

The Applications of Business Intelligence to the Improvement of Supply Chain Management – A Case of an Electronic Company

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Abstract – This study takes an electronic company as example to enhance its supply chain management by applying concepts and guidelines from Supply Chain Council (SCC) as well as business intelligence tools. The company's Supplier Performance Management System (SPMS) was first examined by in-depth interviews with its users under the framework of Information Systems Success Model. Data collected through the interviews was under principles of case study research methods, and then was analyzed by Formal Concept Analysis (FCA) to get systematic, organized and insightful results. Based on these results, the SPMS was modified. The appropriateness of the Information System Success Model as well as system improvement was well validated.

Index Terms—Supplier Performance Evaluation, Information Systems Success Model, Key Performance Indicator, Formal Concept Analysis, Case Study

I. INTRODUCTION

In response to the challenges of global competition, the digitalization and effectiveness of supply chain management has become the critical competitive strategy of electronic industry. As a result, it's essential for electronic companies to manage their suppliers effectively to enhance and sustain their competitive advantages. In addition, the changing nature competition, rapid changing of customer requirements have greatly increased the degree of uncertainty, consequently a Supply Chain Management (SCM) system with great responsiveness is an imperative. Besides the performance of SCM members especially the supplier plays an important role in this regard. Under these backgrounds, Business Intelligence (BI) has become an essential tool for businesses to create

and sustain their competitive advantages. According to International Data Corporation (IDC) [1] research shows that the economic return with business intelligence for 2010 was 11.61% greater than that of the previous year. Research findings also showed that the adoption of BI helps enterprises to be more competitive [2, 3, 4].

In order to enhance managerial ability, company needs a set of proper criterion to evaluate its suppliers so that efficiency and effectiveness of the supply chain can be achieved. However, research concerning the applications of BI supplier performance management was rare, and this study tried to overcome this drawback. This study applied Information Systems Success Model (ISSM) and Supply Chain Council (SCC) as theories basis to establish set of Key Performance Indicators (KPI). Additionally, case study approach and in-depth interview were conducted to collect data and validate associated supplier performance from practical point of view. The purpose of this research can be listed as follows: (1) enhancing a BI-based supplier management system, (2) improving the acceptance of the system to related users, and (3) providing strategies for managing the performance of suppliers.

II. LITERATURE REVIEW

A. Business Intelligence

Business intelligence is a common term for gathering and analyzing an organization's data in the pursuit of better business decisions. Inmon [5] is often cited as the pioneer of business intelligence concept. The greatest value of BI is its analytical ability to assist in decision-making, to purify and integrate data, and to obtain necessary information after calculation and

analysis. Data warehousing, data mining, and online analysis and processing are all representative tools of business intelligence.

B. Supply Chain Operations Reference Model

The Supply Chain Council (SCC) developed the Supply Chain Operation Reference Model (SCOR) in 2008; based

on process reference, to aim in describing, evaluating, and analyzing the implementation of supply chains. SCC suggests 5 dimensions and related 13 indicators for this purpose, as shown in Table 1.

TABLE 1.
PERFORMANCE DIMENSIONS AND INDICATORS

Performance Dimensions	Description	Indicators
Distribution of supply chain	Deliver the correct products to the customer in correct quantity and package them in correct time and place.	Distribution performance
		Order process
		Order fulfillment performance
Feedback of supply chain	The speed of providing customer with the needed products.	Order handling lead time
Flexibility supply chain	The ability of supply chain to change quickly to obtain or maintain competitive advantage or to respond to the market.	Reaction time of supply chain
		Production flexibility
Cost of supply chain	Cost expenditures related to the operation of supply chain.	Sales cost
		Total management cost of supply chain
		Productivity of added value
		Quality warranty/ return and handling cost
Asset management of supply chain	The organization manages the assets in order to satisfy requirements, including management of all assets, such as fixed capital and operating capital.	Circulating time of cash
		Warehousing days of the supply
		Asset turnover

Weber et. al [6] conducted a study followed Dickson’s approach, and summarized most widely accepted criteria were price, delivery date, quality, production equipment, and productivity. Chi-Ming Hsu [7] applied Analysis Hierarchy Process (AHP) to investigate this issue in electronic industry, and identified the delivery date, quality, and transaction cost as important factors for supplier selection. Wei-Ning Bi [8] integrated AHP and TOPSIS (Technique for order preference by similarity to ideal solution) methods to evaluate supplier performance, and recognized quality, delivery date, price, and service as critical criteria.

C. Information System Success Model

DeLone and McLean’s [9] IS success model is one of the most comprehensive model as it received numerous support from subsequent empirical studies [10,11,12,13]. DeLone and McLean reviewed 180 studies from seven

major MIS publications and synthesized six factors that contribute to IS success. The categories of taxonomy are system quality, information quality, IS use, user satisfaction, individual impact, and organizational impact. DeLone and McLean suggest that by studying the interactions along these factors as well as factors themselves, researchers and practitioners shall constitute clear framework of IS success.

