國立交通大學

科技管理研究所

博 士 論 文

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中文摘要

隨著經濟全球化，國際競爭日趨激烈，企業經營出現危機，企業流程再造(BPR)藉由結合組織策略與資訊科技、建立或重整跨功能的企業流程，以增加企業競爭優勢。而電子商務的盛行，更將企業流程的實踐領域從企業內進一步擴展到跨企業與企業間作業流程的整合，故企業流程再造的重要性更為顯著。

企業在推動企業流程再造時，必須要有一套完整的實施步驟，使企業流程再造概念可付諸實行，並讓執行企業流程再造的人員有一程序得以依循，引導企業一步一步地將改造的成果落實到整個企業中。以往針對企業流程再造實施方法的諸多研究未臻詳盡，其中大多集中在高層次的定義描述，而未進一步探索實施細則；少數涵蓋實施細則者，卻也未臻完全而且缺乏實務的驗證。

本研究的目的,是要提供一個包含 5 個高層次階段和 36 實施細則步驟的結構化和系統化的實施架構，以降低企業在施行企業流程再造時之風險，和提昇企業流程再造的執行成功率。為了驗證此架構的可行性，本研究並深入探討二個高科技國際企業依循此架構以成功導入企業流程再造的經驗。

關鍵字：企業流程再造，供應鍊管理，價格管理

An Effective Business Process Reengineering (BPR) Implementation Model

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Abstract:

Adopted by many organizations worldwide, business process reengineering (BPR) has become a popular management tool to cope with rapid technological and business changes in today's competitive environment. BPR projects typically attempt to transform the organizational subsystems of management, people, information technology, and organizational structure. Such a large-scale change recognizes that BPR is not a monolithic concept but rather a continuum of approaches that need a solid implementation methodology. However, previous research on the subject of BPR implementation methodology has primarily focused on high-level definition of discrete stages, and only a few further explore to detailed activity but yet comprehensive. This article aims to develop a comprehensive project implementation framework comprising 5 stages and 36 activities in order to help people successfully carry out BPR in their organizations. The validity of the framework was verified by two major BPR initiatives undertaken at two leading international companies in a high-tech industry.

Key words: Business Process Reengineering (BPR), Supply Chain Management, Pricing Process Management

誌謝

自大學畢業至今，已超過 20 多個年頭；在不惑之年還能重時拾書本，浸淫於學術殿堂，攻讀博士學位；過程雖然辛苦，但卻是一段豐碩的自我實現歷程。

回首過去數年的博士求學生涯，特別要感謝我的指導教授--虞孝成老師。虞老師在民國 94 年我第一次博士班入學考試失敗之時，即鼓勵我再接再勵，並提醒我早入學不一定早畢業，儘快開始著手撰寫期刊論文，方是畢業的主要關鍵。在虞老師悉心安排之下，我認識了張世其學長(時為彰化師大的助理教授)，並在世其學長指導之下，提前開始了論文撰寫的準備工作。同樣也在虞老師建議之下，我先後於 94、95 二學年期間，陸續註冊所上的學分班課程，使我在入學科管所之前，對科管所學程有一基本認識。96 年正式入學後，在科管所課堂親炙諸位老師的知識傳授，更是讓我受益良多：包括虞老師所教授的『孫子兵法與競爭優勢』與『科技企業經營典範』、袁建中老師的『技術評估與預測』與『技術前瞻與政策』、林亭汝老師的『國際行銷』與『企業調查研究方法』、徐作聖老師的『企業政策與策略管理』與『宏觀策略管理』、以及洪志洋老師的『財務策略與管理』與『智慧財產評估』等等….；老師們淵博的學識和啟發式的教學，讓我深深享受在科技管理的浩瀚中。

除了感謝師長們的殷切教導，另外也要感謝陪我一起奮鬥的學長和同學們。首先是鄭昭仁和張世其二位學長，昭仁是大我五屆的學長，也是我在教會中的弟兄，正因為昭仁的引薦，使我有幸能成為虞老師的門生；在二次準備博士班入學考試的過程中，昭仁不遺餘力地教導我基本的計量研究方法。世其學長則是在我投稿期刊屢次受挫之際，持續給我鼓勵和指導，使我論文最終能被接受。另外要感謝永祺、嘉麗、榮新、光斌、佩翰等同學，在那一段一起準備期前考和資格考的日子裡，大家一起打拼、互相支持、互道祝福，著實是一段充滿歡笑和汗水，且令人懷念的閃亮日子。

在家人方面，則一定要感謝我的妻子苡君，她辛勤地照顧家庭和二個孩子的課業，讓我沒有後顧之憂；還有教會中二重小組可愛的弟兄姐妹，在我準備博士論文計劃書和最後口試前的殷切祈禱。回首過去的求學日子，就如聖經上所說『那美好的仗我已經打過了，當跑的路我已經跑盡了，從此以後，有公義的冠冕為我存留』;那份冠冕，對我而言不單是一項畢業的方帽子，更是一群教導我、鞭策我、陪伴我一起成長的師長、同學、家人和朋友們的祝福和鼓勵。

再一次謝謝親愛的你們 **and Praise the Lord**。

Table of Content

List of Tables

List of Figures

1. Introduction

1.1 Research Background

The concept of Business Process Reengineering (BPR) was first introduced by Hammer in 1990. BPR has been defined as a fundamental rethink and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed (Hammer, 1990). Adopted by many organizations worldwide, BPR has become a popular management tool to cope with rapid technological and business changes in today's competitive environment (Hamid, 2004). One study showed that about 87% of firms surveyed were either engaged in BPR projects, or indicating their intention to take up BPR projects in the next few years (Ranganathana & Dhaliwal, 2001). With the rise of e-commerce, the development of inter-organizational relationships and significant increases in the business integration has made BPR even more important. Such integration requires facilitating processes across the boundaries of organizations as well as streamline of back and front office processes (Fadel and Tanniru, 2005; Lin et al., 2002). In this decade, businesses will need to continue by using technology to add customers, suppliers, and other partners to the process redesign mix. The redesign of work will be between a company and its customers, suppliers and partners (Champy, 2002). With such high importance and adoption rate of BPR to organizations worldwide; however, various surveys and assessments reported that as many as 60-80 percent of BPR projects having been unsuccessful (Chiplunkar et al., 2003; Dennis et al., 2003).

1.2 Research Motivation

BPR projects typically include attempts to transform the organizational subsystems of management (style, values, measures), people (jobs, skills, culture), information technology, and organizational structure, including team and coordination mechanisms (Kettinger &

Grover, 1995). Such an organizational change perspective recognizes that BPR is not a monolithic concept but rather a continuum of approaches that need a solid implementation methodology (Kettinger et al., 1997). According to Wu (2003) and Vakola & Rezgui (2000), BPR methodology plays a crucial role in the success of BPR implementation for a number of reasons. First, a methodology provides a framework for suggesting structured knowledge, idea and techniques. It makes it possible to apply, evaluate and test them in a facilitated manner. Second, a BPR methodology develops a capability to organize, plan, and monitor the project life cycle, and to measure the performance of the re-engineered organization. Finally, the methodology holds the potential of creating a coordinated collaborative working environment. Then, it is possible to assign tasks to team-based groups, monitor the executing tasks, and measure the performance. Empirical researches also confirmed that establishing a disciplined approach for BPR and using a sound methodology are prerequisites for BPR success (Berrington et al., 1995; Majed et al., 1999; Al-Mashari et al, 2001;Paper & Chang, 2005). Various researchers have introduced different methodologies with their own specialties, characteristics, and techniques (Reijers and Mansar, 2005; Wu, 2002). These methodologies address different stages in implementing BPR, although they reveal key similarities (Al-Mashari and Zairi, 2000; Vakola and Rezgui, 2000). Some methodologies consider BPR as strategic-oriented and then emphasize the defining of the goals of the project. In contrast, systematic-oriented methodologies focus on process analyzing and modeling (Abdolvant et al. 2007). Nevertheless, none of these methodologies is comprehensive enough for every BPR project (Adesola and Baines; 2005; Chan and Spedding, 2003). Moreover, the previous research were either inadequate to provide implementation guideline details or short of empirical case study to verify the methodology (Tennant & Wu; 2005). Thus, it is difficult to select an appropriate methodology in order to guarantee the comprehensiveness and hence success.

1.3 Research Objective

Therefore, the purpose of this research is to develop a comprehensive project implementation methodology framework outlining the stages and activities of a BPR project that can help people to successfully carry out BPR in their organizations. The validity of the framework will be verified by two major BPR initiatives. One is an electronic Supply Chain Management (eSCM) process integration undertaken at Taiwan Semiconductor Manufacturing Company (TSMC), the world's largest dedicated semiconductor foundry and also the 2nd largest IC manufacturing company in the world. The other is a pricing management process reengineering at one company in the electronic industry.

1.4 Research Method

To address the research objective of this research, a literature review of BPR essence is conducted, which includes the definition, types, critical successful factors, and implementation methodology. Some key elements of the proposed methodology framework are extracted and synthesized from the result of literature review. In addition, practical experience of three consulting firms is also referred. To verify the completeness of the proposed framework, a thorough comparison with previous academic works is performed. The case study research methodology is adopted to test the validity of the proposed framework. The case study research methodology is often appropriate for studying “how” and “why” questions (Yin 2003). As such, a multiple-case study to illustrate how effective BPR was achieved and why. This case study illustrates how a leading high-tech manufacturing company successfully applies the proposed framework and implementation guidelines that yield a series of initiatives to improve its competitive advantage. The following figure demonstrates the research method framework.

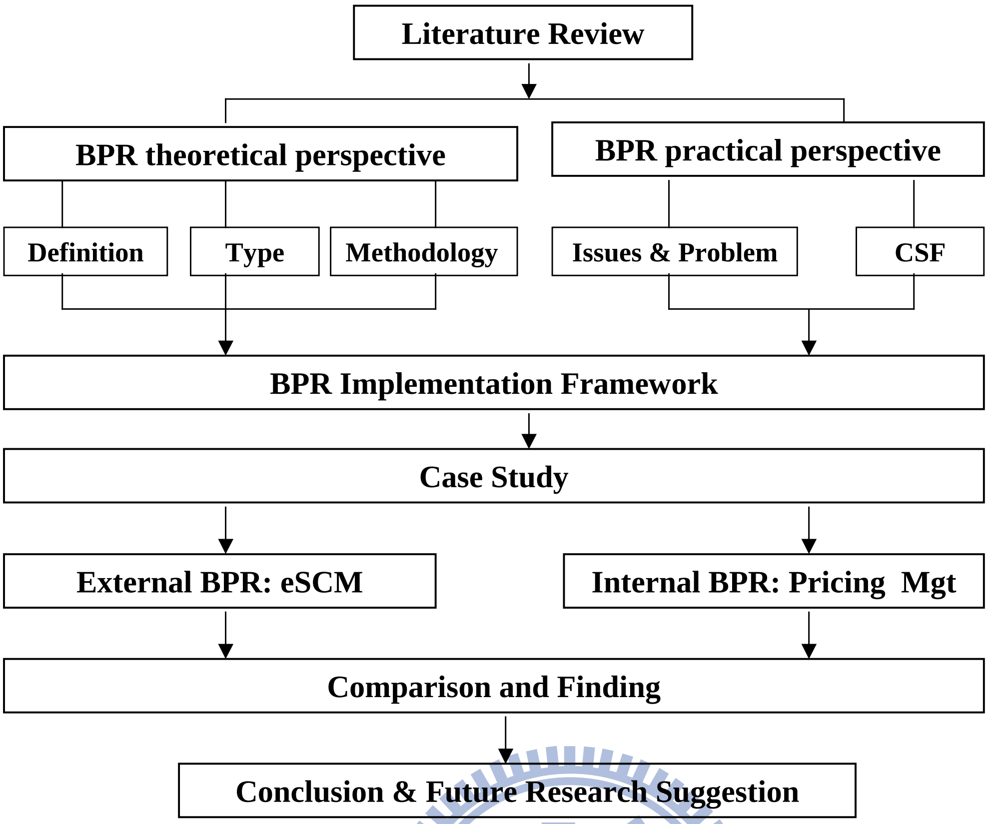

Figure 1 Research Method Framework

1.5 Organization of the dissertation

The remainder of this dissertation is organized in the following sections. In chapter 2, a literature review was conducted to examine the definition of BPR, the critical success factor (CSF) of BPR, and implementation methodology. Chapter 3 presents a comprehensive BPR implementation model comprising of 5 stages and 36 activities. Chapter 4 describes how the framework were successfully applied in two major business process reengineering initiatives. Chapter 5 compares the difference of these two BPR adopting the proposed implementation model and essential commonality that contributes the project success. Chapter 6 is the conclusion and suggestion of future research.

2. Literature Review

2.1 Business Process Definition

Business process reengineering (BPR) concerns the rethinking and redesign of business processes. The "business process" is the center of all concerns. Davenport and Short (1990) defined the business processes as a set of logically related tasks performed to achieve a defined business outcome. A set of processes forms a business system-the way in which a business unit, or a collection of units, carries out its business. Processes have two important characteristics:

(1) They have customers; that is, processes have defined business outcomes, and there are recipients of the outcomes. Customers may be either internal or external to the firm.

(2) They cross the organizational boundaries; that is, they normally occur across or between organizational subunits. Processes are generally independent of formal organizational structure.

For example, ordering goods from a supplier typically involves multiple organizations and functions. The end-users purchase and receive accounts payable; and the supplier organizations are all participants. The user could be viewed as the process's customer. The process outcome could be either the creation of the order, or, perhaps the actual receipt of the goods by the user.

2.2 Business Process Reengineering Definition

Several researchers and practitioners have defined BPR in different ways with different emphases (Herzog, et al. 2005). For example, Davenport and Short (1990) have described BPR as the analysis and design of workflows and processes within, and between, organizations. Hammer and Champy (1993) have promoted 'the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed'. Short and Venkatraman (1992) exposed the customer point of view when defining BP redesign as the company's action to restructure internal operations by improving product distribution and delivery performance to the customer. For Zairi (1997), BPR includes continuous improvement and benchmarking, within Business Process Management, which is a structured approach to analyze and continually improve fundamental activities such as manufacturing, marketing, communications and other major elements of a company's operation.

