同步供應鏈管理架構之進階研究與開發結案報告

在台灣的政府、學術界以及民營企業之合力下試圖尋找方法以重新塑造矽島競爭優勢-全世界的半導體工業的整合設計和製造中心[2]。本研究闡述一個同步供應鏈管理架構(Synchronous Supply Chain Management Architecture，SSCMA)，其為一個對於供應鏈績效持續性改良之有效價值創造的方法學。SSCMA部署兩個獨特的策略，敏感度分析與即時反應機制，首先是正確的偵測市場需求以及制定商務計畫；次之為有效地發展行動及服務來滿足客戶的需求，強化需求的穩定性以及合作價值。主要在SSCMA有九大同步模組來管理即時回應。朝向同步管理的敏感度分析規劃與即時反應機制。本文提出一個符合企業商務流程之執行程序以及新服務發展樣版之結構性架構。以學術上的模型和實際的案例評估顯示SSCMA能有效的合理化商務流程和提升供應鏈管理的績效與價值。具體而言，SSCMA證實其能力與潛力足以成為一個整合型企業級供應鏈同步化管理之解決方案。

關鍵字:供應鏈管理、矽島、商務流程、同步管理

Abstract
The joint force of Taiwan government, the academic and the private sector are constantly seeking the ways to reshape the competitive advantages of the Silicon Island-an integrated design and manufacture hub of the worldwide semiconductor industry [2]. This research presents a Synchronous Supply Chain Management Architecture (SSCMA) to be an effective value creation methodology for continuously refining the performance of supply chain management. Two characteristic strategies, Sensitivity-based Planning and Real-time Execution, are deployed in SSCMA. The first is accurately detecting the market demand and formulate the business plan. The second is effectively developing the actions and services to fulfill the customer demand, enhance demand stability and partnership value. The essential nine synchronization modules are identified and integrated in SSCMA as the enablers to manage the responsiveness. Towards the synchronization management of the Sensitivity-based Planning and Real-time Execution, this paper propose a structured framework with supporting business processes, implementation procedures and new service development templates. Our evaluation on both the academic prototyping and empirical cases shows that the SSCMA had effectively streamlined the business process and upgraded the enterprise supply chain performance and value. Specifically speaking, the SSCMA proves the capabilities and demonstrates the potential to be the integrated solution towards the synchronization management of the enterprise supply chain.

Key words: Supply Chain Management, Silicon Island, Business Process, and Synchronization

1 Background and introduction

1. 1 Background of semiconductor supply chains on Silicon Island

Taiwan silicon industry's first industry evolution was facilitated by Taiwan government's Complimentary Metal Oxidation Semiconductor Program to the prosperous semiconductor industry in Taiwan with above $16 Billion for IC industry and $50B for PC Industry since 1976 to 2000. This innovation program enables Taiwan's silicon industry as the importance player in the global value chain. Another best practice is the 2002 Corporate Innovation Award from IEEE "for pioneering and realizing the dedicated IC wafer fabrication business." This award recognizes Taiwanese foundry business model, which has fostered significant and innovative contributions to the global semiconductor industry. [2,16] Nowadays, Taiwan has played the successful role of manufacturing hub, the Silicon Island, of worldwide semiconductor industry. However, the Silicon Island is encountering the challenge of the advanced silicon technology countries, the emergent raising of China and the getting more and more complex of technology evolution roadmap. Looking ahead, Taiwan silicon industry is in the stage of "second silicon industry evolution". Hence, a series of national programs had been launched for enlarging the completive advantages.

1.2 SCM Problems of the Semiconductor Industry

Semiconductor industry is both the capital and expertise-intense industry. As the corporate and supply chain management view, capital investment and demand fulfillment effectiveness are the critical successful factors to enable the industry or the corporate to enlarge competitive advantages. From the analysis of the worldwide historical data, it shows that the technology capacity deviation between the actual supply and planned supply was huge. [8,20,26] Specifically speaking, the over-investment was amplified in the up term and the over-cost down was also amplified in the down term. It shows that bullwhip effect is the dominator to affect the performance of the worldwide semiconductor industry [4]. It shows that the capital effectiveness of the semiconductor was getting lower and lower. Obviously speaking, the industry suffered the unsatisfied performance of supply chain management in the responsiveness of the market dynamics. [4, 20, 24]

