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Identifying Key Success Factor For Supply Chain Management System in the Semiconductor Industry - A Focus Group Approach

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***Abstract*—**Developing a supply chain management (SCM) system is costly, but important. However, because of its complicated nature, not many of such projects are considered successful. Few research publications directly relate to key success factors (KSFs) for implementing a SCM system. Motivated by the above, this research proposes a hierarchy of KSFs for SCM system implementation in the semiconductor industry by using a two-step approach. First, the literature review indicates the initial hierarchy. The second step includes a focus group approach to finalize the proposed KSF hierarchy by extracting valuable experiences from executives and managers that actively participated in a project, which successfully establish a seamless SCM integration between the world's largest semiconductor foundry manufacturing company and the world's largest assembly and testing company. Future project executives may refer the resulting KSF hierarchy as a checklist for SCM system implementation in semiconductor or related industries.

***Keywords*—**Focus Group, Key Success Factors, Supply Chain Management, Semiconductor Industry.

I. INTRODUCTION

A. The Need for Supply Chain Management (SCM)

In today's global business arena, competition is marked by volatile demand, decreased customer loyalty, shorter product life cycle, and mass product customization. Pushed by the competition, companies need to drastically reduce inventory, improve throughput, and still provide on-time delivery. To achieve these goals, companies are rethinking their collaboration relationship with their business allies both upstream and downstream. Firms have begun to realize that competition is no longer company to company, but supply chain to supply chain [1], [2], and have started seeing themselves as a member in the whole supply chain rather than a separate entity in business to compete with the others.

B. Research Motivation

While supply chain management has become one of the important management approaches to creating closer enterprise collaborations [3]–[5], many companies continue to invest significant resources in developing information systems to achieve desirable supply chain management. Error-free decisions about information technology (IT) investment are vital for a firm to adapt to its business environment [6]. However, due to the complicated nature and large scope of SCM IT implementation, few supply chain management systems are considered successful [7]. Furthermore, according to Gunasekaran and Ngai [8], few research publications are directly related to the success factors of implementing a supply chain management system.

C. Research Objective and Approach

Motivated by the need of references described in section B, this research proposes a hierarchy of key success factors (KSFs) for implementing SCM system in the semiconductor industry by using a two-step approach to construct the hierarchy. The literature review of SCM, operation management, and information systems and management identified the initial KSF hierarchy. The second step includes a focus group approach to finalize the proposed KSF hierarchy by extracting valuable experiences from executives and managers who actively participated in a project, successfully establish a seamless SCM integration between the world's largest semiconductor foundry manufacturing company and the world's largest assembly and testing company.

The proposed hierarchy provides a valuable reference for future SCM system implementation project managers, ensuring consideration of all key success factors to avoid failure. This hierarchy may serve as a foundation for academic research in fields related to SCM system implementation.

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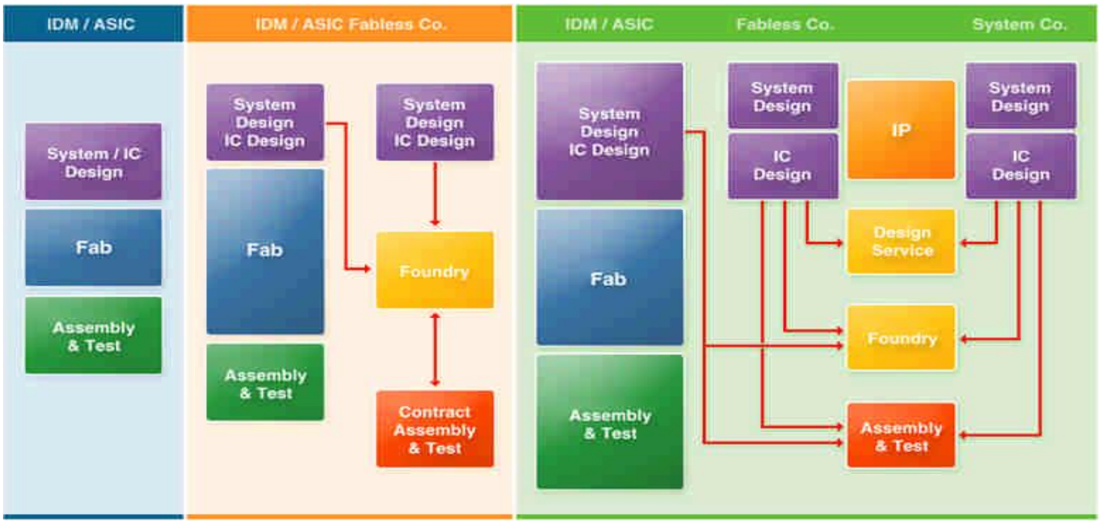


