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ABSTRAK

Future competition advantage will be about business partnership team in terms of design service industry to obtain sufficient resources and knowledge. To do so, a good supply chain management is inevitable, and by incorporating the green issue into new product development. The green design has increasingly considered as systematic method for companies to reduce the environmental impact of their products and processes while simultaneously cutting costs and increasing product marketability. The present research proposes conceptual framework related to green supply chain management value creation to improve design service performance through several critical condition factors and critical ability factors. This research has adequate sample size for Structural Equation Model analysis through AMOS software. The results successfully construct business process synchronization and supply-demand element realignment as a critical condition factors in the context of green SCM area and several ability factors as a critical ability dimension. This paper also approved the hypothesis that green supply chain management value creation has positively influence design service performance. The results also contributes several new insight for academic as well as practical implication.

Keywords: Green Supply Chain management, Design service, Critical Condition, Critical Ability, SEM

INTRODUCTION

Services have come to dominate many economies around the world, and value creation through service is the focus in industries, government and public service organizations. Service innovations, service design and new service development will be important for company growth, competitiveness and profitability. Many manufacturing companies are trying to increase their service orientation, and the service transition can be described as an evolutionary change on a goods-to services continuum. In this competitive global markets generation, companies are trying to enhance their service value through their resources, which can in turn lead to competitive advantages. But how to create successfully new service? It still typically challenges a lot of companies because they are lack of systematic innovation management and integrated tools to support the development process, suitable models and methods, and adequate organizational structures (Thomas, 2008).

In order to remain competitive within a global economy context, companies need to compete through their supply chain. So, they should focus in creating value for their customers and shareholders. Green supply chain management (GSCM) has emerged as an important new approach for enterprises to achieve profit and market share objectives by reducing environmental risk and impact. GSCM thus has emerged as a strategy for some leading companies in the electronics industry, including Dell, HP, IBM, Motorola, Sony, Panasonic, NEC, Fujitsu, and Toshiba. This phenomenon implies that companies are now starting to recognize that environmental awareness can be a source of competitive advantage. GSCM can also promote efficiency and synergy among business partners and their lead corporations, and helps to enhance environmental performance, minimize waste and achieve cost saving.

Fox (2000) and Croxton (2001) allows the identification of a set of basic SCM concepts on their previous research, which is in the next step we can summarize as a SCM condition, they are business process synchronization and supply-demand realignment which can create a SCM value creation. Where supply chain value creation is a primary goal of SCM to create value, business process synchronization is a result of synchronizing the geographically-distributed interrelated business processes of the independent companies so they work as a whole unit. Supply-demand elements realignment is based on the realignment of the supply chain partners static and dynamic elements (i.e. network structure and decision-making processes) affecting the material, information, and cash flows. Although such conditions have been mentioned, little research attention has been paid to construct a research model that defines it through empirical data in the context of green supply chain in order to continue exploring Green SCM practice for acquiring competitive advantage.

Based on the review of Supply Chain journal of Jayaramy (2004) and Caridi (2005) on their previous research, there are some governance mechanisms that are necessary precursors to supply chain value creation. One of them is behavioral mechanisms which directly related to the elements composing an integrated supply chain such as communication, coordination, collaboration, and cooperation. Limited research to construct those behavioral mechanism as ability dimension being necessary to test in order to continue exploring Green SCM practice for acquiring competitive advantage.

Many researchers have argued for green management, however, it was unclear how green management needs to be implemented. This study attempts to develop a comprehensive framework based on green supply chain management value creation through supply chain critical conditions factor (business process syncronization, supply and demand realignment) and supply chain critical abilities factor (communication, coordination, and cooperation) in order to enhance design service performance and build up a conceptual design service model for design service industries.

RESEARCH METHOD

In order to examine the hypotheses and achieve the aims of this research, we choose structured questionnaire method which is the most appropriate method to collect the relevant primary data from different departments such as R&D department, manufacturing department, and purchasing department. The collected data from questionnaire survey was then analyzed using structural equation modeling (SEM) to test our measurement and structural model and find the positive relation among four constructs mentioned above.