1.3 The industry effort to improve the enterprise SCM performance

The semiconductor industry is badly expecting for a perspective and theoretical SCM management methodology to upgrade their competency in the enterprise level. In our observations and interviews, we found that a great of the companies are seeking the methodology and redesign the process with IT systems to improve the SCM performance. SCM is discussed as a brilliant remedy to enable the company to improve the current situation. However, most of the delivered SCM projects focus on the IT system introduction. The business process and customer needs responsiveness were not addressed. There were few companies had an integrated supply chain strategy and management architecture to ensure their supply chain performance. There were few successful cases, which could actually benefit from the implementation of SCM. The proven capability of managing the market and demand change is not found. An improvement in the responsiveness of capacity and service management is the central of the semiconductor supply chain management research. [7,12,22,26, 28,36,40]

1.3 The relevant academic effort for the semiconductor industry

Specifically speaking, the industry is seeking the remedy to manage the external market dynamics, customer demands, and the capacity expanding and service development of supply side. Actually, the comprehensive and proven methodology for the enterprise to manage the dynamics environment and conduct the successful value creation for the excellent supply chain performance is not found. As our literature review, we found that the limited SCM model dominated the SCM performance. We summarized this kind of practices as the asynchronous SCM model, which had the following features that might reduce the supply chin management performance:

(1) A lack of the evaluation framework for integrating the corporate objectives, SCM and physical operation execution [12,15,22,34, 38, 40]
(2) A lack of the real time responsiveness to manage the market dynamics and demand volatility [5,6, 13,14,17,18,28,36,38, 40]
(3) A lack of real efficient logistics or business process to fulfill the planning objectives[1,7,30,31,32, 37, 40,43,44]
(4) A lack of knowledge and experience abstraction and accumulation mechanism for the senior management to handle the strategic decisions such as the capacity investment and expanding [9,15, 17,19,23, 40]

(5) A lack of the research and proven experience of architecture reengineering which help the industry to deploy and adoption [12,15,22, 34, 40]
(6) A lack of efficient implementation procedures to reconstruct the supply chains with IT [3, 4,5,19, 24,37,40,44]

2. Elements of stopping the asynchronous SCM

After identifying the problems of the semiconductor industry on Silicon Island and summarizing the key barriers towards the effective management and improvement. The research adopted the following critical improvement initiatives to formulate the methodology for improving the current situation.

2.1 Integrated Supply Chain Management (SCM) model

The SCOR model of Supply Chain Council define the basic scope of customer interactions, product (physical material and service) transactions among your supplier's supplier to your customer's customer, including equipment, supplies, spare parts, bulk product, software, etc. The SCOR model focuses on the operation efficiency with the sufficient considerations on the methods or tools adoption. However, the methods to enlarge the leading edge competitiveness, such as the innovation in the new service design and delivery is not embedded originally [38] Tom's approach to model the supply chain uncertainty with major four landscapes: customer demand, supplier performance, and manufacturing and customer deliveries. Based on this integrated framework, the interactive analysis platform for the managers to propose the changes and see the simulation results will be one of the core capabilities of uncertainty management. [40] Haul identified that "Efficient supply chains often become uncompetitive because they don't adapt to changes in the structures of market." [15] He demonstrates the best supply chain management identifies the structural shifts by capturing the latest data, filtering out the noise, and tracking key patterns. Hence, the triple-A was proposed as the thinking dimensions fro the SCM reconstruction. The first A is agility for responding short-term demand or supply changes quickly& handle external disruptions smoothly; the second A- adaptability to adjust supply chain design to meet structural shifts and modify supply network to strategy, products, and technologies; the third A is alignment – create incentive for better performance.

2.2 Business process integration and synchronization

The business process integration of supply chain is to making the supply to meet the market demands. The information collecting, analyzing, and action responsiveness are usually performed separately by the different organizations and systems. [7,30,32,35,37] Hence, the coordination among the cross departments is the central of concurrent management or synchronization management. [43] Institute for Defense Analyses (IDA) provided the first well-known definition of Concurrent Engineering (CE or Synchronization Engineering). "CE *is a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and supporting. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from concept to disposal, including quality, cost, schedule, and user requirements.*" [44] At present, the shortened Time-To-Market (TTM) is getting the central role in competitive advantages.[31] This particular advantage requires consistently greater speed in making operation and management decisions, delivering new business service and products to customers. Charles formulates a 3-D CE to conduct the value chain innovation. It's a customized CE approach to manage product, process and value chain redesign and development. Specially, the Double Helix illustrated the thinking and review process to construct the new value chain. [1,9]

3. Methodology of synchronization supply chain management

3.1 Methodology overview

The synchronization management of supply chain management is the integration of the market dynamics and the corporate response such as the operational processes of order management, strategic initiatives of new service development and technologic capacity expanding. Additionally, an effective SCM methodology must have the capability for the corporate to synchronize the internal business processes with the external market dynamics. The benefit of an effective SCM is not only the premium operational performance but also the premium capability to fulfillment customer needs with constant value creation. The purpose of this paper is to demonstrate an effective reference model for the world-class manufacture or service provider to conduct the SCM reengineering toward the synchronization management of external dynamics and internal response.