Fig. 1 Disintegration of the semiconductor industry value chain

II. The Successful SCM System Implementation Project

A. The Project Introduction

From 1998 to 2004, Taiwan Semiconductor Manufacturing Company (TSMC), the largest semiconductor foundry and second largest IC manufacturing company in the world and Advanced Semiconductor Engineering Inc. (ASE), the world's largest semiconductor assembly, testing, and packaging service provider, jointly completed an e-Supply Chain Management (eSCM) project integrating 11 key business processes through the Internet. The result was a seamless interface between TSMC, ASE, and their joint customers. The success of this project allowed them to obtain accurate, timely information on their product status and respond appropriately when needed. Their pioneering experience has evolved from a two-company project into a potent force, upgrading the efficiency of the entire semiconductor industry through process and data standardization via RosettaNet.[1]

B. The Semiconductor Value Chain

The continuing trend of the semiconductor value chain disintegration has improved cost efficiency at each stage of the value chain as shown in Fig. 1. These companies in the value chain need to closely collaborate with their partners both upstream and downstream in order to meet the relentless end consumer demand to achieve shorter time-to-market, lower cost, higher responsiveness, and better quality. Therefore, how to streamline the business processes between partners, how to share information appropriately, and ultimately, how to effectively "re-integrate" the value chain in a virtual manner have become some of the most critical issues in the semiconductor industry today.

C. The Project Background

To cope with the above issue, TSMC and ASE embarked on a pioneering effort to integrate the key business processes between them, covering all major business activities in the production life cycle. The overarching goal of the project was to integrate key operational activities and data between TSMC and ASE, resulting in a seamless information and transaction interface to their joint customers, as if manufacturing took place in the customers' own backyard. These process integration and data exchange experiences subsequently became the foundation of three RosettaNet standards, RosettaNet 3D8 (WIP, Work In Process), 7B5/7B6 (Work Order and Work Order Acknowledge), in Semiconductor Manufacturing (SM) Council.

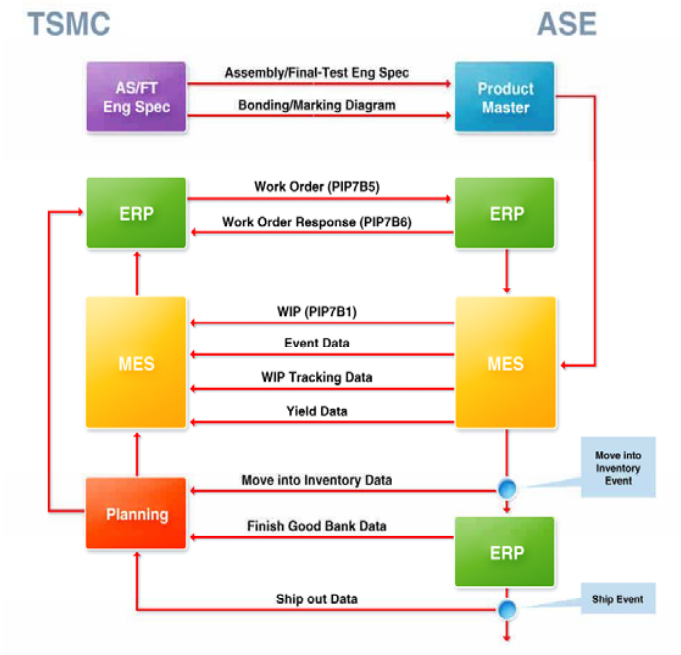
D. The Project Scopes

The project was comprehensive in scope, encompassing all major business activities between TSMC and ASE in the following two dimensions:

(1) Engineering Collaboration, including
- Engineering spec and diagram
- Engineering test data
- Yield data

(2) Logistics Collaboration, including:
- e-PO and Order Acknowledge
- WIP data
- FG tracking
- Advanced shipping notice

[1] RosettaNet, formed in 1998, is a standards development organization, which provides the standardized data infrastructure for integrating business processes for collaborative commerce. The data standards now defined are widely adopted by companies to conduct inter-company SCM. The organization has more than 500 world-leading organizations joining and working to create, implement and promote open e-business standards and services.



AS: Assembly, FT: Final-Test, ERP: Enterprise Resource Planning, MES: Manufacturing Exec ution System

Fig. 2 TSMC/ASE's key process integration – conceptual overview

The inception of the TSMC/ASE e-Supply Chain project can be dated as early as 1998, a truly pioneering initiative ahead of other players in the industry. In the early stage of this project, between 1998 and 2000, was conducted without any international standards at the time. Hence the two companies were truly in uncharted waters as they discussed various aspects of process streamlining, process linkage, data exchange protocols, and integrated system architecture and functionalities. After numerous mutual visits, meetings, e-mail exchanges, and telephone communications, eleven e-processes were established including yield rates, testing results, order and order acknowledgement, work-in-process, and shipment of finished products in stock; etc. Fig. 2 illustrates the identified key processes between these two companies.

E. The Significance of the Project

While scoping and defining the project architecture, these two companies intended not only to integrate existing process but also to build a "foundation" upon which more process integration and data exchange would be established both upstream and downstream the value chain. This model was eventually extended to more than 20 of TSMC customers (with TSMC as the interface), and to around 10 suppliers (with ASE as the interface).

This pioneering experience was significant in that it provided a practical, "down in the trenches" experience base with which the two companies were able to contribute when RosettaNet Semiconductor Manufacturing Board (SM Board) was established in 2000. Such an experience base proved instrumental in defining common e-commerce language and protocols for the semiconductor industry as more players adopted the same standards to benefit from the resulting operational efficiency and synergy.

III. FOCUS GROUP METHODOLOGY

Focus group is a carefully planned discussion designed to obtain perspectives regarding a specific topic in a non-threatening environment. This discussion group should be small and follow a semi-open format led by a moderator [9]. During the discussion, participants directly converse with each other, and through this interaction they can re-evaluate their own understanding of the specific topic.

The process of conducting a focus group discussion consists of three phases: planning, conducting, and analyzing. Within each of these phases are suggested steps [9]. These three phases are introduced below.

1. Planning phase:

First, the purposes and topics of the focus group discussion need to be defined clearly and then an appropriate moderator must be appointed. The moderator provides clear explanations of the topics, keeps the discussion focused, and ensures that everyone can participate in the discussion and express opinions. The moderator encourages participants to feel at ease, stimulate discussions, and promote interactions between group members. The moderator must have a thorough understanding of the topics and purposes of the discussion and good communication skills. The moderator facilitates the discussion, but does not lead to avoid favouring particular participants or directing discussions a certain way.

The number of participants in a focus group discussion usually ranges from 4 to 12. While careful selection of focus group members is necessary, identifying appropriate participants is not always easy. Member selection should follow these three guidelines: homogeneity, heterogeneity, and representative. Morgan [10] proposed that participants should possess similar understanding about the topics of the meeting. However, members with different positions, backgrounds, experiences, and expertise should be considered to include different perspectives. Stewart and Shamdasani [11] suggested that the focus group consist of members that are representative of the discussion topics.

2. Conducting phase:

A prepared set of questions and guidelines help facilitate the discussion so that it does not lose focus. As for session duration, Fern [12] suggested that a focus group discussion usually last for 90 to 150 minutes.

Many different approaches can be used for data collection during the focus group discussion. Memory, transcripts, notes, and tapes are frequently used. Tape recording is the most commonly used data collection method since it records all ideas produced from the discussion completely without any judgement made by the note taker. This research collects discussion data by taking notes since certain participants have concerns in recording the discussion.