Fernandes et al. (1996) believed that BPR not only improve the product quality, international operation efficiency but also escalate other areas of an enterprise, such as innovation and agility. Loewenthal (1994) described the fundamental rethinking and redesign of operating processes and organizational structure; the focus is on the organization's core competence to achieve dramatic improvements in organizational performance.

Even if the main BPR characteristic still remains in the radical nature of change, some, such as Yung and Chan (2003), have proposed a slightly less radical approach, named 'flexible BPR'. Other authors, such as Vantrappen (1992) or Talwar (1993), focused on the rethinking, restructuring and streamlining of business structure, processes, work methods, management systems and external relationships, through which value is created and delivered.

The following table classifies these BPR definitions as groups of strategic and operational.

Table 1 BPR Definition

Classification	Scholar	Definition
Strategic	Hammer and Champy, 1993	The fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed.
	Talwar (1993)	The rethinking, restructuring and streamlining of business structure, processes, work methods, management systems and external relationships, through which value is created and delivered.
	Loewenthal (1994)	The fundamental rethinking and redesign of operating processes and organizational structure; the focus is on the organization’s core competence to achieve dramatic improvements in organizational performance.
	Fernandes et al. (1996)	BPR not only improve the product quality , international operation efficiency but escalate other areas of an enterprise, such as innovation and agility.
Operational	Short and Venkatraman (1992)	the company’s action to restructure internal operations by improving product distribution and delivery performance to the customer.
	Zairi (1997)	including continuous improvement and benchmarking, a structured approach to analyzing and continually improving fundamental activities such as manufacturing, marketing, communications and other major elements of a company’s operation
	Schnitt (1993)	BPR is about how an organization redesign work flow, three functional areas must be considered: organization design, human resource policies, and information systems
	Guha et al. (1993)	involves a fundamental analysis of the organization and a redesign of organizational structure, job definitions, reward structures, business work flows, control processes, and in some cases, a reevaluation of the organizational culture and philosophy.

Despite the differences in definitions and terminology, there are essential components within BPR that make it distinct from other management tools and paradigms (Al-Mashari et al. 2000).

- Focus on business processes

BPR focuses on the core concept of business process rather than on function, product or service. As business processes are the manner in which work gets done within an organization, they are a distinguishing characteristic among organizations, and thus a significant factor leading to competitive edge (Hinterhuber, 1995). In addition, the elimination of functional bias can only be best done by adopting process orientation to gain substantial business improvement (Andreu et al., 1997).

- Notion of radical

BPR involves radical and fundamental changes; with the aim to lead organizations to re-engineer old business processes and introduce new structures and procedures of doing business. Consequently, BPR is getting involved in dramatic and revolutionary changes (Hammer, 1990).

- Use of IT

IT is considered to be a major tool and a fundamental enabler of BPR efforts. IT reshapes business processes in that it has the potential to facilitate the flow of information between globally distributed processes, and ensures the availability of instantaneous and consistent information across the business (Davenport, 1993). The greatest advantage resulting from IT can be attained by exploiting its capabilities to create new effective business processes, rather than merely automating outdated functions (Venkatraman, 1993).

2.3 BPR Type

Davenport and Short (1990) had defined 3 major dimensions to define process; namely, entity, object, and activity. The detailed definition and description are shown below.

- Entity: Processes take place between types of organizational entities.
  - Inter-organizational processes: are those taking place between two or more business organizations. Companies are concerned with coordinating activities that extend into the next company along the value chain. For most companies, simple market relationships are the most common source of inter-organizational processes.
  - Inter-functional processes: These processes exist within the organization, but cross several functional or divisional boundaries. Inter-functional process achieve major operational objectives, such as new product are those taking place between two or more business functions within one organization. To develop a new product, for an example, needs the closed collaboration among the departments of Marketing, R&D, and manufacturing within the same company.
  - Inter-personal processes: involve tasks within and across small work groups, typically within a function or department. Example includes a commercial loan group approving a loan. This type of process is becoming more important as companies shift to self-managing teams as the lowest unit of organization.
- Object: Processes can be categorized by the types of objects manipulated. The two primary object types are physical and informational. In physical object processes, real, tangible things are either created or manipulated; manufacturing is the obvious example. Informational object processes create or manipulate information. Processes for making a decision, preparing marketing plan, or designed a new product are examples. Many processes involve the combination of physical and informational objects. Indeed, adding information to a physical object as it moves through a process is a common way of adding value. Most logistical activities, for example, combine the movement of physical objects with the manipulation of information concerning their

warehouses.

- Activity: There are two types of activities being involved in process: operational and managerial. Operational processes involve the day-to-day carrying out of the organization's basic business purpose. Managerial processes help to control, plan, or provide resources for operational processes.

The following table summaries the process type classification (Davenport and Short; 1990)

Table 2 BPR Types

Type	Sub-type	Example
Entity	Inter-organization Inter-function Inter-personal	B2B supply chain management Product development process Bank loan approval process
Object	Physical Informational	Product manufacturing process Request for quotation process
Activity	Operational Managerial	Order fulfillment process Marketing strategy definition process

2.4 BPR Methodology

The BPR methodology acts as a rallying point to keep people engaged and to help management continuously monitor the transformation as it unfolds. Consensus within an organization is critical as management at all levels and people involved in charge along the process path need to understand and believe in its potential for success. Methodology is therefore a joint activity between top management, middle management, and process workers on an ongoing basis to fine-tune the approach (Paper & Dickinson, 1997). Top management and project leaders must offer direction; partners' (customer and vendors) support must be covered in the methodology because they are the main reasons for transformation in the first place (Paper & Chang, 2005).

An effective BPR methodology should be creative, realistic, and effectively;

additionally, it should be cost-effective (offering me least expense), timely (performing in the least duration), of the best quality (having a high degree of excellence in improvements), feasible and achievable (performable by organizations' managers and employees), and flexible (having a capability of adapting to changes and extensions) (Dennis et al., 2003; Marir and Mansar, 2004).

Furthermore, in order to avoid inconsistent BPR efforts, a methodology should cover the following various aspects (Lin et al., 2002; Mansar et al., 2003; Reijers and Mansar,2005; Vidovic and Vuhic, 2003):

- Functional: it should have the capability of determining what activities and tasks have been performed
- Operational: it should identify how is a workflow operation implemented
- Behavioral: it should be capable of determining how activities, and when the workflow, are executed
- Informational: it should identify all the required information related to the business's processes, which are created, processed, and stored
- Organizational: it should represent the structure of organization and the related involved resources, which describe where, and by whom, activities are executed

Various researchers have introduced different methodologies with their own specialties, characteristics, and techniques. These methodologies address different stages in implementing BPR. For example, Hammer is the first one introduced the methodology to the academic and industry filed; and the framework was then referred by most of researcher afterwards. Mische and Warren (1996) and Harrison and Pratt (1992) integrated the concept of continuous improvement in Total Quality Management (TQM); Alavi and Yoo (1996) emphasized the importance of pilot system whereas Furey (1993) emphasized benchmarking the best practice. Davenport and Short (1990) focused their methodology on the area of applying IT. Lee and Chuah (2001) incorporated continuous process improvement (CPI) and business process benchmarking (BPB). Abdolvant et al. (2007), the most recent researchers complement with human factors of change management and supportive environment. The following table summarizes the key stages of methodologies introduced by researchers in the last twenty years.

Table 3 BPR Implementation Stage Comparison

Author	**Stages**						
Hammer (1990)	Mobilization	Diagnosis	Redesign	Transition			
Davenport & Short (1990)	Business vision & process objective	Process identification	Understand and measurement	Identify IT levers	Design and build prototype		
Harrison & Pratt (1992)	Set direction	Baseline and benchmark	Create vision	Project launch	Redesign	Implementation	Continuous improvement
Furey (1993)	Set objectives	Map and measure existing process	Analyze existing process	Benchmark	Reengineering	Roll out	
Guha et al. (1993)	Envision	Initiate	Diagnose	Redesign	Reconstruct	Evaluate	
Talwar (1993)	Define organization reengineering	Set objective	Analyze current process	Redesign	Implementation	Measurement	
Westell et al. (1994)	Define process	Identify core process	Evaluation	Redesign			
Elzinga et al. (1995)	Preparation	Process selection	Process description	Process Quantification	Process improvement	Implementation	
Alavi & Yoo (1996)	Initiation	Analysis	Redesign	Pilot Study	Implementation		
Fitzgerald & Murphy (1996)	Process selection	Team forming	Understand existing process	Set vision of new process	Establish new process	Execution	
Mische & Warren (1996)	Set Vision & objective	Baseline & Benchmarking	Process redesign	Organization transformation	Continuous improvement		
Lee & Chuah (2001)	Select process	Understand process	Measure process	Improve process	Review		

2.5 BPR Critical Successful Factors (CSF)

In this section, the CSF analyses of BPR implementation process are synthesized by reviewing the relevant literatures mainly done by Al-Mashari et al (1999), Paper & Chang

(2005) , and Herzog, at al. (2007). The factors are categorized into 4 sub-groups (as shown in Figure 2); i.e., Top Management, Organization, Project Management, and IT, each of them has associated elements as described below.

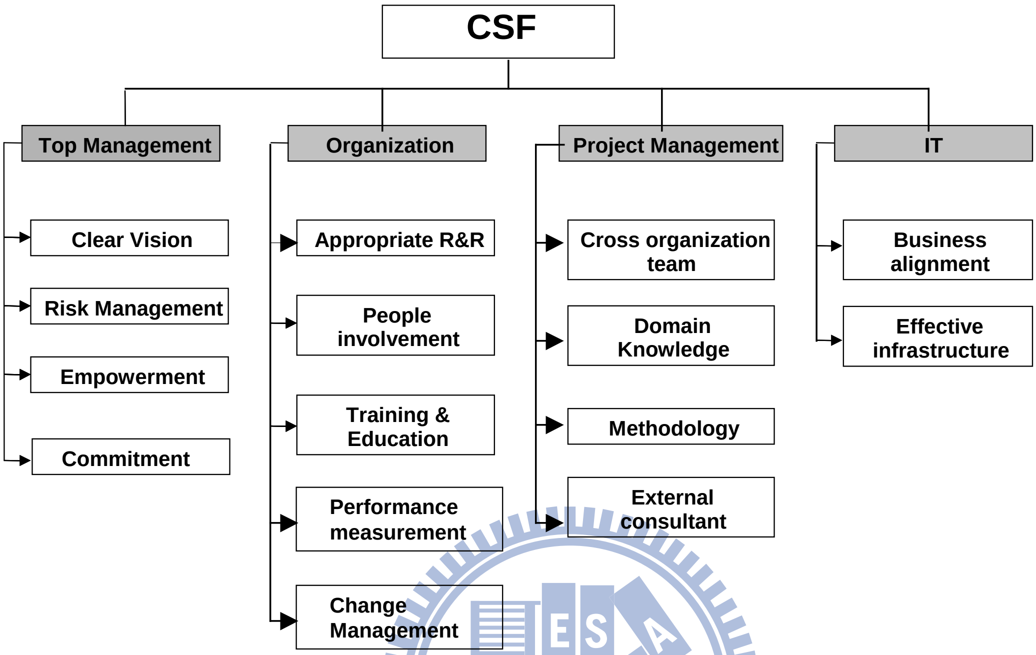

Figure 2 BPR CSF

1. Top management: Support from top managers must be fully committed to and involved in BPR for it to be succeeded. Hall et al. (1994) suggest that top managers must act as consensus seekers and role models for employees. In contrast, Hammer and Champy (1993) argued that, at least in the initial stages of BPR implementation, top management must adopt an autocratic and aggressive style of leadership in line with the unpopular decisions that have to be made. Some variables were designed from a set of items relating to top management commitment. They are identification of top managers with BPR goals, communication, management of risk, empowerment, and BPR understanding.

- Commitment: Management needs to foster commitment and ownership at all levels. At the same time, management must be tolerant of failure (Paper &

Dickinson, 1997). A willingness to allow failure and learn from it is paramount to BPR success (Caron et al., 1994).

- Clear Vision: The vision offers a blueprint for directing change. As such, it must be fully communicated to all. Moreover, it must be enacted. That is, top management must 'live' the rules laid out by the vision. Top management must also be 'actively' involved in all implementation stages of BPR (Kettinger et al., 1997).
- Risk Management: BPR implementation involves radical changes to several systems in the organization. Risks associated with acceptance of changes in the organizational structure, deploying emerging ITs with little familiarity, large investment in new resources, loss of personnel, and loss of earnings (Towers, 1994) are some examples that an organization may take when implementing BPR.
- Empowerment: Empowerment entails that staff are given the chance to participate in the redesign process (Bashein et al., 1994). When empowered, employees are able to set their goals and monitor their own performance as well as identify and solve problems that affect their work, thus they are supporting the BPR efforts.

2. Organization: As BPR creates new processes that define jobs and responsibilities across the existing organizational functions, there is a clear need to create a new organizational structure which determines how BPR teams are going to look, how human resources are integrated, and how the new jobs and responsibilities are going to be formalized.
    - Appropriate job definitions and allocation of responsibilities: As BPR results in a major structural change in the form of new jobs and responsibilities, it becomes a prerequisite for successful implementation to have formal and

clear descriptions of all jobs and responsibilities that the new designed processes bring along with them (Talwar, 1993).

- People involvement: Work within the processes is organized in teams, into which different specialized competences flow, and the sense of belonging to a team is enhanced, since teams are encouraged by the management to make decisions regarding the process itself. Moreover, team working creates a fertile ground for learning and adapting continuously to external stimulus; efficient teamwork has been shown to be a key element for improving business process performance (Telleria et al. 2002).
- Setting high goals for performance and extendable targets: As BPR aims for achieving dramatic improvements with radical changes in the organization, it's necessary to set goal high and performance measurement stretched.
- Education and training: It must be concentrated on developing people to thrive in a dynamic environment. People perform better if they understand how their jobs fit into the overall scheme of the organization and how they do them with adding value (Paper & Dickinson, 1997). Managers must thereby devise and execute plans to better link education and training with what people must do to enact change at the process level.
- Change management: People tend to be risk-adverse, which is natural in an organization that fails to foster change and risk taking. To redirect this tendency, change management at all levels of an organization that are impacted by the new process is critical to BPR success. A effective change management involves all human and social related changes and cultural adjustment techniques needed by management to facilitate the insertion of newly-designed processes and structures into working practice and to deal effectively with resistance (Carr, 1993).