After a decade, DeLone & McLean [14] updated an Information Success Model, which attributes information system success to three important factors, namely system quality, information quality, and service quality; they in turn affect user’s perceptions of satisfaction and net benefits, and their intention to use the system. The relationships among these constructs can be described as shown in Fig.1 below.

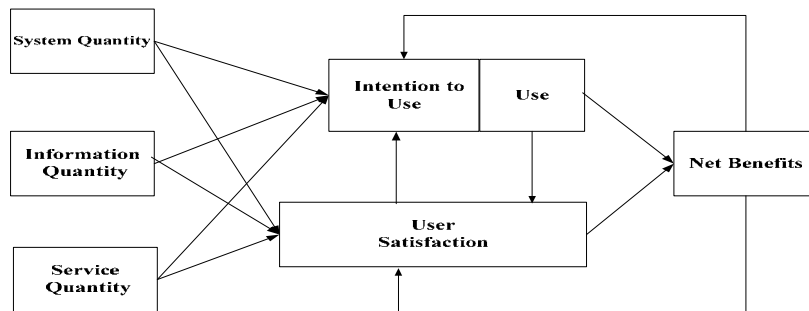


Figure. 1 Updated Information System Success Mode.

D. Formal Concept Analysis

Formal Concept Analysis (FCA) is a mathematical approach used for conceptual data analysis and knowledge processing. Proposed by Rudolf Wille [15], it permits the graphical visualization of sets, such as in quantitative analyses, which are insufficiently captured in the social sciences. FCA is employed in this paper as the principal means to establish a knowledge structure; it emphasizes the conceptual structures of data sets.

Definition of Formal Concept Analysis can be described as follows :

A triple (G, M, I) is called a formal context if G and M are sets and $I \subseteq G \times M$ is a binary relation between G and M . The elements of G are called objects; those of M are called attributes, and I is the incidence of the context.

For $A \subseteq G$, we define:

$$A' = \{m \in M \mid \forall g \in A : (g, m) \in I\}$$

and dually for $B \subseteq M$: definition in the same way:

$$B' = \{g \in G \mid \forall m \in B : (g, m) \in I\}$$

And assuming all sets are limited, especially G and M .

III. RESEARCH DESIGN

The research design is a combination one, which include theories indices of Information Systems Success Model, SCOR model, and SPMS as well. The in-depth interview was then conduct to collect data and coding into formal concept base on the framework of KPI. Finally, FCA was applied to validate these concepts and eventually utilized by managers as access criteria toward supplier performance.

A. Research Background

The focal company is a transnational one established in 1976, it is a world leader in design, manufacturing, and service activities, specialized in four areas including computing, communication, consumer electronics, and car electronics, spread over Taiwan, California, Mexico, and major cities of China such as Shenzhen, Shanghai, and Kunshan.

In order to enhance its abilities in information integration and analysis, the company invested in business intelligence software, to grasp a clear vision on future developments. Besides, in order to locate excellent supply chain management partners, the company implemented a Supplier Performance Management System (SPMS), using key performance indicators (KPI) to screen and manage prospective suppliers. Based on SCOR model as well as literature previous discussed, the SPMS was implemented with 3 important dimensions and 15 related KPIs, as shown in Table2.

Case study research method was then applied on this regard. In-depth interviews with members from procurement, quality assurance, and material management departments were conducted with interview framework established from Information System Model. The information garnered from the interviews was analyzed with Formal Concept Analysis.

B. Interview with System Users

In order to understand users' perceptions toward current SPMS, in-depth interviews with them were conducted, based on framework adopted from DeLone and McLean's Information System Success Model. The access dimensions were focused on systems quality, information quality, service quality, user satisfaction, intention to use the systems, and net benefits respectively.

To ensure the quality of collected data from interviews, principles of qualitative research methods were followed [16], such as the coding method suggested by Strauss & Corbin [17] including the open, axial, and selective coding steps. Triangle confirmation was adopted to find consensus open coding. After three runs of this activity, the validity of this coding is 70.8%, which meets the 70% required threshold. Overall, 85 common open codes were obtained. The FAC were then used to analyze he verbatim transcripts of interviews as described below.

C. FCA Results

FCA is a data analysis method, in which the data is termed contexts and individuals with certain attributes and objects are termed concepts. Six major constructs of Information System Success Model were analyzed by FCA to get their concept map respectively. We presented the results of FCA as shown in Table 3. The representative concept map of system quality was also shown in Fig.2.