Research Procedure

The research procedure is divided into three stage as shown in figure 1:

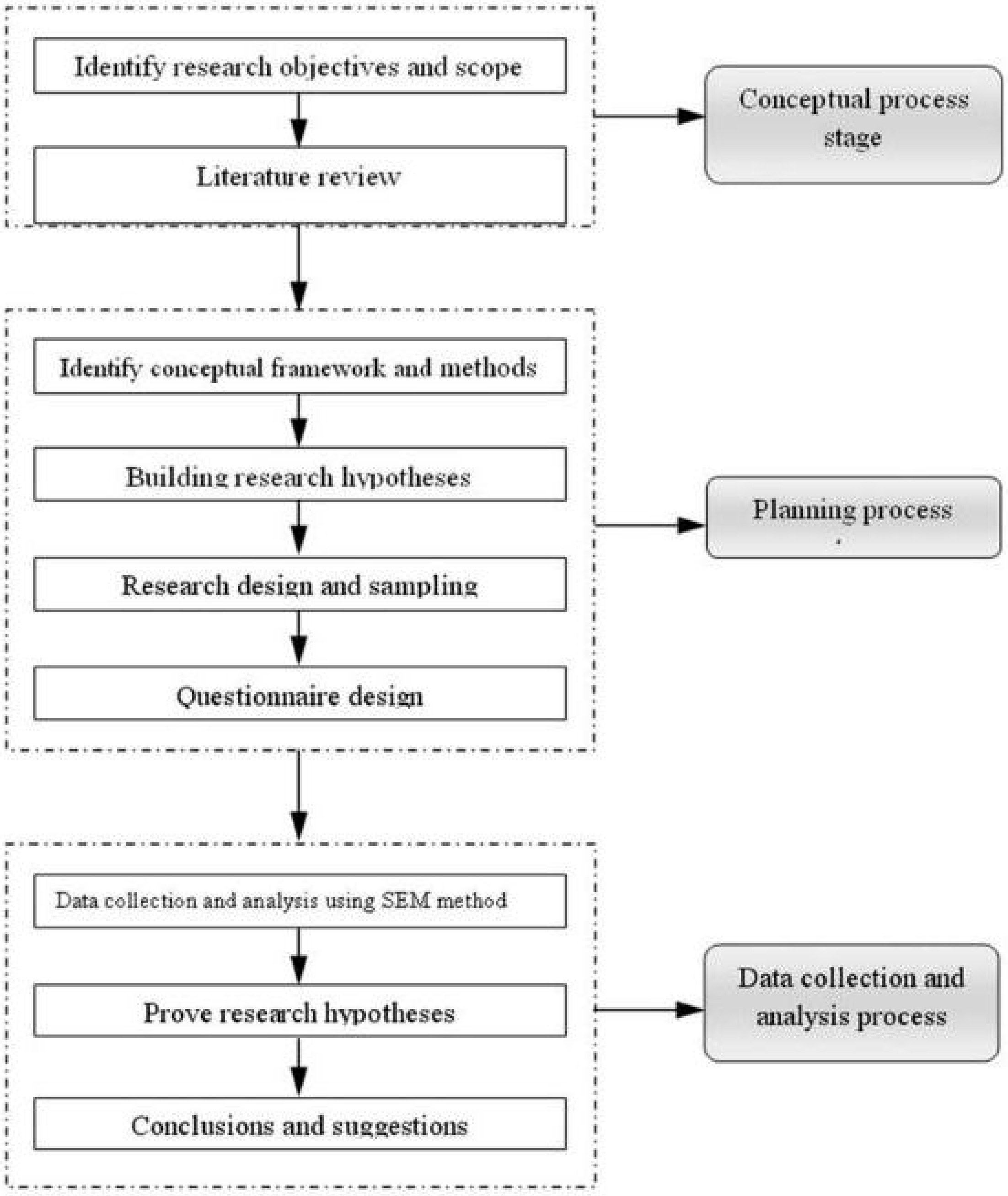

Figure 1. Research Procedure

Structure Equation Model (SEM) Technique

We firstly refine the measurement scales of each item and verify these dimensions. Then, we adopt explanatory factor analysis, validity test, and reliability test to extract items, factors, and dimensions. To achieve high validity to support the research analysis, we conduct principal component factor analysis, varimax, and factor loading to confirm the factors and dimensions. We also check reliability of the measures by Cronbach's α and item-to-total correlation to examine the internal consistency. The step of SEM technique is shown in figure 2.