3. Project Management: Successful BPR implementation is highly dependent on an effective BPR project management (CSC Index, 1994) which includes cross-organization team formation, sound domain knowledge equipped by the project team members, appropriate adoption of methodology (Carr, 1993), and effective use of consultants (Davenport, 1993); etc.

   - Cross-organization team. This includes line managers, process owners, those involved in IS and human resources, and workers (Bashein et al., 1994). Identifying process owners is also vital to BPR implementation (Boyle, 1995).
   - Appropriate adoption of methodology: A BPR methodology should be designed or selected creatively to satisfy the current needs of the organization. Adequate customization of available BPR methodologies determines the level of comprehensiveness and effectiveness that a new customized BPR methodology can reach (Kettinger et al., 1997; Klein, 1994).
   - Effective use of consultants: Consultants can bring to the organization specialized skills, experience, and know-how that the organization needs and it is both time-consuming and expensive for it to build internally. They can also provide a wide view, encourage unity between members, and are usually neutral (Davenport, 1993).
   - Domain Knowledge: Appropriate level of process knowledge (Zairi and Sinclair, 1995) including familiarity of the current business operation, insight of the future organization direction, appropriate selection of core processes, and use of resources inside or outside of the organization are all critical to BPR success. Adequate identification of process gaps and evaluation of effectiveness of current processes (El Sawy et al, 1997) is also useful.

4. Information technology: In leading edge practice, information technology and BPR have interdependent relationship that each is the key to thinking about the other. Thinking about IT should be in terms of how it supports new or redesigned business processes. Business processes and process reengineering should be considered in terms of the capabilities IT can provide (Davenport and Short 1990). Strategic use of IT has opened up possibilities for the integrated automation of preceding manual, paper-based business processes (Wells 2000).

   - Alignment of IT infrastructure and BPR strategy: Top management should act as a strategy formulator to provide commitment for the whole process of redesign, while the IS manager should be responsible for designing and implementing the IS strategy. The degree of alignment between the BPR strategy and the IT infrastructure strategy is indicated by including the identification of information resources needs in the BPR strategy, deriving the IT infrastructure strategy from the business strategy, the active involvement of management in the process of IT infrastructure planning and IT managers in business planning, and by the degree of synchronization in formulating the two strategies (Reich and Benbasat, 1996).
   - Building an effective IT infrastructure: The IT infrastructure and BPR are interdependent in the sense that deciding the information requirements for the new business processes determines the IT infrastructure constituents, and a recognition of IT capabilities provides alternatives for BPR. An IT infrastructure is made up of physical assets, intellectual assets, shared services, and their linkages. An effective IT infrastructure composition process follows a top-down approach, beginning with business strategy and IS strategy and passing through designs of data, systems and computer architecture (Ross, 1998).

3. BPR Implementation Model

3.1 Model Overview

There were various researchers introducing different methodologies with their own specialties, characteristics, and techniques. Although they reveal certain similarities, none of these methodologies comprehensively cover all the stages for today's organizations (Adesola and Baines; 2005; Chan and Spedding, 2003, Abdolvand et al, 2007). Valiris and Glykas (1999) highlighted other limitations of existing methodologies

- There is a lack of systematic approach that can lead a process redesign through a series of steps for the achievement of process redesign.
- Most methodologies concentrate on organizational processes without paying much attention to the roles and responsibilities of the employees that carry out the activities that compose these processes.
- There is no formal underpinning to ensure consistency across models.

Moreover, the previous research were inadequate to provide implementation guideline details such as key consideration for top management when review BPR, guiding principles of process diagnosis and process redesign, etc. The previous researches of BPR methodology were also short of empirical case study to prove the validity of methodology. In view of the above, it is necessary to define a methodology that covers all aspects of a BPR project. This research seeks to introduce a comprehensive methodology by incorporating the mentioned characteristics from previous published methodologies, integrating with critical successful factors of BPR implementation, and adopting the practical experience of three consulting firms in BPR engagements, ie, Atos Origin[1], Accenture[2], and Oracle[3]. The proposed BPR implementation methodology consists of 5

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[1] Atos Origin is a leading international IT services provider. It provides integrated design, build and operate solutions to large multi-national clients in carefully targeted industry sectors.

[2] Oracle is the 3rd largest software company in the world; it specializes in developing and marketing enterprise software products. Oracle consulting provides the service of defining company strategy and

stages and these stages are further divided into 36 activities. The five stages are Initiation, Study, Pilot, Full-scale development, and Transition.

The key characteristics of the proposed methodology are as following:

(1) It comprehensively covers al the key implementation stages, breakdown activities, and implementation guideline details.

(2) It particularly addresses the importance of top management support and active participation of key process owners by incorporating continuous communication and close-loop feedback within all stages.

(3) The validity of the methodology is proven by a leading international company that had implemented two major BPR projects successfully.

The Table 4 shows the detailed composition of the model and the Table 5 compare the proposed model with previous published ones. The remaining sections in this chapter will introduce the implementation details of each stage and its associated activities

implementing it with Oracle's best practices.

[3] Accenture, formerly known as Andesen Consulting, is a global management consulting, technology services and outsourcing company. Accenture has more than 181,000 employees serving clients in more than 120 countries.

Table 4 BPR Methodology Overview

Stages	Activities	
Initiation	1	Identify the challenges and problems company is facing
	2	Review company's vision
	3	Identify the bottle business process
	4	Select the high-impact BP to be re-engineered
	5	Designate process owners
	6	Set BPR objectives
	7	Search for BPR benchmark target
	8	Secure commitment from top management
Study	9	Organize the BPR team
	10	Delineate the existing BP
	11	Measure and analyze the existing process
	12	Diagnose the processes
	13	Propose cocept of new BP
	14	Ask feedback from user groups
	15	Design the prototype according to the proposed concept
	16	Develop change management plan
	17	Ask feedback from user group and modify the prototype
	18	Report BPR study result to senior management
Pilot	19	Develop pilot process and small scale implementation of new process
	20	Ask feedback from user groups and modify the pilot
	21	Report BPR pilot result to senior management
Full scale implementation	22	Define full scale BPR development plan
	23	Detailed design new BP
	24	Ask feedback from user groups & modify the process design
	25	Set the new BP performance target
	26	Determine enabling technologies
	27	Develop IT systems
	28	Conduct integration test
	29	Report BPR development result to senior management
Transition	30	Define new BP deployment plan
	31	Ask feedback from user groups and modify the deployment plan
	32	Deliver training & education
	33	Conduct organization change
	34	Transfer to new working environment
	35	Measure overall performance goals
	36	Continuous monitoring and improvement

Table 5 BPR Model Comparison

Stages		Activities	Davenport & Short (1990)	Harrison & Pratt (1992)	Furey & Timothy (1993)	Guha et al. (1993)	Talwar (1993)	Wastell et al. (1994)	Elzinga et al. (1995)	Alavi and Yoo (1996)	Fitzgerald & Murphy (1996)	Mische & Warren (1996)	Kettinger et al (1997)	Vakola et al. (2000)	Lee & Chuah (2001)	Wu (2003)	Abdolvaud et al (2007)
Initiation	1	Identify the challenges and problems company is facing	v	v	v	v	v	v	v			v			v		
	2	Review company's vision						v							v	v	v
	3	Identify the key or bottleneck business process		v		v	v		v	v	v		v		v	v	
	4	Select the high-impact BP to be re-engineered											v	v	v	v	
	5	Set BPR objectives		v	v	v		v	v	v	v	v	v	v	v	v	v
	6	Designate process owners											v				v
	7	Search for BPR benchmark target		v	v			v	v			v			v		
	8	Secure commitment from top management				v		v					v			v	v
Study	9	Organize the BPR team	v			v				v	v		v		v	v	v
	10	Delineate the existing BP	v		v	v	v	v	v	v	v		v	v	v	v	v
	11	Measure and analyze the existing process	v		v	v	v	v	v	v			v		v	v	v
	12	Diagnose the processes				v		v	v	v			v		v	v	v
	13	Propose cocept of new BP	v	v	v	v	v	v	v	v	v	v	v		v	v	v
	14	Ask feedback from user groups															
	15	Design the prototype according to the proposed concept	v		v	v				v			v			v	v
	16	Develop change management plan						v						v			v
	17	Ask feedback from user group and modify the prototype															
	18	Report BPR study result to senior management															
Pilot	19	Develop pilot process and small scale implementation of new process	v		v	v				v							
	20	Ask feedback from user groups and modify the pilot															
	21	Report BPR pilot result to senior management															
Full scale implementation	22	Define full scale BPR development plan			v			v					v		v	v	
	23	Detailed design new BP						v			v		v	v		v	v
	24	Ask feedback from user groups & modify the process design															
	25	Set the new BP performance target		v	v	v		v	v	v	v	v	v		v	v	v
	26	Determine enabling technologies	v			v		v					v	v		v	v
	27	Develop IT systems	v			v		v					v	v	v	v	v
	28	Conduct integration test															
	29	Report BPR development result to senior management															
Transition	30	Define new BP deployment plan													v		
	31	Ask feedback from user groups and modify the deployment plan															
	32	Deliver training & education			v	v							v			v	
	33	Conduct organization change				v	v	v					v			v	
	34	Transfer to new working environment		v	v	v			v	v	x	v	v	v		v	v
	35	Measure overall performance goals			v		v	v					v	v	v	v	v
	36	Continuous monitoring and improvement		v		v		v	v			v	v	v	v	v	

3.2 Stage 1: Initiation

The purpose of this first stage is to mobilize, organize, and energize the people who will perform reengineering. This initial stage involves the crucial components of aligning corporate goals and strategies with the reengineering effort. It is within this stage that management commitment is secured, vital business processes are identified, and process owners are chosen.

1. Identify the challenges and problems:

   The starting point for a reengineering project is to identify the challenges and problems faced by the company. The challenges that a company faces are coming from either internal or external. One can employ the six-force analysis model (Groove, A, 1996) to identify the external challenges and value-chain analysis (Porter, M, 1999) model for internal ones respectively.

2. Review company's vision:

   BPR's mission must be aligned with the corporate strategy. Reengineering efforts may differ greatly depending on varying strategic directions--for example, market share expansion, profit increasing, growth of existing market, expansion into new market, or cost reduction. A review of strategic alignment helps to identify critical reengineering efforts that have profound strategic significance.

3. Identify the key or bottleneck process:

   It aims to investigate the problematic processes that are critical to and essential for enhancing the company's competitive position. By doing so, a company needs to list all the key business processes and to measure their performances. The bottleneck processes are the ones with the unsatisfying performance and consequently hinders a company from reaching its goals. Atos Origin categorized processes as followings:

- Value-adding process: the one converts inputs into output to generate greater values; such as research and development, product/service produce and delivery, marketing and selling.
- Enabling process: the one supports one or more processes as enterprise infrastructure; such as financial resources management, logistic management, human resources management
- Governing process: the one monitors or tunes other processes, such as quality and reliability control, internal audit and control.

Brand and van der Kolk (1995) identified four main measurement dimensions in the effects of redesign measurement: time, cost, quality, and flexibility. A company can derive its own specific measurement indexes according to its business requirements. For examples, a manufacturing company defines ‘yield rate’; a service company defines ‘number of customer complaints’ as indexes to measure their operation quality. By analyzing the collected measurement indexes of its business processes and comparing with desired targets, a company can effectively identify the potential bottleneck processes.

4. Select the high-impact process to be re-engineered:

Processes to be reengineered should have high impact on the business. Due to the nature of vast amount of resource required for BPR project, organizations can’t afford to conduct multiple BPR in the same time. Therefore, the management team in an organization needs to identify the business process to be reengineered with the highest business impact and relatively lowest cost. The implementation cost is normally a function of process complexity. Oracle Consulting developed a two-dimension matrix, i.e., business impact and process complexity, to identify the candidates of high-impact processes to be re-engineered. The variables used to evaluate the business impact are revenue, cost, operation cycle time, quality of product or service etc. Whereas the variables to evaluate the process complexity are number of process steps, number of organization involved, number of integration points, number of decision points, number of process exception. As the Figure 3 demonstrates, the business processes fallen in the quadrant of high business benefits and low process complexity are good candidates of quick win of BPR project.

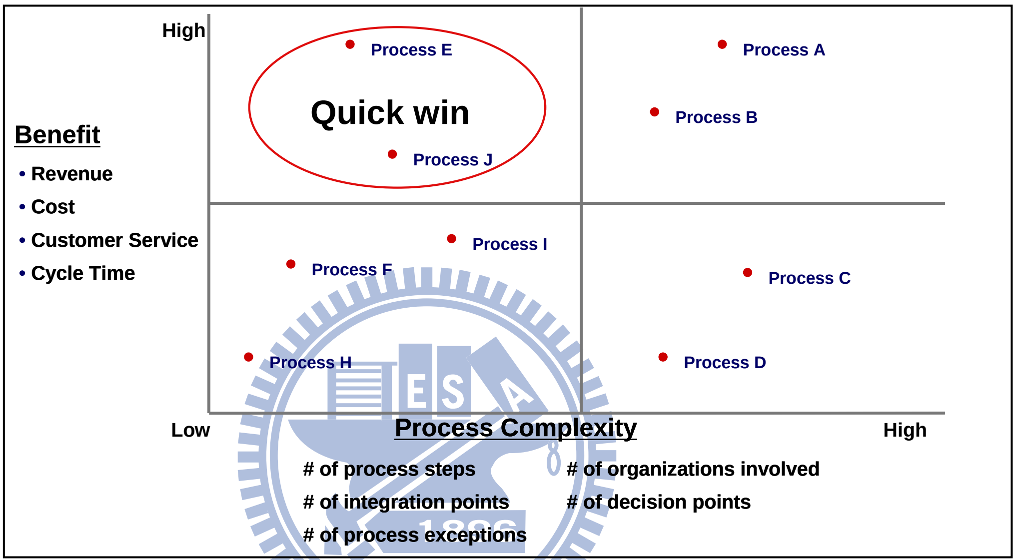


Figure 3 Business Process Impact and Complexity Matrix

5. Set BPR objectives:

To determine the level of success of the reengineering project, the performance of the new process must be measured and compared to that of the processes replaced. These improvements are generally expressed in terms of

- Productivity
- Speed
- Quality
- Cost
- Customer service (Alavi & Yoo, 1996)

BPR objectives must be ambitious, radical, and highly optimistic in nature. It is not unrealistic to set performance goals of 50% to 60% improvement in cost and productivity or reductions in staffing by half. It's also suggested that a stretch goal helps to create the organizational momentum necessary to depart from the status quo (Kettinger et al 1997).