IV. CONCLUSION

This study adopted business intelligence tools to implement a platform for supplier evaluation, bases on data from the material management module of its information system firstly. Nevertheless, the system seemed not so well-accepted by its intended users. Consequently, this study further tried to improve the acceptance of this system. Case study research method was applied on this regard. In-depth interviews with members from procurement, quality assurance, and material management departments were conducted with interview framework established from Information System Success Model. The information garnered from the interviews was analyzed with Formal Concept Analysis (FCA).

The contribution of this study is that we provide an integrated approach to evaluate supplier performance. The Key Performance Indicators refer from IS Success Model and in-depth interviews were well validated by FCA. It is notable that user's satisfaction perception of SPMS is critical. System quality, information quality, and service quality are key drivers directly influence intention to use systems and user satisfaction respectively. In addition, the impact that an individual feels an SPMS has on their work reflects the effect of the information product on organizational performance. Major conclusions were used to improve the supplier evaluation system. Based on statistics data about system usage, the improvement gained significant success.

TABLE 2.
DIMENSIONS AND INDICATORS OF SPMS

Dimensions	KPI	Relationship to SCOR
Quality	Incoming Acceptance Rate	Distribution reliability of the supply chain
	Production Line Fall Out	Distribution reliability of the supply chain
	Customer Complaints	Distribution reliability of the supply chain
Cost	Cost Competitiveness	Flexibility of the supply chain
	Cost Reduction	Cost of the supply chain
	Payment Term	Cost of the supply chain
	Proactive Price Reduction	Cost of the supply chain
Delivery & Communication	Normal PO Reply Rate	Responding speed of the supply chain
	Normal PO Compliance	Distribution reliability of the supply chain
	Normal PO Confirm	Response speed of the supply chain
	Order Revise Reply Rate	Response speed of the supply chain
	Notification of Forecast Reply Rate	Response speed of the supply chain
	IT Supporting	Response speed of the supply chain
	Material Assets Management	Asset management of the supply chain
	Other Performance	Response speed of the supply chain

TABLE 3.
FCA ANALYSIS RESULTS

Construct	Attribute
System quality	(1) The systyem is appropriate for evaluating supplier's performance. (2) It brings convienience in work. (3) Its operation is stable. (4) More filtration conditions can be created. (5) The system's operation is quite smooth.
Information quality	(1) It is easy to understand the information content. (2) Summarized data can be enhanced. (3) The data association can be improved. (4) The safety measures are well-established.
Service quality	(1) Most IT personnel can finish their jobs as scheduled. (2) They provide good care. (3) They respond quickly. (4) They emphasize the user's requirements.
Satisfaction	The satisfaction toward software, information, and overall are all fair.
Intention to Use	The frequency of use is not high enough.
Net benefits	(1) Saves working hours (2) There are no obvious solutions for market extension.

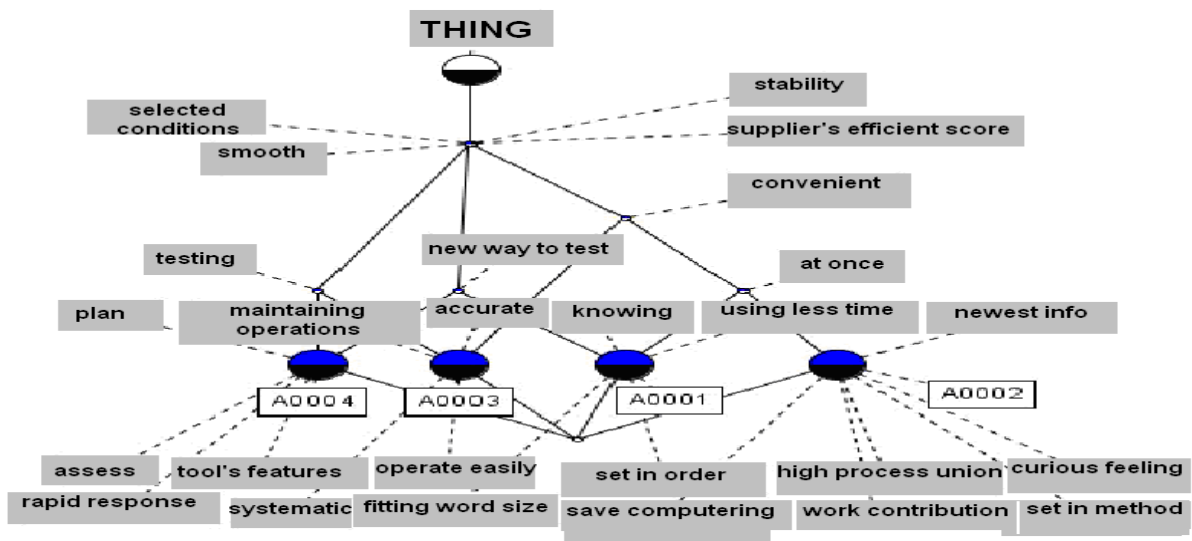


Figure 2. Concept Map of the System Quality

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