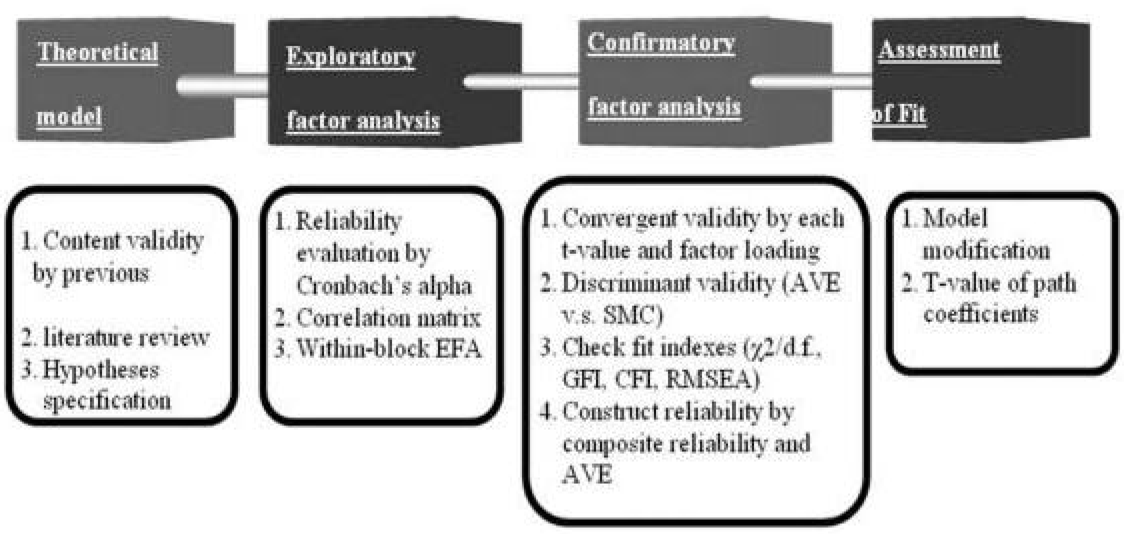

Figure 2. Step of SEM Technique

Sampling

The Taiwan's high technology industry was chosen as a highly fitting sample for our structured questionnaire survey since this industry has an excellent context of green supply chain management in product development.

The questionnaire-survey was sent to 200 participants, all of them are heads of marketing department, R&D department, and purchasing department. There are 41 valid samples (response rate of 21%) as shown in figure 3 that could be analyzed by SPSS and AMOS.

Those firms were selected because most of them has implemented green manufacturing and obtained the ISO14001 certification and were listed in the directories of the 2010 top 1000 firms in *Business Weekly* (Taiwan's leading business magazine). The firms under investigation had to exceed the criteria of having annual sales of U.S. $100 million, at least 100 employees, and over 5 years activity in Taiwan.

Industry	firm	Number of questionnaire	Response Quantity	Percentage (%)
IC design service	9	21	4	0.19
Semiconductor Industry	11	28	5	0.18
IT hardware industry (computer systems and peripherals)	15	32	6	0.18
Solar Energy Industry	6	18	2	0.11
Building Material Industry	2	3	1	0.33
LED Industry	6	12	1	0.08
Automobile Industry	6	15	5	0.33
Electronic Industry	20	52	12	0.23
Biotechnology and Pharmacy Industry	5	13	3	0.23
Consumer Goods Industry	2	6	3	0.50
Total	82	200	41	0.21

Figure 3. Sample Frame

RESULT & DISCUSSION

Research Framework and Hypothesis

According to the prior literatures, this research developed the research framework as shown in figure 4 and following hypothesis (H):

H1: Business process synchronization and supply-demand elements realignment will be positively related to Green Supply Chain Management Value Creation

H2: Communication within company, supplier, and cross functional team, coordination and support from top management, customer cooperation with Environmental, will be positively related to Green Supply Chain Management Value Creation

H3: Green Supply Chain Management Value Creation will be positively related to Design Service Performance.