6. Designate process owners:

   The process owner is responsible for reengineering a specific process and is expected to run interference with the bureaucracy and work to gain the cooperation of other managers whose functional groups are involved in the process. The candidates for process owner are senior managers responsible for a key portion of a process to be reengineered. Most companies do not have such "process owner" defined in the organization because in traditional organizations people do not tend to think in process terms and the responsibility for a certain process is fragmented across organizational boundaries (Hammer and Champy, 1993). That's why the process owner is so important for BPR project. The process owner's job will not end when the reengineering project is completed. In a process-oriented company, process owner will play an important role to run and monitor the process after the new process is in place.

7. Search for BPR benchmark target:

In order to broaden the project team's perspective and reduce subjectivity, to seek the internal or external benchmarks is widely adopted by companies during the initiation stage. A company can search for benchmark target from the following four categories (Mische and Warren,1996):

- Internal benchmarking: benchmarking against peer organization in the same company.
- Competitive benchmarking: benchmarking against competitors in the same industry.

- Functional benchmarking: benchmarking against external best practice company in the same industry but is not direct competitor.
- Cross industry benchmarking: benchmarking against external best practice company in different industries.

8. Secure commitment from top management:

The CEO, president, and leaders of all the major functional departments must realize that their efforts are required in guiding the direction of the new processes and in selling the project to employees (Guha et al, 1993). In general, top management's supports are critical to BPR project in the following areas:

- BPR's objective and scope: The objectives of BPR should be aligned with company's ultimate goal and serve as one of critical means to solve the challenges that a company faces. Top management is the one setting a company's goal and knows well the challenges and problems, so it's in the best position to define BPR's objective and scope and to monitor the progress of BPR in order to reach the company's goal.
- Cross-organization resource allocation: A BPR project requires large amount of resources. Due to the fact that most critical processes in a company usually across multiple organizations, to form a dedicated BPR task force consisting of employee from different departments is imperative to BPR success. And forming such a cross-organization team needs the approval and commitment from the top management.
- Budget allocation: In addition to the human resource, most BPR projects need major amount of financial budget to hire external BPR expertise, develop new IT systems, purchase additional computer hardware and software, etc. To allocate such large amount of capital budget needs the approval of the top management.

- Mitigate the resistance to change: BPR will result in changes and changes often cause the fear or resistance from the employees who are involved in the existing process. These changes include new role and responsibility, new knowledge and skills to fulfill requirements of the new process, or sometimes job replacement or reduction. To mitigate the potential resistance or fear due to the introduction of BPR, the consecutive attention and frequent communication from the top management are important.

3.3 Stage 2: Study

The study stage ensures that careful preparation is conducted in anticipation of organization-wide radical change. Reengineering projects must be staffed with the right team members to sustain the effort. The project should have definite performance goals that can later provide the metric for judging success, and these goals should be justified against anticipated costs. There are ten activities composing the stage of study.

9. Organize the BPR team:

   Because the process of reengineering involves organizational design around processes rather than functional hierarchies, it is important that the team includes representatives from the primary organizational units involved in the process under consideration and members from various parts of the company. Executives and key staff members from different functional areas, as well as from the information systems unit, should be included on the project team. Furthermore, because by definition a business process has a well-defined customer (either internal or external to the company), it is important that the customer also be represented on the reengineering team (Alavi & Yoo, 1996). Due to the nature that the reengineered process will be new to most employees, companies often enlist the help of consultants. Hiring those who have helped other companies adds valuable experience to the team and brings in an outsider's viewpoint and creativity.

10. Delineate the existing process:

    To redesign a business process, the organization must clearly understand how the existing process works. There are five perspectives to depict a process (Jablonski and Bussler, 1996):

    - Function perspective: what has to be executed?
    - Operation perspective: how is a workflow implemented?
    - Behavior perspective: when is a workflow executed?
    - Information perspective: what data are consumed and produced?
    - Organization perspective: who has to execute a workf1ow?

11. Measure and analyze the existing process:

    During the study stage, the project team evaluates existing processes with the performance measurement indices defined in the previous stage. Process bottlenecks and pathologies are uncovered so that they could be eliminated in the reengineered process. Furthermore, the team accurately measures and documents the performance of the existing process against the established reengineering objectives to establish a baseline for determining the success of the reengineering project.

    Atos Origin suggested analyze process from the perspectives of ‘activity’ and ‘role’, the details is depicted as following:

    - Activity Analysis:
        - How many steps does a process require?
        - How many layers of the organization does a process require?
        - How many hand-offs are required to complete a process?

- Role Analysis:
    - Who, when, how, are they involved in the business process?
    - Are they really needed? What's the consequence if they are not involved?
    - Any over- or under-capacity for the people in charge?
    - Can people be replaced by IT? Any performance gap?

People and activity are two main objects that constitute a process. The role analysis is more qualitative oriented to examine the necessity, capability, and capacity of people involved in a process. Whereas the activity analysis is more quantitative oriented to review the umber of 'parameter' such as steps, organization layers, and interaction, required completing a process. More the instances of such parameters are, more cycle time and likelihood for a process introduces operation errors.

12. Diagnose the processes to be reengineered:

To uncover pathologies in the existing processes, a critique of the existing value and non-value-added activities should be conducted. The BPR team can identify the potential problems based on the qualitative and quantitative analysis result obtained from the last activity. Guha et al (1993) also suggested the following diagnose actions to take:

- Identifying undesirable sequential activities and unnecessary bureaucratic steps.
- Identifying functional information systems that can be integrated into a single process-wide system.
- Questioning the need for various forms, approvals, and reports and identifying all paper float and redundancies.
- Identifying dysfunctional policies and rules, formal as well as informal.

13. Propose concept of a new process design:

This activity allows the BPR team to construct a framework on which the new business process can build. Accenture suggested seven fundamental rules, as shown in Table 6, in consideration of process design. The key to successful redesign is to constantly question why a certain task is done, what are better ways of doing it, where is the most appropriate location to carry out, who should be responsible, and which information technology best supports the redesigned process.

Table 6 BPR Process Redesign Rules

Rule	Object
Rethink (why)	Assumption, Rational, Root Cause
Reassign (who)	People, Organization
Reconfigure (what)	Activity
Re-sequence (when)	Timing
Relocate (where)	Location
Retool (how)	New technology
Reduce (how much)	Frequency, Quantity

14. Ask feedback from user group of processes under consideration:

The changes brought on by business process change may cause resentment. Therefore, the feedbacks directly form the first-line workers who in charge of the existing process must be collected. Otherwise, these people would resist with fear, uncertainty, lower productivity, and lack of cooperation with the reengineering project. In order to foster positive results, the major user groups, when being asked the feedback, must be continually educated the fundamental change to the company brought by the new process. Being familiar with the current business process, the user group can evaluate the effectiveness of the concept of the redesign and offer alternatives.

15. Design the prototype according to the proposed concept:

    Prototyping is a useful tool for BPR team because it can be used to demonstrate proposed redesigns that would otherwise be difficult for people to comprehend. It creates rapid feedback that helps estimating and planning business and system scope required by the reengineered process.

16. Develop change management plan:

    Resistance to change can be a critical failure factor in BPR projects. In such situation, the BPR team should address change management and human resource issues (Al-Mashari et al., 2001). The change management plan initiates by identifying the stakeholders and their interests. It defines how communications will be managed to ensure that the stakeholders are kept informed in a constructive way. Some stakeholders are people holding the same jobs; they usually have common interests. Other stakeholders hold unique jobs that are directly or indirectly related to the process being reengineered. While the employees are an obvious class of stakeholder, there are many others, such as customers, distributors, suppliers, and shareholders, etc, which should be incorporated in the change management plan as well. The change management should start as early as top management decides to engage BPR and should be continuous thorough the whole BPR project lifecycle. The key elements constituting a change management plan include

    - Why the reengineering project is needed
    - What is the scope of the BPR project
    - What are the expectation results
    - What is the BPR team composition and why
    - What will happen during the project and when

- What will be the impact in terms of organization structure, job function, and performance measurement (Manganelli & Klein, 1994)

17. Ask feedback from user group and modify the prototype:

    People who carry out the existing process and will be affected by new ones are the key communication target because their acceptance of the new process is critical to BPR success. The feedback collected from them at this stage primarily focuses on the operational and functional level such as whether all the major problems of the existing process are identified and whether the new process effectively addresses the problems. They are also very helpful to identify the designed flaws and explore the feasibility of the proposed prototyping.

18. Report BPR study result to senior management for approval to next stage:

    At this stage, the reengineering team presents to the senior management the finding, root causes, recommended process design, prototyping, and change management plan. Senior management can examine the healthy situation of the company from the process's perspective and decide the scope of the BPR project. The estimated human and monetary resources of the BPR project need to be approved by senior management in order to proceed to the next stage.

3.4 Stage 3: Pilot

Since the time and cost of repairing an error goes up exponentially as the error is promulgated through requirements, design, development, and implementation of a system, the purpose of the pilot is to understand the essential features of the new system and to experiment with modifications before making a heavy investment in system construction (Manganelli & Klein, 1994). A pilot enables the new process in a limited area in order to identify any needed improvements or correction, without incurring the risk of a full deployment. The following activities are presented for BPR team to follow while building a pilot system.

19. Develop pilot process and small scale implementation of new process:

    Unlike the prototype, which is a facsimile of an end product and only used to demonstrate a design concept rapidly, the pilot is an initial project that will be performed in the real working environment and served as a model or template for future implementation. The pilot implementation facilitates full-scale implementation by enhancing management and employee understanding of the new process and providing realistic estimates of the scope of its organizational change and resource requirements. Atos Origin defined the criteria for pilot selection:

    - It can be completed within 90-120 days
    - In can be limited in a controlled environment implementation
    - Relatively low cost to implement
    - Low employee resistance

    Overall, the pilot implementation improves the chances of organizational success by providing an opportunity to address the operational aspects of the reengineered process (Alavi & Yoo, 1996)

20. Ask feedback from user group and modify the pilot:

The feedback collected from the user group at this stage primarily focuses on the operational and functional level such as whether all the major problems of the existing process are identified and whether the new process effectively addresses the problems. They are also very helpful to identify the designed flaws and explore the feasibility of the proposed pilot.

21. Report BPR pilot result to senior management for approval to next stage:

    Pilot implementation allows for estimating and planning the scope and resources required by the full-scale implementation of reengineered process. With the pilot implementation result, the senior management can evaluate to what degree the initial BPR goal is achieved and to what degree the project scope and milestone progress need to be further extended.

3.5 Stage 4: Full scale development

This stage is the actual development of the new process. As with any major organizational change, a methodical process should be adopted that takes advantage of small-scale pilot projects completed in the previous stage. This stage is the most important one in the entire reengineering project. After this point, resources will be expended much more quickly than before and knowledge of the BPR project will be spread beyond the BPR core team. Whereas before the reengineered process was an opportunity and a compelling vision, now it becomes a concrete roadmap with detailed milestones and requires a lot of hard work and difficult change.

22. Define full scale BPR development plan:

    There are two dimensions to the development plan; ie., technical and social (Manganelli & Klein, 1994). For the technical aspect, the development plan defines the tasks of process design and system development with respect to scope, quality, time and cost. To the social aspect, the development plan defines the appropriate organization of resources and responsibilities to carry out and monitor the future process.

23. Detailed process design:

There are six key elements to depict the process details (Reijersa and Mansarb, 2005)

- Customer: the internal or external customers of the business process
- Output: the products (or services) generated by the business process
- Workflow (with two views):
  - Operation view: how is a process operation implemented in terms of number of tasks, relative size of tasks, nature of tasks, degree of customization?
  - Behavior view: when is a process executed in terms of sequencing of tasks, task consolidation, scheduling of jobs, etc?
- Participants: the organization or individual directly or indirectly involved in executing the process in terms of users, groups, departments, etc.
- Information: the data that the business process uses or creates.
- Technology: the business process uses to generate output, control quality, or monitor the progress.

Based on the key elements depicted above, one common tool used to illustrate the process activity with a structured way is ICOM (Input, Control, Output, and Mechanism), as shown in Figure 4.

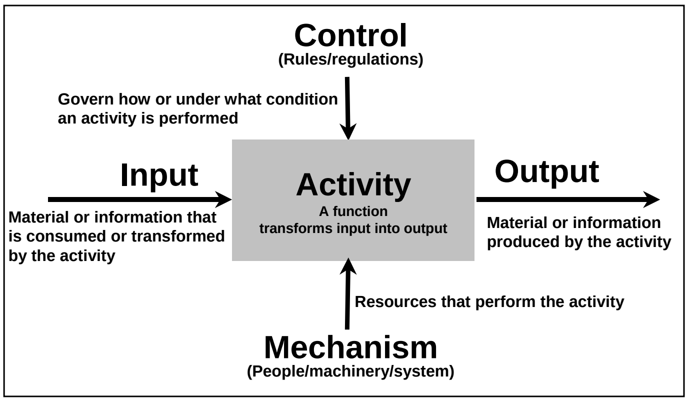


Figure 4 BPR design Tool: ICOM

24. Ask feedback form user group and modify the process design:

    Unlike the prototype and pilot processes that are implemented in a controlled environment with limited functions, the scope and depth of new process defined in this stage are more extensive and have profound impact to the future operation. The purpose of collecting feedback from user group at this stage is two folds: one is to confirm the completeness, effectiveness, and feasibility of the complete new processes; and the other is to assess the readiness of the user group to the significant change made by the new process. If any design flaw identified by the user group, which will impede BPR from reaching the desired goal, the BPR team needs to tune the process before it is released to the company.