3. Analyzing phase:

This is the final phase of the focus group approach. Data collected from the group discussion is analyzed and results are reported. There are several analyzing approaches available [10]. This research adopts note-based analysis. An abridged transcript and a brief summary for each focus group discussion are prepared for analyzing and identifying the commonalities and patterns.

According to Kreueger [9], the approaches to conduct a focus group discussion and analyze the results can be very different, depending on topics and participants. Experienced researchers should be consulted to determine the appropriate approaches.

IV. CONSTRUCTING THE KSF HIERARCHY FOR SCM SYSTEM IMPLEMENTATION

A two-step approach was undertaken to construct the hierarchy of key success factors for implementing supply chain management systems. Sections A and B describe these two steps.

A. Step1 – Literature Review to Construct the Initial KSF Hierarchy

A literature review was performed to construct the initial KSF hierarchy as the focus group discussions foundation. However, according to Gunasekaran and Ngai [8], few research publications directly relate to the success factors of implementing a SCM system. To be comprehensive, the literature review encompassed the field of supply chain management, operation management, and information systems and management for related SCM KSFs. The following paragraph summarizes some of the publications reviewed in the current study.

Fawcett, Magnan and McCarter [13] conducted a literature review, cross-functional mail survey, and 51 in-depth case analyses of supply chain integration and summarized the success and hindering factors for supply chain management. Gunasekaran and Ngai [8] presented four major areas of decision-making for build-to-order supply chains; i.e., organizational competitiveness, development and implementation, operation, and information technology. They also sub-classified critical factors within these four areas. Another study by Gunasekaran and Ngai [14] reviewed and classified previous publications regarding information technology in supply chain management. This study presents a framework that identifies the key area of focus in applying information technology to supply chain management. Liu, Zhang and Hu [15] performed a case study of an inter-enterprise workflow-supported supply chain system and presented the key success factors of supply chain management based on experiences and lessons learned. Bose, Pal and Ye [16] presented a case study of enterprise resource planning (ERP) and supply chain management integration in China.

The current study collects forty eight previously published key success factors and categorizes them into five initial dimensions. This initial KSF hierarchy will be used as a foundation for focus group discussions in step 2.

B. Step2 – Focus Group Discussion

The current research adopts the focus group approach. Based on the initial KSF hierarchy, a series of focus group discussion were conducted. The purpose of these discussions is to finalize the KSF hierarchy for SCM system implementation by extracting successful experiences from executives and managers who actively participated in the SCM implementation project described in section II. While the initial hierarchy from step 1 was a summary of SCM KSF from a review of literatures that discussed SCM KSF from many different perspectives, the resulting KSF hierarchy from step 2 is a comprehensive KSF hierarchy for SCM system implementation focusing on the semiconductor manufacturing industry. The following five questions were asked in each of the focus group discussion sessions to ensure that expected results are obtained:

- Which KSFs do you think are appropriate for SCM system implementation in the semiconductor industry?
- Which dimensions do you think are appropriate for SCM system implementation in the semiconductor industry?
- Which KSFs and which dimensions can be consolidated?
- Which KSFs should be put under which dimension?
- Is this KSF hierarchy for SCM system implementation a comprehensive one?

Five focus group discussions were conducted. All these discussions were held with four to six participants from both industry and academia. While the same moderator facilitated each discussion, the participants were carefully selected to have