H4: Communication within company, supplier, and cross functional team, Coordination and Support from top management, Customer cooperation with environmental, and Customer cooperation with environmental will positively related to Design Service Performance

H5: Business Process Synchronization and Supply-Demand elements realignment will be positively related to Design Service Performance

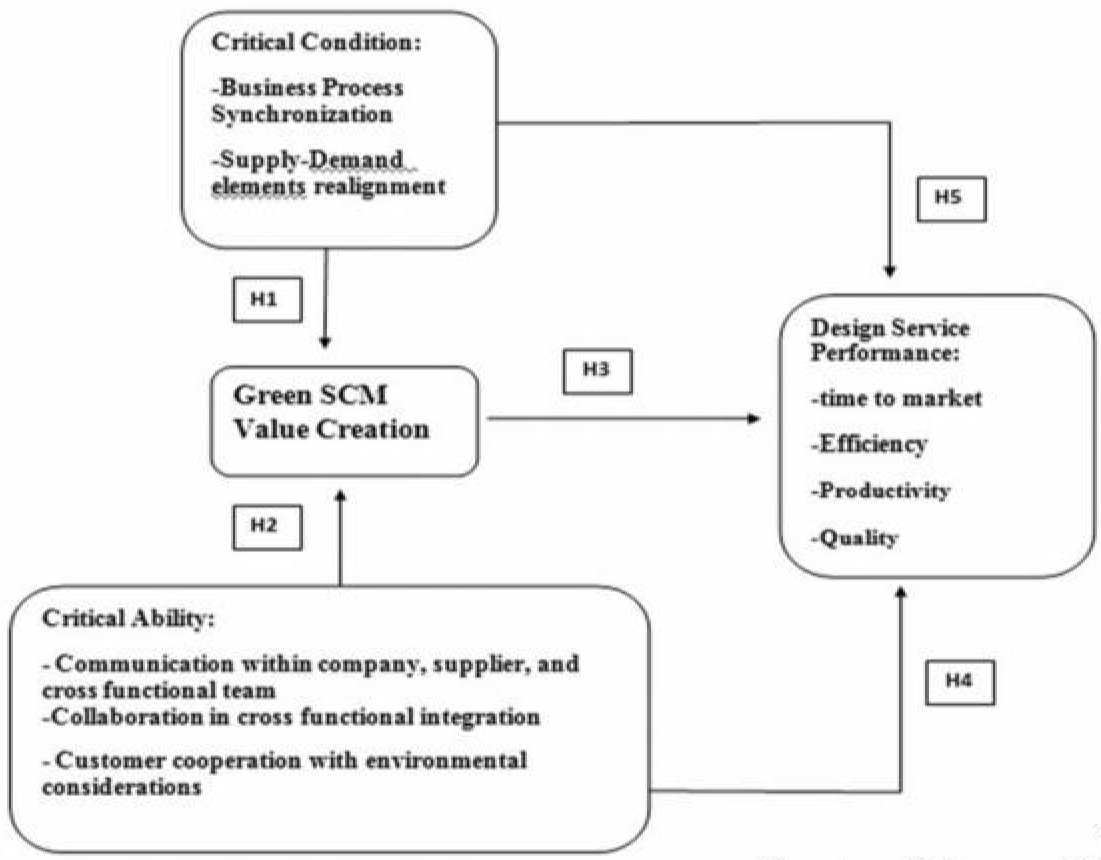

Figure 4. Research framework

Measure of constructs

All items in the questionnaire were framed as five-point Likert-style questions (with answer ranging from 1="strong insignificance" to 5="strong significance").

About the construct of critical conditions dimension, we use total 7 items divided into two factors which are Business Process Synchronization (Narahari, 2000; Wu, 2006) and Supply-demand Element Realignment (Bolat, 2009; Bailey, 2007).

We developed 3 factors for the construct of Critical abilities dimension. There are 8 items were used and divided into 3 factors, they are: communication between company, supplier, and cross functional; coordination and support from top management; customer cooperation with environmental. Some scale items were applied from the framework of the practice constructs of critical factors which proposed by Allen Hu (2010); Qinghua Zhu, et. al (2010); Jayaramy (2004). And also about the construct of Green Supply Chain Management Value Creation dimension, we use total 7 items divided into two factors which are internal and external value. Some scale items were applied from the framework of the practice constructs of Green Performance Outcome which proposed by Mohammed (2008).