25. Set the performance target of the new business process:

    Unlike the high level BPR objectives defined in the activity 6 which set the direction and vision of the BPR in consideration, the performance target set at this stage is more specific, detailed-oriented, and measurable. For example, a manufacturing department sets it's productivity target as twice as many as current output, and sets the operation cycle time as 0.5 day per unit with high quality result as 1 ppm (parts per million). An IT department set its target operation cycle time as 3 seconds per order transaction with 99.5% system operation up time.

26. Determine enabling technologies:

Information technology is considered not only to automate a process but also actually create new process design alternatives. In a successful project, business process reengineering and the deployment of IT are viewed as mutually supportive and synergistic activities (Davenport and Short, 1990). The reengineering project must identify enabling information technologies that provide the opportunity to improve internal efficiency, satisfy customers, and allow organizations to ignore geography (Guha et al 1993). The application of IT in integrating various functional areas to reengineer business process is presented in Table 7. In reengineering the business process, the IT plays a major role to integrate various functional areas for reducing the cycle time for the delivery process of the goods/services (Gunasekaran and Nath, 1997).

Table 7 Key Information technology for BPR

Functional areas	Information technologies
Marketing	Multimedia, internet, database
Maintenance	AI, expert system, scheduling, database
Distribution	Internet, RFID, GPS, EDI
Personnel	Internet, Multimedia training, database
Accounting	ERP, shared database, spread sheet
Design and Engineering	CAD, CAM, database, ED1
Purchasing	Internet, database, MRP,
Production	CAM, CIM, multimedia, MRP, database, RFID,EDI, SPC

27. Develop IT systems:

This task is concerned with the design and construction of the new or revised system supporting the reengineered process. The IT system development mainly consists of process and data areas. In the process area, it includes modeling of sub-processes, segregation of the business rules into system modules, interconnection among the modules, and interface with end users of the system. In the data area, it includes defining the attributes of data entity involved in the process, mapping the attributes into database schema, and specifying how the relationships among data entities. If the application is based on a package, the next step involves selecting the package options, designing extensions or modifications to the package, building interfaces between the package and other systems. If the application is custom developed, the next step is to build the physical data structure and write the code according to the defined business logics.

28. Conduct integration test:

Testing is a sequence of steps that determines whether the functions properly are performed according to the original design. A business process is often composed of several interdependent sub-processes to carry out certain sub-function; consequently the supporting IT system is decomposed into several modules accordingly to satisfy the need of each sub-process. Before conducting the test, the BPR team needs to map the business processes into different scenarios, and then organize each scenario into multiple test cases. The testing life cycle progresses from module, system, to integration test. The module test focusing on testing basic features of each individual module; the system test is the aggregation of multiple module tests; and the integration test focuses entirely on the application system from an overall perspective. Additional testing is usually performed to determine the behavior of the system under stress, to compare the results of the new system with that of the old, and to develop client comfort with the system (Manganelli & Klein, 1994).

29. Report to BPR development result to senior management:

At this stage, the new business process, its supporting IT system, and new performance goal are completed. It's ready to roll out the new process to the entire company. This all-encompassing development requires the attention and endorsement of senior management. The management team needs to ensure the active participation of the employees impacted by the new process for smooth operation transition.

3.6 Stage 5: Transition

In this last stage, the new business processes and supporting systems are developed and ready to deploy to the operational environment. Once traditional business practices have been reengineered into business processes, they must be implemented and successfully integrated into the organization. This integration involves employee education, organizational change, and structural realignment and redeployment of technical and human resources. Although actual transformation into the reinvented enterprise is the last one stage, it is the most challenging and demanding task (Mische and Warren, 1996).

30. Define new BP deployment plan:

    The deployment plan analyzes the dependencies among the activities of the reengineered process and interactions between activities and organizations; it clusters activities by function correlation and by time and space adjacency. The analysis leads to the deployment of process component in space, time, and organization. This deployment plan also addresses the social aspects of the reengineered process, including reorganization, recruitment, education and training.

31. Ask feedback from impacted user groups and modify the deployment plan:

    The impacted personnel include the people within the company such as working team responsible for operating the new process and managers responsible for measuring and monitoring the performance of the new process; it also include the people outside of the company such as customers, distributors, and suppliers. The feedback collected at this stage is not for how to revise the new process, but how the new process can be effectively deployed. The collected feedback will also be helpful to ensure the performance goal and new organization is aligned with the new process.

32. Deliver training and education:

Because the major doctrine of business reengineering involves the elimination of functional hierarchies and the development of organizational structures based on processes, training personnel in a newly installed process-based environment is critical (Guha et al., 1993). People in organizations undergoing reengineering often need training in what and how of reengineering, redesigned jobs, and teamwork (Bashein, et al 1994). Training in process reengineering teaches people how to be more resilient during times of uncertainty, thus fostering a culture able to withstand ongoing turbulence. This type of training is usually most effective if it is conducted at all levels of the organization, from senior executives on down.

33. Conduct organization change:

A crucial element for reengineering success is the design of a new organizational structure consistent with the newly defined process. The human resources architecture outlined in the redesign stage must be thoughtfully executed to minimize any disruption to employee morale (Guha et al., 1993). Reorganization incorporates such improvements as subunit reorganization, job rotation and staff reduction, the empowerment of remaining employees through training and educational programs, and in general, improving the quality of work life. An ideal reorganization is to attain the following transformation (Mische and Warren, 1996):

- From hierarchy to cross-functional
- From task-driven to outcome-driven
- From command & controlling to empowerment
- Self-learning and innovation

34. Transfer to new working environment

Once the new process is in place and the supporting IT system, required knowledge and skill of employee, and new organization with clear role and responsibility are prepared, a company is ready to transfer to the new working environment. There are two approaches to manage the transfer, one is to have the old and new process operate in parallel for a certain period of time to ensure the effectiveness of the new process before cutting off the old one; the other is to switch to the new process and obsolete the old ones immediately. The adoption of which one of these two approaches depends on the complexity of the new process and the organization's resource to handle new and old processes simultaneously.

35. Measure overall performance goals:

To ensure the fulfillment of company's ultimate performance goals, in addition to measure time, costs, productivity, quality, and capital of the new process, and compare to the processes they replaced, a broader spectrum of monitoring must be attempted. Atos Origin suggests the following overall performance measurement items:

- Top line: market share growth, premium pricing, revenue increase
- Bottom line: margin improvement, headcount reduction, productivity gain
- Customer satisfaction: loyalty, retention, market share growth
- Employee satisfaction: morale, reduced turnover

36. Continuous monitoring and improvement

Continual monitoring and improvement of the redesigned processes should come after radical process change and that this activity is never-ending. The reengineered processes and transformed operations and organizations are constantly evaluated and calibrated to the vision and goals established in stage 1 to ensure that desired results are achieved. This activity also involves reaching out to customers, business partners, and potential business alliance members to create new processes designed to achieve greater integration among processes and organizations. Such an activity provides not only an audit of the performance of the redesigned processes but identifies processes that are candidates for further redesign to adapt to change (Mische and Warren, 1996).

4. Case Study

This section demonstrates a practical case application of BPR at two companies in the high-tech industry. The research method applied in the case study is observation. During the research period, the author played the role of participant-observer that became part of the work team and adopt structured observational study with a predetermined set of activities to be studied (Cavana et al, 2001). The following study observed from these companies revealed that the BPR program following the methodology stages described in the previous chapter. The BPR outcome indicated that the BPR taken had raised this company's business performance, improve customers' satisfaction, and further enhance its leadership in the industry. There are two BPR cases introduced in this chapter: one is an inter-company value chain integration program conduct by TSMC and the other is an intra-company pricing process reengineer program conduct by one leading high-tech company.

4.1 Case1 : e-supply chain BPR

Founded in 1987, TSMC was the world's first pure foundry, focused solely on the manufacturing of semiconductors. Operating in the cyclical semiconductor market, the company managed to grow rapidly and to become the world's 5^{th} largest semiconductor manufacturer with more than 50 percent market share in the foundry business. Before emerging of TSMC, all the Integrated Circuit (IC) manufacturers in the semiconductor industry were Integrated Device Manufacturers (IDMs)-fully integrated manufacturers that designed, fabricated, and marketed their own products. However, by the mid-1970s many had started outsourcing portion of their manufacturing activities. In the mid-1980s, entrepreneurs with new ideas for IC chip designs searched for IC fab to manufacture their products. These chips companies became known as fables organizations that concentrate their engineering resources on innovating new product designs rather than on product manufacturing. The market demand from IDM's outsourcing and fables companies resulted in the disintegration of the semiconductor industry and creation of foundry business model.

From 1998 to 2004, TSMC and ASE conducted a major BPR project by completing electronic process integration of 11 key business processes through the Internet. They can now obtain accurate, timely information on their product status. The direct economic benefits are estimated to be around US$ 10M through productivity increase over a total investment of about US$ 2M; the indirect benefits of this initiative could be on the order of US $100M million if the joint customers' benefits are considered. In collaboration with the RosettaNet organization, TSMC and ASE leveraged their BPR experiences to define three data exchange standards that can then be widely adopted in the semiconductor industry.

4.1.1 Initiation stage

(Challenges and Problems) The continuing trend of the semiconductor value chain disintegration has resulted in specialized companies that are independent yet co-dependent upon one another, as shown in Figure 5. These companies need to closely collaborate with their partners both up and down the value chain to meet the relentless end-consumer demand to achieve shorter time-to-market, lower costs, higher responsiveness, and better quality. Therefore, streamlining the business processes between partners, sharing information appropriately, and ultimately effectively "re-integrating" the value chain in a virtual manner have become the most critical issues in the semiconductor industry.

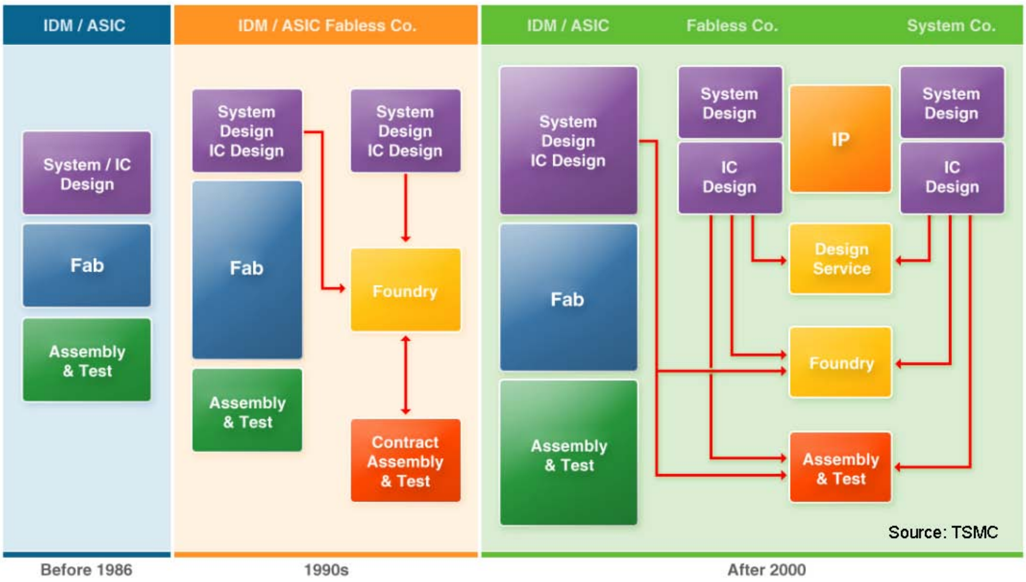


Figure 5 Disintegration of the Semiconductor Industry Value Chain

(Review company's vision) The vision statement of TSMC is "to be the most advanced and largest foundry services provider to our target customers, and in partnership with them, forge a powerful competitive force in the semiconductor industry. To realize the vision, we must be:

(1) a technology leader,

(2) the manufacturing leader

(3) the most reputable and service-oriented and the greatest total benefits provider."

In the company's early days, TSMC focused on manufacturing excellence and technology leadership. As competition in the sector intensified in the late 1990s, the company began to focus on customer service to further differentiate itself from competitors. Therefore, in order to respond to the industry trend of value chain integration and strengthen its market competition, TSMC decided to implement the concept so-called "Virtual Fab" (customer can online engage business and inquire about the status of their production orders as if they were in their very own manufacturing unit) to transform itself and become a service-oriented enterprise. The concept of "Virtual Fab" would be realized by a series of initiatives defined in a strategic "e-foundry" program. As shown in Figure 6, the “e-foundry” consisted of three initiatives: design, engineering, and logistics collaborations, which as a whole integrate TSMC and its upstream customers and downstream partners in testing and packaging. All the major business activities between TSMC and its customers, and its downstream partners in testing and packaging that contribute the IC manufacturing and delivery life cycle are all included. In order to meet different needs of information access by different kinds of customers, TSMC decided to establish two types of information delivery channels. One is TSMC-Online that provides web access interface to allow all customers manually access the Design, Engineering, and Logistic related information; and the other is TSMC-Direct that provides even faster and more reliable system-to-system link to selective customers with packaged information.