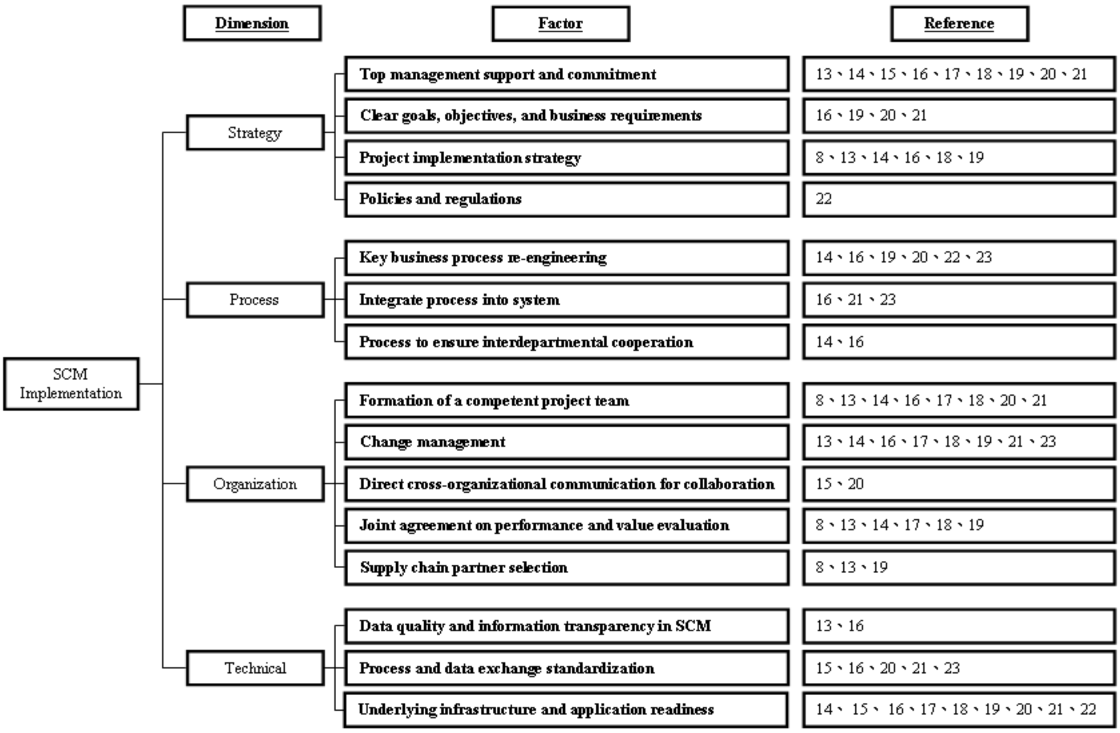


Fig. 3 Key success factors in implementing supply chain management systems

different opinions, in compliance with the guidelines of homogeneity and heterogeneity. The following table is a summary of the composition of the participants for the five focus group discussions (TableI).

Each of these focus group discussions lasted 60 to 90 minutes, and data from each discussion session was recorded by note taking. The moderator made a summary note for each session.

TABLE I
COMPOSITION OF PARTICIPANTS OF GOCUS GROUP DISCUSSIONS

Field / Background	Industrial Engineering and Management	Technology Management	Informantion Technology	Business
Academia	5	2		
Industry			4	2

C. Proposed KSF hierarchy for SCM implementation in Semiconductor Industry

All collected notes are used in the final analysis process to identify the commonalities and differences. The result of this analysis is a KSF hierarchy for SCM system implementation in the semiconductor industry, shown in Fig. 3. The hierarchy consists of four dimensions: strategy, process, organization, and technical. Fifteen KSFs divide between these four dimensions. The reference numbers following the factors denote reference literatures in which the factor was originally been discussed. The relative importance of the dimensions and factors is not represented by the number of factors under it, nor by the number of reference in which it was discussed. The relative importance of these dimensions and factors can be analysed in future researches with numerical results to provide further decision support information to future project executives.

V. CONCLUDING REMARKS AND PROPOSED FUTURE

While successfully implementing an SCM system is often vital for a company [6], the success rate for such a high-cost project is low [7]. However, few research publications directly relate to the success factors of implementing a SCM system [8]. The current research proposes a KSF hierarchy for implementing supply chain management system in the semiconductor industry.

The hierarchy was proposed based on a review of SCM related publications and especially on the valuable industrial experience extracted through focus group discussions from executives and managers of a successful SCM implementation project. The proposed hierarchy provides a valuable reference for future project managers of SCM implementation projects, ensuring consideration of all key success factors to avoid failure, which often associates with high costs. This hierarchy may serve as a foundation for academic research in fields related to SCM system implementation. Future research can conduct analysis on the relative importance of these dimensions and factors with numerical results to provide further information to project executives for decision-making.

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