Finally, we use total 7 items as observed variables for the construct of design service performance. The design service performance was constructed based on previous studies as follows: time to market, cost down, quality, productivity, effectiveness, and efficiency (Rao, 2005). But in this study, we extracted just two factors which are: Productivity and Efficiency.

Reliability and Validity

This study measured the reliability of each dimension using Cronbach's alphas value in EFA. Measured construct reliabilities (CR), squared multiple correlation (SMC) and average variance extracted (AVE) in CFA. The criteria of the reliability test are as follows: Cronbach's α is greater than 0.35 (Cuieford, 1965); Item-to-total correlation is greater than 0.35 (Robinson et al., 1991); all construct reliabilities (CR) were at least 0.5 (Raines-Eudy, 2000) ; Average variance extracted (AVE) of at least 0.5 is considered satisfactory for basic research (Fornell& Larcker, 1981). Squared multiple correlations (SMC) of the measured variables were larger than 0.5 indicating that the measures had a good reliability (Bagozzi & Yi, 1988); Factor loading should be greater than 0.5 (Robinson et al., 1991). The results of this research indicate those criteria are qualified. But there are several items of SMC value less than 0.5 but we still kept for further studing because factor loading, eigen value, and other goodness of fit are qualified. The result of test is shown in Table 1

Prove Research Hypotheses

In order to test the hypothesized relationships in a path-analytic framework, the results have been divided into three models. The first model seeks

Table 1.
Construct Measures Validity and Reliability Analysis

Factor and Item	SMC	Standardized Factor Loading	Cronbach's α	Item to total correlation	AVE	CR	t-value
Business Process Synchronization			0.782		0,52	0,806	
BP 1	0.931	0.965		0.511	0,52	0,806	T=a
BP 2	0.564	0.751		0.757	0,52	0,806	5.776
BP 3	0.294	0.542		0.624	0,52	0,806	3.711
BP 4	0.308	0.555		0.520			3.826
Supply-Demand elements realignment (SD)			0.677		0.44	0.69	
SD 1	0.666	0.816		0.557			2.959
SD 2	0.365	0.604		0.489	0.44	0.69	2.662
SD 3	0.285	0.533		0.441	0.44	0.69	T=a

Goodness-of-fit: χ^2/df=1.188, p=0.004; GFI=0.914, CFI=0.973 and RMSEA=0.069

Note: "a" means that the regression weight was fixed at 1.000, not estimated

Factor and Item	SMC	Standardized Factor Loading	Cronbach's α	Item to total correlation	AVE	CR	t-value
Communication between company,supplier, and cross functional (COM)			0.725		0.51	0.76	
COM 1	0.293	0.541		0.442	0.51	0.76	3.128
COM 2	0.495	0.703		0.655	0.51	0.76	T=a
COM 3	0.252	0.502		0.372	0.51	0.76	2.909
COM 4	0.803	0.896		0.683	0CO L.51	0.76	4.438

Coordination and support from top management (CTM)			2.004		0.79	0.88	
CTM 1	0.681	0.825		0.785	0.79	0.88	T=a
CTM 2	0.906	0.952		0.785			5.490
Customer cooperation with environmental (COL)			1.887		0.75	0.85	
COL1	0.512	0.716		0.710	0.75	0.85	T=a
COL 2	0.983	0.992		0.710			4.233

Goodness-of-fit: χ^2/df=1.823, p=0.02; GFI=0.937, CFI=0.969 and RMSEA=0.050.

Note: "a" means that the regression weight was fixed at 1.000, not estimated

Factor and Item	SMC	Standardized Factor Loading	Cronbach's α	Item to total correlation	AVE	CR	t-value
Internal Value (IN)			0.873				
IN 1	0.444	0.667		0.600	0.66	0.88	4.786
IN2	0.765	0.875		0.822	0.66	0.88	T=a
IN3	0.845	0.919		0.835	0.66	0.88	7.736
IN4	0.583	0.764		0.686	0.66	0.88	5.857
External value (EX)			0.852				
EX1	0.693	0.832		0.712	0.67	0.83	5.876
EX2	0.721	0.849		0.687	0.67	0.83	T=a
EX3	0.610	0.781		0.800	0.67	0.83	5.466