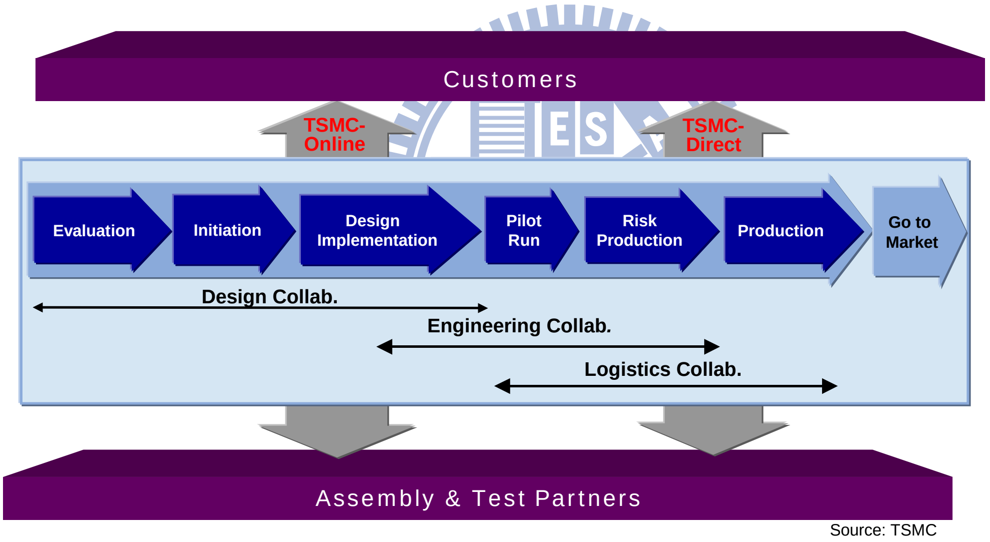


Figure 6 Illustration of TSMC e-foundry

(Identify the key processes and select the ones to be re-engineered) While preparing to implement the “e-foundry”, TSMC identified 15 main business initiatives and/or processes in the categories of Design, Engineering, Logistic Collaboration and Common Foundation as shown in Table 8. To define the implementation priority, these 15 business processes and/or initiatives were compared according to the level of implementation effort and their business impact. As shown in Figure 7, the process of “Tracking of service order status”, “Delivery of engineering specification”, and initiative of “Definition of standard data

exchange" were identified as quick win owning to their relative low level of implementation effort and high business impact. In order to provide the complete set of information including both IC manufacturing front end (wafer manufacturing) and back end (wafer testing and assembly) together to customers, TSMC decided to integrate the supply chain process with its major partner, Advanced Semiconductor Engineering Inc. (ASE), the world's leader in semiconductor assembly and testing. These three process as a whole would serve the foundation of TSMC-Direct.

Table 8 eSCM preliminary business process initiatives

Category	**Key Process/Initiatives**
Common Function	Componentization of TOM / OTIS / Yes views
	Definition & implementation of standard data ex
	Definition and implementation of data adapters
	Provide enhanced granularity of WIP reports
	Emerging technology exploration
Design Collaboration	Customer feedback engine
	Self directed needs assessment and process selection
	Decision support solution configuration
	IP Repository
Logistic Collaboration	Integration of 3rd party web sites (e.g. design enablers, test / assembly houses)
	Tracking of service order status
	Proactive notification of updates, bugs, and fixes
Engineering Collaboration	Self directed troubleshooting guides
	Live "classroom" virtual training
	Electronic delivery of Engineering Specification

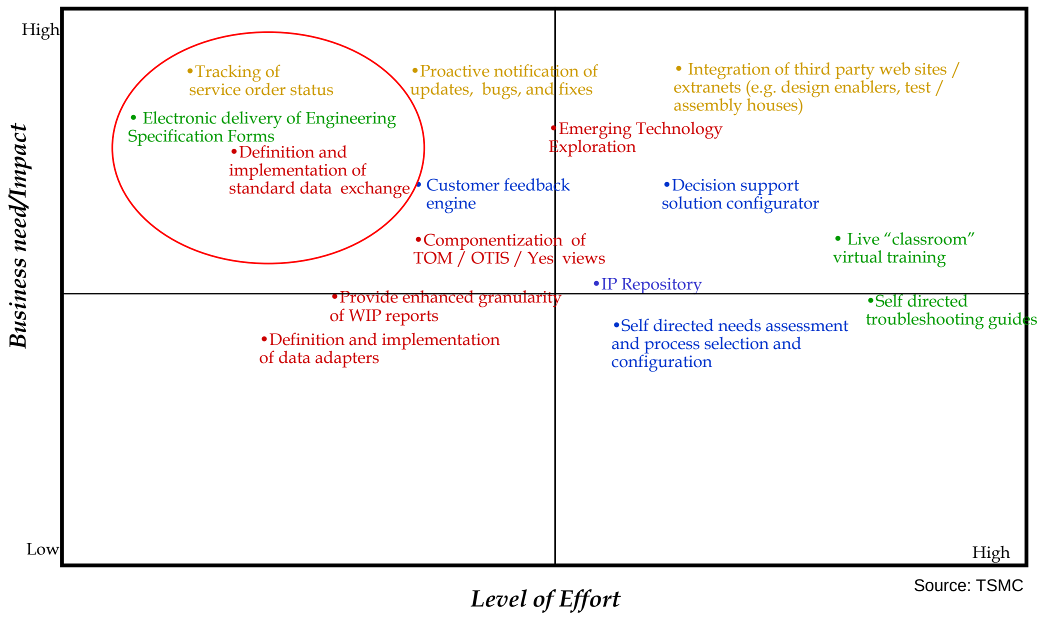


Figure 7 eSCM process Impact and Complexity Matrix

(*Set BPR objective and designate process owner)* The objective of the TSMC/ASE e-Supply Chain integration process 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. Specifically, the objectives of the strategic business process were:

- Streamline and integrate key business processes
- Improve transparency of information exchange
- Increase speed of information delivery
- Standardize process "hand-shaking" protocols and data exchange formats.

Due to the process nature is to integrate supply chain via the modern information technology, a senior VP of Cooperate Development Organization in charge of Information Technology and process integration was designed as the "efoundry" program executive officer; and process owners were jointed performed by the senior managers responsible of e-Commerce in TSMC and ASE respectively.

(*Search for BPR benchmark target)* As the pioneer to integrate the supply chain process in the semiconductor industry, TSMC and ASE could not find reference in the same industry but instead to search for the successful case in other industries. Amazon and Dell were identified as the benchmark targets due to their excellence in the following aspects.

- Planning/Inbound Logistics
- eProcurement
- Configuration
- eJIT/Inventory Management
- New Product Introduction
- Outbound Fulfillment

These two companies not only demonstrated robust and agile new product introduction and demand fulfillment capability, but more importantly, the e-commerce capabilities they possessed help them to create competitive advantage and secure the leadership in the industry they operated.

(*Secure commitment from top management)* As shown in Figure 8, TSMC's competitive advantage had been evolved from manufacturing-focus in 1987,technology-focus in 1997, to service-focus in 2001. As part of service-focus total solution, this TSMC/ASE e-Supply Chain integration process had the strong commitment from top management undoubtedly.

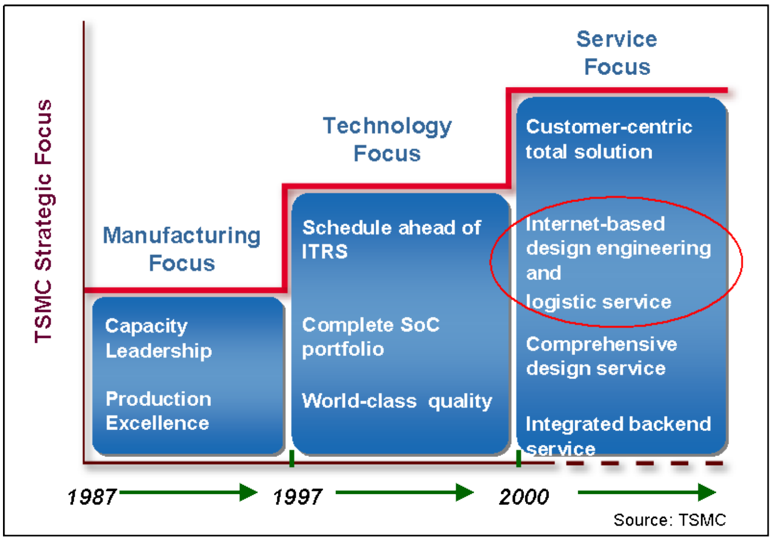


Figure 8 TSMC strategic focus evolutions

4.1.2 Study

(*Organize the BPR team)* As a cross-companies project, the BPR team was jointly formed by TSMC and ASE respectively with team members from business and IT organizations involved in the process. For TSMC site, the key organizations involved in the business process with ASE were "Backend Technology & Service" and "Manufacturing Product Engineering"; for ASE were "Production Planning" and "Manufacturing Product Engineering". These organizations played the role of process review and redesign from the business operation perspectives; whereas, the IT organizations of E-Commerce at TSMC and Service Integration at ASE respectively played the role of process automation and system implementation. Since this e-Supply Chain integration project was fresh for both companies, an outside consulting team was hired to share its successful experience of other companies implementing the similar processes. The figure 9 shows the organization chart of the BPR team.

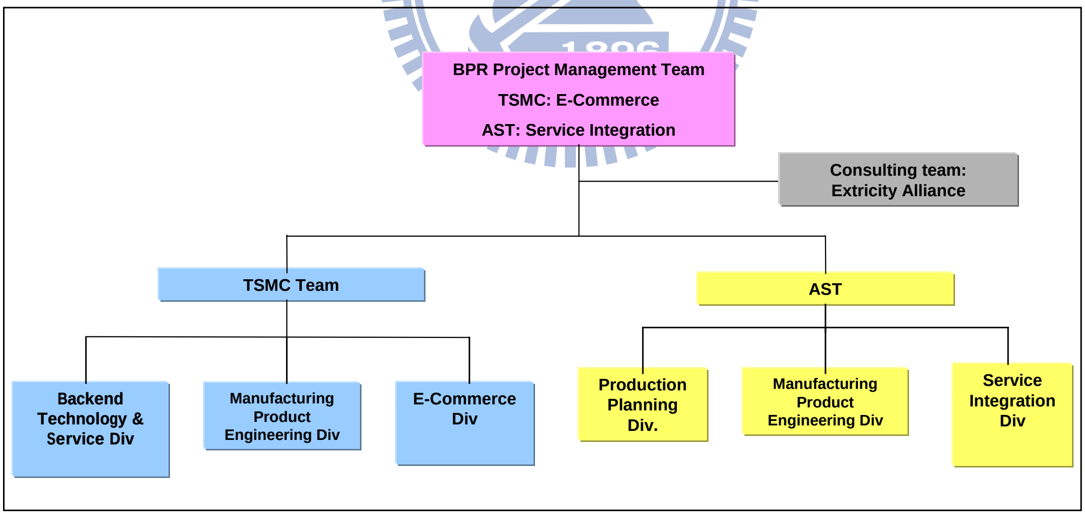
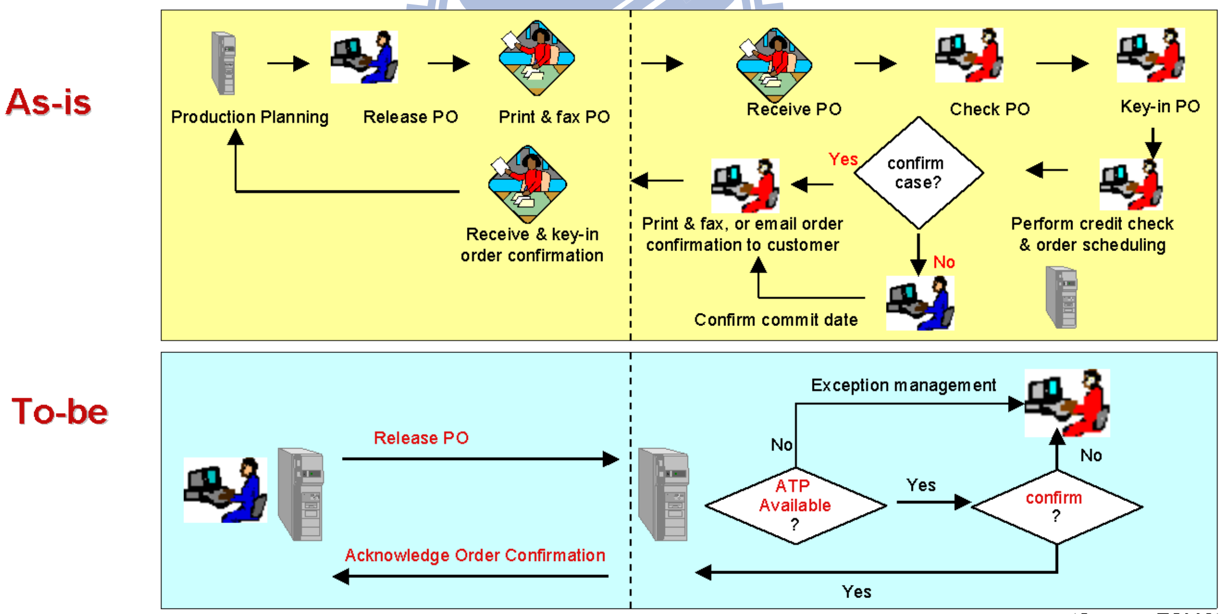


Figure 9 e-SCM BPR team organization

(*Delineate, measure, diagnose the existing process and propose the concept the of new business process)* There were plenty of manual activities between TSMC and ASE business process before the BPR was conducted. Take "order process" as an example, as shown in figure 10, there were totally 10 steps for TSMC and ASE to complete a work order cycle. Not only long processing cycle time, the manual process also caused unexpected operation errors and in turn impacted the accuracy of billing and manufacturing planning. After thorough analysis, the BPR team identified 4 key elements to complete an order process; i.e., PO release, Available to Promise (ATP), PO conformation, and PO acknowledge. The BPR team then proposed the concept of replacing the repetitive manual activities with an automate solution by a business-to-business linkage. The manual process would only be activated when there were exceptional cases that were beyond the definition of 90% of ordinary order type. The Table 9 compares the before and after the redesign based on the seven rules described in the previous chapter. The BPR team also identified three indices to measure the business processes; i.e., processing time, data transmission time, and error rate.