3.2 Essential nine Synchronization Modules

This research identifies the essential nine synchronous modules as the management central to enable the synchronization management of enterprise supply chain. The synchronizations modules are the business content and activity of a business entity for fulfill the enterprise supply chain function to ensure the following objectives of the synchronization management.

- Have the common information platform for consistent planning and execution of order management.
- Have the synchronous technology capacity expansion with the market dynamics and changes.
- Have the interface to consider and accumulate the executive expertise of the senior management.
- Have the integrated supply chain management knowledge base and framework to deploy the new service and strategy innovation.

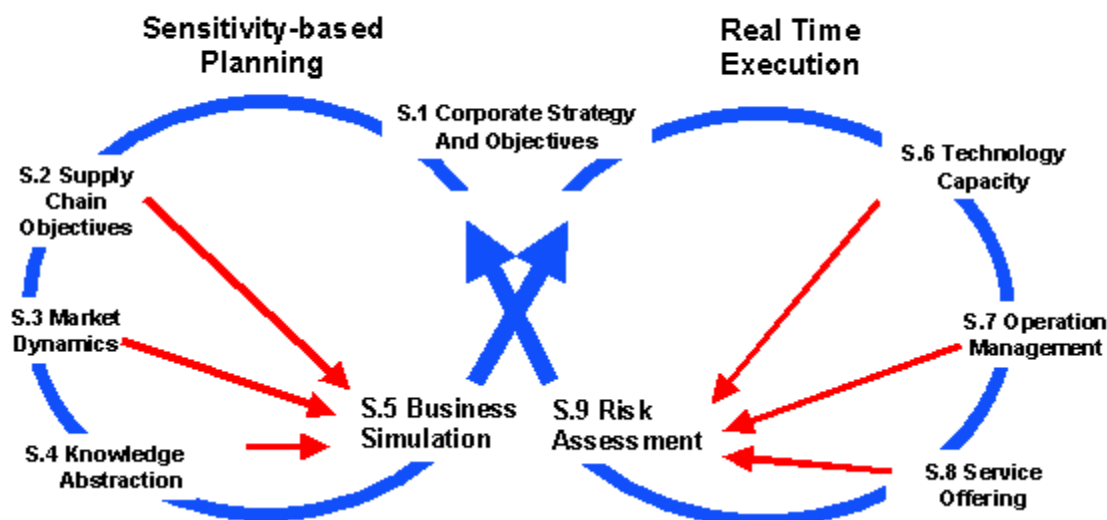| ID.	Synchronous Module	Description	Example
S1	Corporate Strategy and Objectives	The major strategic initiatives derived form the corporate objectives realization.	-60% Market share is the corporate objectives and the strategy might be premium service offering or technology co-development
S2	Supply Chain Objectives	The supply objectives derived from the corporate objectives.	- Reduce 50% Work In Process - Improve capacity utilization to 80% -Improve demand fulfillment rate to 100%
S3	Market Dynamics	The market data and changes or updates that cause the change of customer or market demand.	-Customer profile and demand change -Product inventory level
S4	Knowledge Abstraction	The rule and knowledge discovered from the data mining of the market information and SCM database.	-The factors and formula for judged the raw customer demand. -The loyalty or satisfaction of each customer or product segment.
S5	Business Simulation	Simulate the business scenarios for the decision support.	-Simulate the utilization and service level of the alternative capacity expanding plan -Calculate the risk for the simulated scenarios
S6	Technology/Product Capacity	The technology development roadmap and installed capacity portfolio for customer demand fulfillment	-Technology shrinkage roadmap -Install capacity plan -Technology or product standard cost
S7	Operation Execution	The physical operation and execution for demand fulfillment.	- Manufacture activities -Demand and order fulfillment process
S8	Service Fulfillment	The service development and offering for customer's specific needs.	-The real time Work In Process (WIP) information providing -Development for Manufacture support -Design for test -Mask sharing mask for cost down.
S9	Risk Assessment	Assess the potential factors and impact of business scenarios on supply objectives realization.	Have the trade/off of the service level and investment cost.