Goodness-of-fit: χ^2/df=1.516, p=0.000 ; GFI=0.914, CFI=0.937 and RMSEA=0.042

Note: "a" means that the regression weight was fixed at 1.000, not estimated

Factor and Item	SMC	Standardized Factor Loading	Cronbach's α	Item to total correlation	AVE	CR	t-value
Productivity (P)			0.766				
P 1	0.424	0.652		0.564	0.43	0.68	2.356
P 2	0.689	0.830		0.583	0.43	0.68	2.469
P 3	0.192	0.438		0.669			T=a
Efficiency (QE)			0.820				
QE 1	0.742	0.861		0.696	0.54	0.85	4.227
QE2	0.488	0.698		0.696	0.54	0.85	3.668
QE3	0.558	0.747			0.54	0.85	3.860
QE4	0.403	0.635		0.591	0.54	0.85	T=a
QE5	0.552	0.743		0.591	0.54	0.85	3.842

Goodness-of-fit: χ^2/df= 1.868 ; GFI=.933; CFI= 1.0; RMSEA=0.00

Note: "a" means that the regression weight was fixed at 1.000, not estimated

to solve the problems in Critical conditions dimension, Green SCM Value Creation, and design service performance. The second model investigates the problems in Critical abilities dimension, Green SCM Value Creation, and design service performance. The third model will present the problem in Green SCM value creation and design service performance.

Model 1 for Critical Condition Dimension

Model 1 exhibits a reasonable fit with the data collected. Based on the analysis, the AMOS provides details of significant relationships found, as shown in Figure 5. Our model 1 shows a value of 1.403 in the chi-square to degree of freedom ratio which is satisfactory with respect to the recommended value of less than 3.0. The fit indexes for model 1 are GFI=0.914, CFI=0.904 and RMSEA=0.042. All indicate more than an acceptable fit. In addition to the t-value exceeding 1.96, the data represents a level of significance of 0.05. As hypothesized for 1, a significant relationship between Critical conditions and Green SCM value creation is established (γ=0.574, t=2.232). Statistical results sustain the proposition that the two concepts are absolutely related, which postulates that those critical condition is essential to enhance Green SCM value creation.

The results support hypothesis 5 because a significant relationship exists between critical conditions and design service performance (γ=0.806, t=2.023). The results show that those dimensions are positively related to each other and improving design service performance

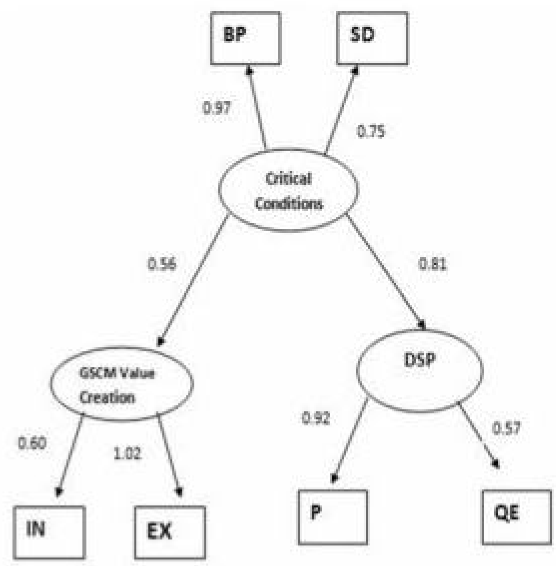

Figure 5. Results of model 1

Model 2 for Critical Ability

In model 2, AMOS analysis demonstrates significant relationships, as shown in Figure 6. Model 2 investigates the problem between critical ability dimension-green SCM value creation and design service performance. The results of fitting the measurement model indicate that model 2 is a good fit, with a value of 1.935 in the chi-square to degree of freedom ratio which is satisfactory with respect to the recommended value of less than 3.0. GFI=0.937, CFI=0.969 and RMSEA=0.050. The results support hypothesis 2 because a significant relationship exists between critical ability and green SCM value creation (γ=0.944, t=2.426). Another result from this model is hypothesis 4. The results support hypothesis 4 because a significant relationship exists between critical abilities and design service performance (γ=0.51, t=2.065). Hence the results support hypothesis 2 and hypothesis 4.