(Source: TSMC)

Figure 10 As-is and To-be analysis of eSCM Order Process

Table 9 Before-and-after comparison of the e-SCM BPR

	Before	After
Rethink (why)	To achieve shorter time-to-market, lower costs, higher responsiveness, and better service quality, it's critical to integrate the value chain of semiconductor industry	
Reassign (who)	manual process by business operation staff	primary by system secondary by manual
Reconfigure (what)	all activities for normal and exceptional cases	system handle normal cases manual handle exceptional cases
Resequence (when)	evet trigger	defined time and frequency
Relocate (where)	no change	no change
Retool (how)	fax, email	Internet, XML
Reduce (how much)	high error rate long processing time long data transmission time	low error rate short processing time short data transmission time

(*Ask feedback from user groups)* After introducing the concept of the new business process to the user groups of the two companies, the feedback was very positive because that the user groups were suffered for a long time the manual process of numerous amounts of business transaction and data transmission. According to the user group of logistics, there were around 20,000 work orders every year, and the average error discover and recovery time was 40 man-hours. Since the full logistic cycle included "Delivery Schedule Planning", "Work Order", "Order Confirmation", and "Shipping/Invoicing", the user group requested the B-to-B solution should incorporate all those processes as a whole. In addition to the logistic data, there were equivalent amount of data need to be exchanged to serve the engineering purpose. The data required by he engineering user groups included engineering specification, testing results, yield data, etc. In order to maximize the benefits out of the B-2-B solution, the user group suggested the e Supply Chain integration project should cover the scopes of both logistic and engineering.

(*Design the prototype and ask feedback from user group)* As the concept and scope of the BPR were decided, a prototype of the "Work Order (WO)" was developed to demonstrate proposed redesigns and to collect rapid feedback that would help estimating and planning detailed business and systems requirements. After reviewing the high-level business processes, execution flow and algorithm of the prototype, the representative user group found several design flaws. For example, a "Work Order (WO)" process was defined as a sequence of activities: TSMC sends a WO to vendor, ASE receives the WO and sends back an acknowledgement to TSMC to complete the purchase order. However, when a transaction failed, the prototype system could not tell whether the failure was caused by inconsistent data content, application server malfunction, or a network problem. To cope with this disconnection, a two-way acknowledgement protocol and error-handling procedure should be implemented. Such valuable suggestion was quickly accepted by the BPR team and put into formal implementation plan.

(*Develop change management plan)* Since the ultimate goal of the supply chain integration project is to achieve shorter time-to-market, lower operation costs, and better service quality, both the management and operational level of TSMC and ASE held high expectation of the project success. The focus of the change management of this project was not resistance mitigation of the user groups impacted by the new process but the smooth transition from the manual to automatic process. The BPR team analyzed the key concerns of the project stakeholders and defined corresponding change management plan. As shown in Table 10, management and operation had common and distinct concerns from their perspective respectively. The management team was more concerned about the project schedule, cost, quality, and results; whereas the operation team was more about the operation effectiveness, such as system reliability, exception handling, and continuous support. Nevertheless, all the concerns were addressed properly in the change management plan.

Table 10 e-SCM change management plan

	Concerns	Change management activity
Management	■ Project delivery time ■ Project cost ■ Solution quality ■ Customer satisfaction	■ Define clear project milestone ■ Monitor project progress ■ Periodical project status update ■ Measure performance to ensure customer satisfaction
Operation	■ Project delivery time ■ System reliability ■ Exceptional case handling ■ Continuous IT operational and enhancement support	■ Define clear project milestone ■ Collect end user requirement ■ Define standard operation procedure ■ Build strong IT infrastructure

(*Report BPR study result to senior management)* After reviewing the BPR study result, the senior management team approved the project scope, budget, and implementation plan. 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 specifications
- Boding diagram
- Yield data

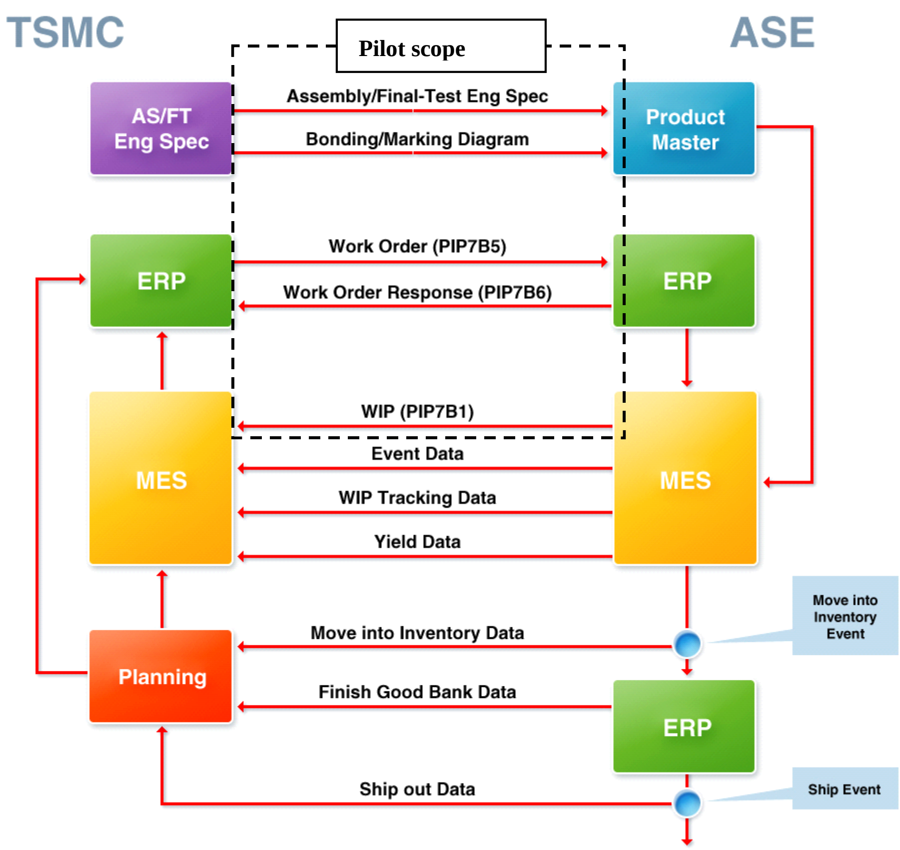
(2) Logistics Collaboration, including:

- Work Order and Order Response
- WIP data and WIP Tracking
- Event and Inventory
- Finished Goods and Ship Out Data

It's estimated a two-year project with US$ 2 million dollar budgets for purchasing hardware, software, and external consultant. Additionally, it would also require 12 full-time-equivalent TSMC and ASE employees to conduct business requirement analysis, system design, and implementation.

4.1.3 Pilot

(Develop Pilot process and small scale implementation) After numerous mutual visits, meetings, e-mail exchanges, and telephone communications, the business-to-business integration of 11 e-processes were established including yield rates, testing results, order and order acknowledgement, work-in-process, and shipment of finished products in stock; etc. Figure 11 illustrates the identified key processes between these two companies. In order to achieve quick win and prove the concept of B2B integration, five of the eleven processes were chosen to be implemented in the first release due to their relatively low complexity or data volume as shown in Table 11. Those processes were Assembly/Final Test Engineering Spec, Bonding Diagram in Engineering category and Work Order, Work Order Response, and WIP in Logistics.



(Source: TSMC)

Figure 11 TSMC/ASE's key process integration–conceptual overview.

* AS: Assembly, FT: Final-Test, ERP: Enterprise Resource Planning, MES: Manufacturing Execution System

Table 11 Complexity and volume comparison of 11 eSCM processes

Dimension	Process	Complexity	Volumn
Engineering	Eng spec	L	L
	Bonding diagram	L	L
	Yield data	H	M
Logistic	Work order	L	M
	Work order response	L	M
	WIP	L	M
	Event data	M	L
	WIP tracking data	H	M
	Move into inventory data	M	M
	Fisish good bank data	H	H
	Ship out data	M	H

(Ask feedback from user groups and modify pilot) The result after implementing the pilot process was very impressive. As shown in Table 12, the data transmission time and transaction processing time were improved 5 to 6 times and the error rate was significantly decreased 8 times.

Table 12 Before-and-after comparison of eSCM Order process

Items	Before	After
Data transmission time	120 minutes/order	20 minutes/order
Order Processing time	100 minutes/order	20 minutes/order
Order Errors	12 orders/month	1.5 order/month

Given such encouraging result, there were still some process misalignments being identified by user groups. For example, one-to-many relationship of customer's product name to vendor's internal manufacturing device name often caused confusion when both sites handled order taking and invoicing. Consequently, a significant amount of manual effort was placed to correct operation errors. To fundamentally solve this problem, the project team re-defined the product's naming scheme and generated a mapping table to maintain a one-to-one relationship.

(Report BPR pilot result to senior management) The success of the pilot proved the concept that the value chain integration could result in closer collaboration between companies. After reviewing the satisfying pilot result, the senior management of TSMC and ASE

determinedly select next wave of collaboration partner both upstream and downstream of the value chain as shown in Figure 12. The top management from both TSMC and ASE also set an ambitious goal as setting the industry standard with the data exchange formats defined by the two companies. It was meant to be the "foundation" upon which more process integration and data exchange would be established both upstream and downstream the entire semiconductor industry value chain.

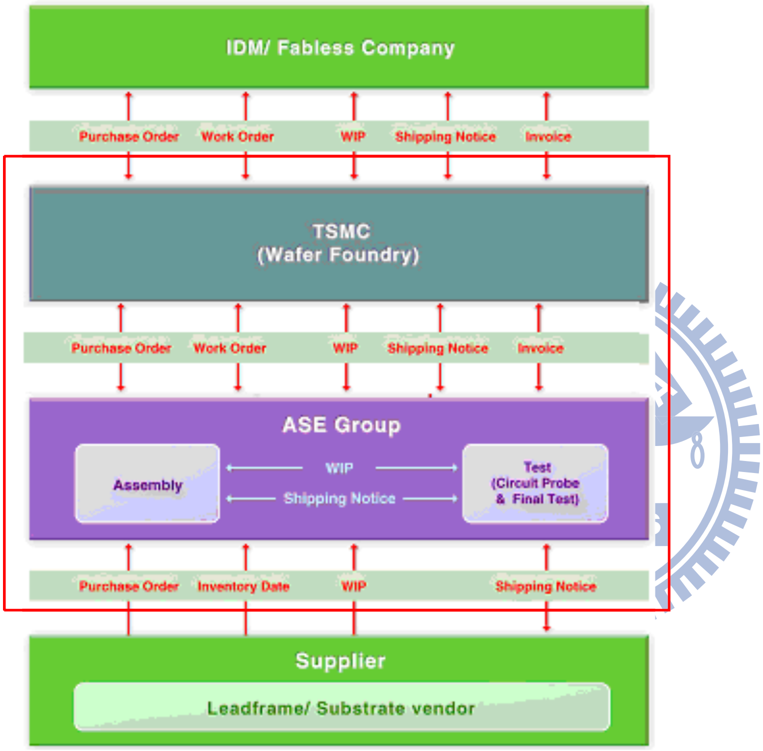


Figure 12 e-SCM: extending integration up and down the value chain

4.1.4 Full scale implementation

(Define the full scale BPR development plan): The full scale development plan consisted of 2 phases and three distinctive milestones as shown in Figure 13. The phase 1 would build 11 e-processes integration between TSMC and ASE in two years. The phase 2 comprised of two tasks in parallel, one is to extend the B-2-B supply chain integration solution to both upstream and downstream partners of these two companies; and in the mean time, submitted the data exchange format defined by TSMC and ASE to RosettaNet[4], a globally supported standards development organization, to be verified as an international standard. The significance of setting the international standard by leveraging the result of TSMC/ASE supply chain integration was two folds: one was to expedite the integration of the companies in the value chain and the other was to strengthen the leadership of these two company in the semiconductor industry.

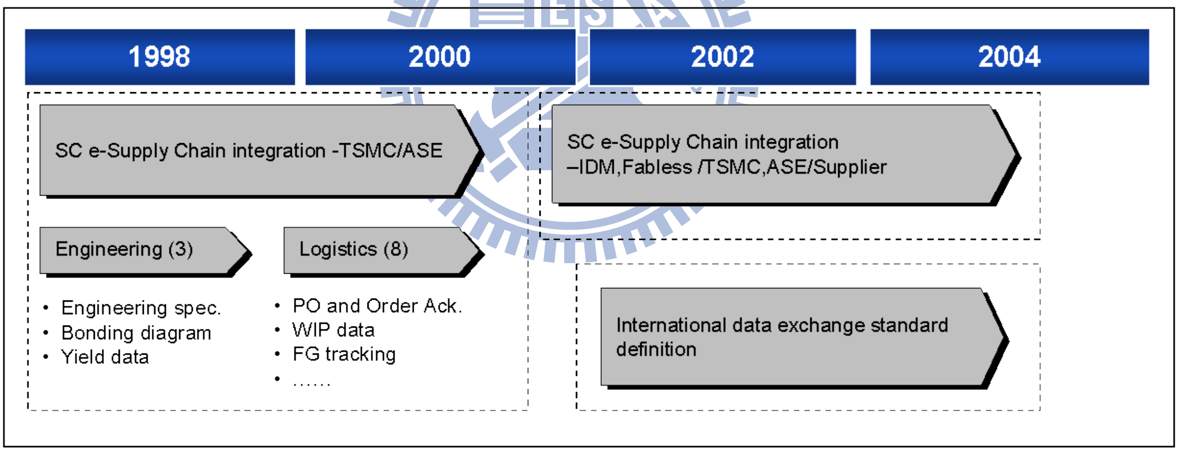


Figure 13 e-SCM BPR full scale program roadmap

To manage such a major cross-company BPR project, a systematic organization with

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[4]RosettaNet, formed by major companies from various industries, provide the standardized data infrastructure for integrating business processes. RosettaNet, formed in 1998, is a globally supported standards development organization for collaborative commerce, mainly in the high-tech industry. The data standards now defined are widely adopted by companies to conduct inter-company SCM. RosettaNet has six established global councils: computer and consumer electronics (CCE), electronic components (EC), logistics (LG), semiconductor manufacturing (SM), solution providers (SP), and telecommunications (TC). The organization has more than 500 world-leading organizations joining and working to create, implement and promote open e-business standards and services.

strong leadership and effective governance is imperative. As shown in Figure 14, the full-scale BPR project implementation team was led by the CIO of TSMC and ASE; and the team was comprised of steering committee, quality assurance team, functional team, solution application team, and training and change management team. In order to align the two parallel tasks of extended supply chain integration and data exchange standardization in Rosettanet, a special sub-team was formed under the overall program management.