3.3 Synchronous SCM architecture (SSCMA)

The essential none synchronization module functions were performed individually by different departments. The effective interaction and efficient information processing of the essential nine synchronization modules is the central to realize the synchronization management of supply chain. The Synchronous Supply Chain Management Architecture (SSCMA) was presented to collaborate the synchronization modules for completing real time management of supply chain. The SSCMA is formulated as the double helix structure to model the synchronization modules of SCM. The integrated

Synchronous SCM Architecture (SSCMA) is illustrated as below. The double helix demonstrates the closed interactions and collaboration among the essential nine synchronization modules.

The Synchronous Supply Chain Management Architecture
THE DOUBLE HELIX STRUCTURE

Sensitivity-based Planning | Real Time Execution

S.1 Corporate Strategy And Objectives

S.2 Supply Chain Objectives

S.6 Technology Capacity

S.3 Market Dynamics

S.7 Operation Management

S.5 Business Simulation | S.9 Risk Assessment

S.4 Knowledge Abstraction

S.8 Service Offering

Start from the corporate strategy and objective (S1) and follow the arrow direction of the helix structure, the synchronization modules- supply chain objective(S2), market dynamics(S3), knowledge abstraction(S4), will be executed respectively and the deliverables will be the input of business simulation(S5). Then the technology capacity (S6) will be invoked to do the sophisticated computations and generate the analysis reports on each business scenario for the decision supporting. Once determining the business scenario, the physical operation management (S7) and service fulfillment(S8) could be carried out with the clear and aligned guidance among all supply chain related organizations. Finally, risk assessment (S9) will be constantly performed and trigger the initiatives to meet the changing market. This research defined the synchronization process as the process or business activity that is performed by the cooperation of the synchronization modules, such as capital investment process, order fulfillment process. The technology capacity (S6) is the kernel and computing environment to serve the synchronization process execution. Specifically speaking, technology capacity (S6) is the synchronization engine of the SSCMA.

4. Discussion and Conclusion

4.1 Success summary

This paper identified the problems of the semiconductor industry. It tells that the asynchronous management of SCM is dominating the performance of SC supply chain. This paper presents a SSCMA to reengineering the management architecture with the features of the synchronization management. The essential nine synchronization modules of the SCM are identified. The complex interactions among the synchronization modules are integrated and illustrated in a helix structure, SSCMA.

SSCMA provides a really clear guidance for the industry participants and academic researchers to reengineering the SCM. Furthermore, this paper presents the critical enabler of SSCMA, Technology Capacity Engine. The four-level-Technology Capacity Engine serves as the executable synchronization-planning engine for analyzing and simulating the various business scenarios and business process tractions. To help the industry participants to adopt and activate the SSCMA in the fieldwork, this paper design and define the two strategic capabilities: Sensitivity-based Planning and Real time Execution Mechanism. The reference process, synchronization plan process and SIM were introduced and practiced with the detailed and executable procedures and templates. Specially, the AI and data mining was practiced to perform the risk assessment on different business scenario. With the above integrated design and deployment of SSCMA, the essential nine Synchronization Modules are well organized and integrated.

4.2 Lessons learnt and Critical Successful Factors

Fundamentally thinking and redesign

This research reviewed the SCM problems fundamentally and redesigns the SCM as the enterprise

integration view i.s.o limited factory operation or channel distribution level. Then, the SCM is positioned as the enterprise strategic program for getting the corporate objectives fulfillment. Two strategically capabilities Sensitivity-based plan and Real time execution was defined for top management. Once get the Top management support the enterprise SC is on the way towards THE architecture reconstruction and performance improvement.

Practical and adoptability consideration of the SCM research
To help the industry to have a executable and adoptable SCM model is one of the determinants as conducting this paper. This research formulates the critical nine synchronization modules for realizing the two characteristic capabilities Sensitivity-based plan and Real time execution. The essential nine synchronization modules in SSCMA, such as corporate objectives (S1), marketing dynamics (S3), knowledge recovery (S5) Technology capacity modeling (S6), risk assessment (s7) reminds the SCM participants or researchers to have the comprehensive thinking and communication protocol while the intensive SCM reconstruction and refinement.

5. Conclusion

This paper presents the nine synchronization modules as the central of synchronization management. With the structure procedures defined in this paper, the corporate could establish and reengineering their enterprise level SCM architecture. The SSCMA is presented to enhance the SCM performance. From the theory study, industry benchmarking and case study, the SSCMA's capability in improving the entire SCM performance and promote the value chain position is demonstrated. This research also provides the reference model to assist the industry of world-class manufacture and service providers on Silicon Island, to conduct the SCM reengineering with the business model innovation. Specially, this paper delivers an efficient and effective model of creating the new age of the supply chain management in the industry.

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