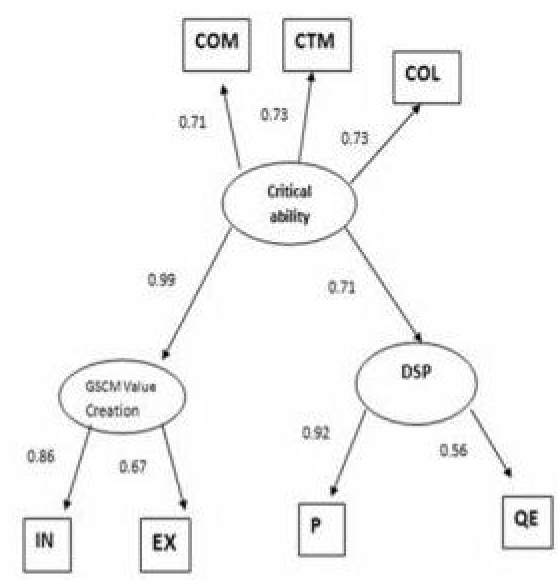

Figure 6. Results of model 2.

Model 3 for Green SCM Value Creation

Model 3 exhibits a reasonable fit with the data collected. Based on the analysis, the AMOS provides details of significant relationships as shown in Figure 7. The results fit the measurement model and indicate that model 3 is a good fit, ($\chi 2$/df= 1.778 p=0.000), GFI=0.926, CFI=0.985 and RMSEA=0.041. As hypothesized for 3, a significant relationship between Green SCM value creation and design service performance is established (γ=0.511, t=2.004).

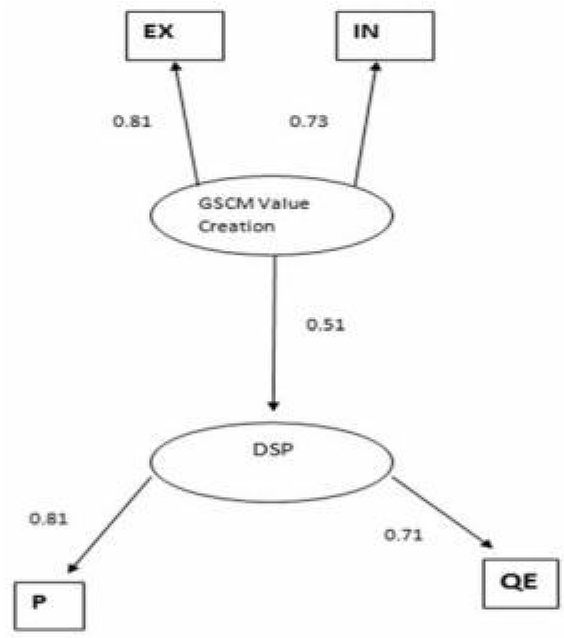

Figure 7. Results of Model 3

CONCLUSION & SUGGESTION

Conclusion

In summary, this research provides some new insights into the idea that:

1. Business process synchronization and supply-demand realignment as a critical condition dimension also play important roles not only in Supply Chain Management context but also for creating value in Green Supply Chain Management context and design service performance context.
2. Communication within company, supplier, and cross functional team; Coordination and support from top management; and Customer cooperation with environmental as a critical ability dimension have positive impact for a successful Green SCM value creation and design service performance.

Suggestion

First, the present study suffered from small sample sizes and a sample selection that could not represent whole high-tech firms in Taiwan. In order to obtain a better and more comprehensive understanding of this research, it is suggested to increase the number of participating firms, hence a larger survey with a larger set of responses is needed.

Second, because this sample were gathered from many industries in high-tech firms, so future research may explore further how different industry specific characteristics may impact firms' commitment to green orientation and design service area. These contextual factors also may indicate different product design and supply chain practices. Future research also could compare with different countries, particularly in China, because many manufacturers have shifted their factories to China. In other word, China are providing design service.

Third, this finding show that high-tech firms emphasized more in productivity factor on design service performance while previous references stated that high-tech firms emphasized more in time to market factor on design service performance. Future research could put attention in this issue through involving larger sample.

Fourth, future research could extend in depth case studies on how Green SCM worked and implemented to enhance design service performance and perhaps identify factors contributing to design services & innovation, factors contributing to buyer & seller relationship, and factors contributing to fulfill legal requirements.

Fifth, this paper did not test the relationship between different business unit and factors in this research. Future research could conduct Analysis of Variance to see whether different departments have different views on factors used in this study.

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