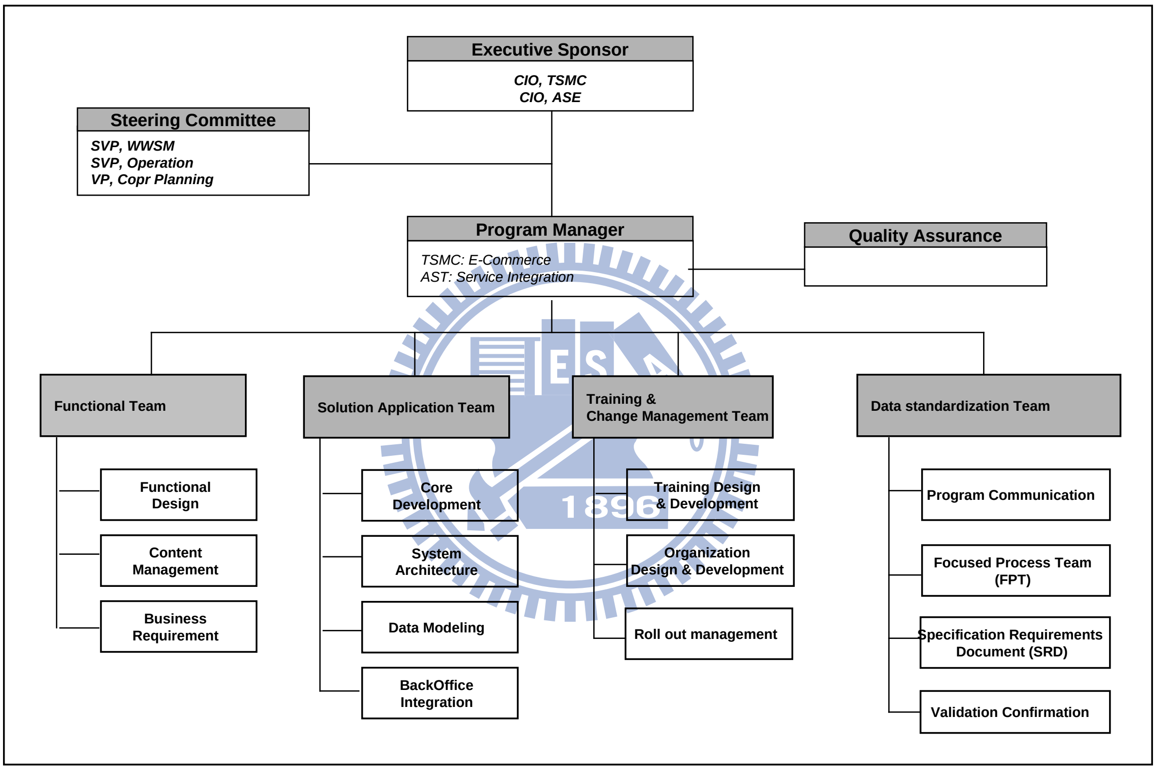

Figure 14 e-SCM BPR program organization

(Detailed design new BP): At this particular activity, a detailed step-by-step flow exploration and ICOM (that is input, output, Control, Mechanism), as shown in figure 15 and figure 16, were performed to specify the operational flow, control point, and control mechanism for each of the e-process to be integrated.

The sophistication of the detailed design also showed in the work of RosettaNet data exchange standard definition. To have the exchange protocol meet the requirements of all business transactions among TSMC, ASE and their joint customers, the protocol needs to be as comprehensive and universal as possible but without sacrificing the system performance. Take WIP as an example, there were more than 300 data elements being defined. Each was marked as mediatory or optional in order to fulfill different needs. One of the key data elements, "Stage Name", had a resolution that could be very detailed, down to hundreds of process routes, or aggregated up to less than ten key stages. The data spectrum and granularity of adopting such a protocol is often a compromise between business needs and the sophistication of the installed ERP or MES system.

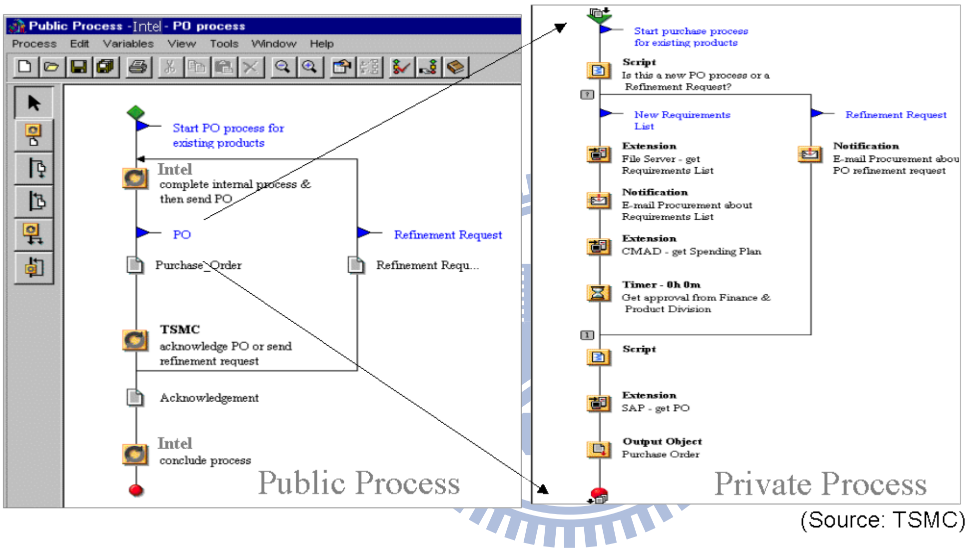

Figure 15 eSCM process detailed design-Flow Exploration

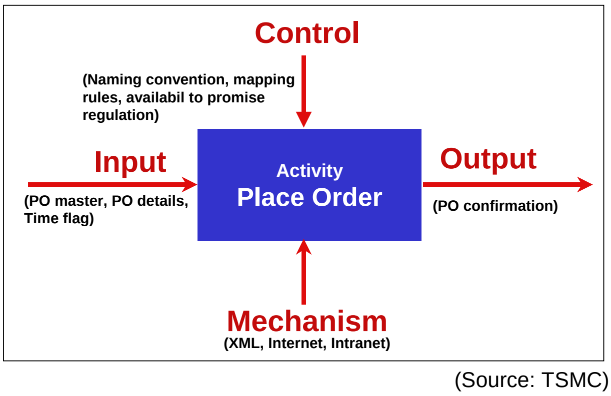

Figure 16 e-SCM process detailed design-ICOM

(Ask feedback from user groups and modify process design): As the supply chain integration scope planned to extend to the entire value chain, there was a dilemma of commonality and

customization after presenting the detailed process designs to different customer groups. There was one type of customers whose requirements were straightforward can adopt standard data exchange protocol; on the other hand, there was another type of customers required customized process in order to adapt to their special business needs. For example, one international company with multiple regional offices worldwide requested a process customization that when a master PO was received in TSMC it needed to be split into multiple sub POs for each of its regional office for this particular international customer. As a result, the BPR team had to modify the process design to fulfill both standard and customized needs. Figure 17 shows the customization example.

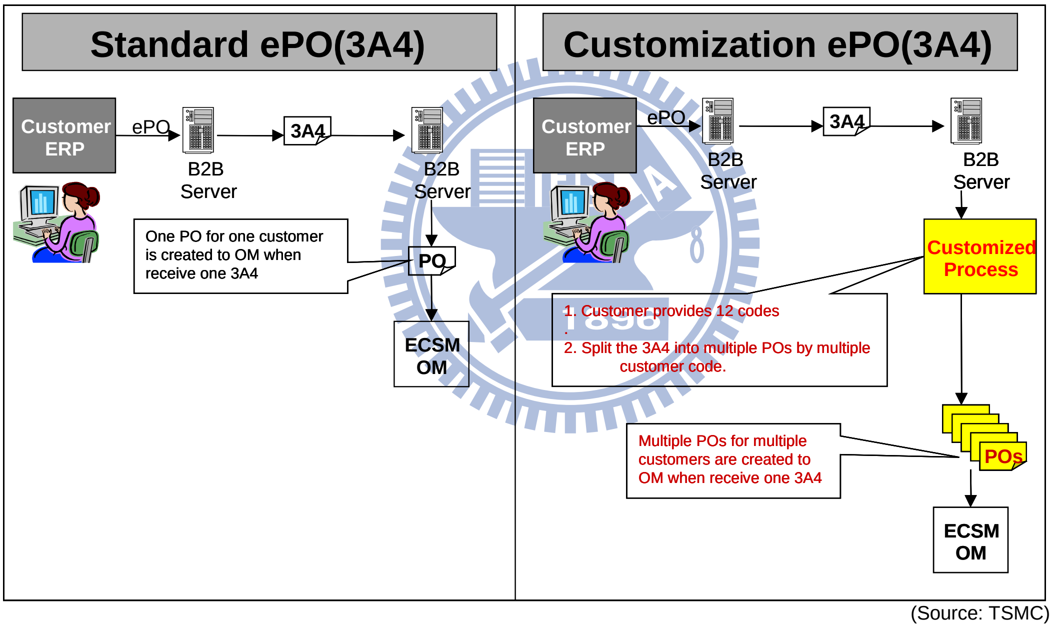

Figure 17 e–SCM process design for standard and customization needs

(Set the new BP performance target): There were four performance indices of the value chain integration BPR project. In addition to the three measurements, i.e., ‘transaction processing time’, ‘data transmission time’, ‘operation error rate’, were set in the “Study” stage, the ‘customer satisfaction ‘ was identify to measure the project success from the customer perspective. According to the results realized by the pilot system that average

5-6 times performance gain of process operation time and data transmission time, the BPR team decided to set an even more aggressive goal of 10 times performance improvement and the error rate reduction.

(Determine enabling technologies): As the emerging of Internet, there were numerous types of Information Technology available address the need of e-Commerce in early 2000's. To enable the supply chain integration via Internet, this project required the IT provide the following functions:

- High speed and high capacity
- Flexibility to set up and change rapidly
- Easy access to internal information, transaction and knowledge for Give internal and external users
- Security control to prevent unauthorized data access

There were six types of Information Technology required to fulfill the business needs as shown in Table 13.

Table 13 e-SCM BPR IT execution components

Component	Description
Security	Covers security strategy, products, and administration processes across the entire infrastructure including hardware, system software, network, and applications
Information Management	Focuses on database management and web content management strategies and tools
Middleware	Contains services that allow for integration with legacy systems for transaction processing and data access
Web Services	Contains components specific to Internet architectures, such as web servers, browsers, application/commerce servers, template engines, Java/HTML/XML, etc
Network	Covers hardware and software necessary to facilitate communications as well as network management strategy and tools
Hardware and Operation System	Covers hardware and OS elements of the infrastructure including strategies for sustaining growth and performance

(Develop IT systems and conduct integration test): The IT system was so complicated that needed to integrate many in-house and Internet systems. As shown in Figure 18, the data were generated by in-house Enterprise resource Planning (ERP) system, consolidated and compiled by the Business-to-Business Integration (B2BI) system into RosettaNet compliance format at customer site, and then sent to the recipient site of TSMC and ASE via Internet. Once received, the data needed to be decompiled into a proprietary format by local B2BI system and then send to ERP and MES system for transaction. All the data transmission and processing were accurately performed; should any error occurred the predefined error-handling process would activate immediately.

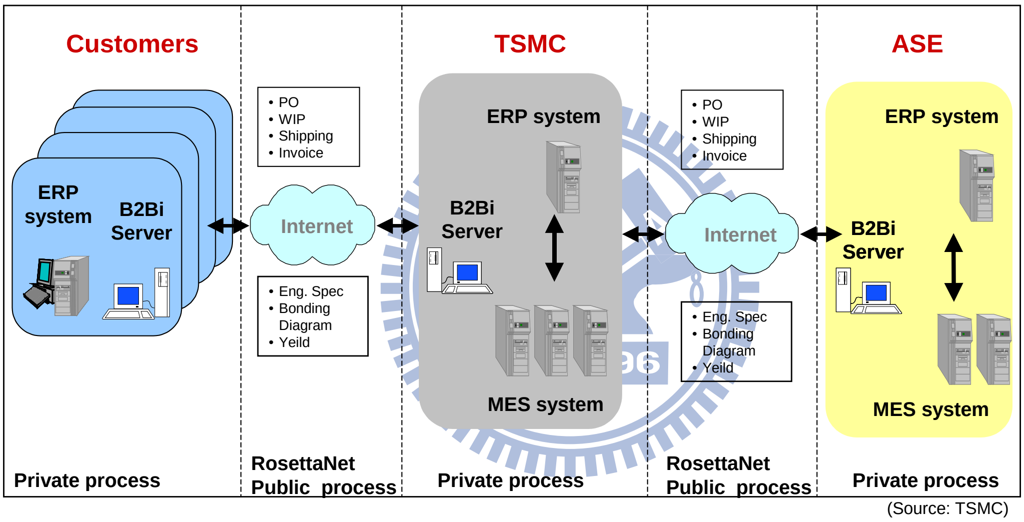

Figure 18 e-SCM System architecture

After building such complicated system, the IT team conducted a series of test from unit test, module test, to large scale of end-to-end integration test. All key processes were first simulated by different scenarios in a testing environment to ensure the feasibility before deployed to the real production environment. It took TSMC and ASE around 150 man months and 1 year to build and test the value chain integration system.

(Report BPR result to senior management): When the new business process, supporting IT system, and new performance goal were all in place, the BPR team was ready to roll out the new process to the upstream and downstream partners for TSMC and ASE. With the

successful result demonstrated by the pilot process integration between TSMC and ASE, the management team needs to ensure the active participation of other companies. To their surprise, here were concerns raised by some customers during the initial contact with them. One of the concerns was that some companies had multiple foundry and/or FT and Assembly suppliers, to engage the business-to-business integration with single supplier didn't seem to bring them full value because they still need to engage business with other suppliers in the conventional way. If they planned to integrate the key business processes with all suppliers, to maintain the various data elements and business rules in their IT systems for each of the supplier would be cumbersome. Besides, to change the status quo, these companies needed additional investment to enhance their IT systems. The electronic data exchange standard sponsored by RosettaNet was exactly the cure to such concern of installing multiple systems and business rules for those companies. To ensure the smooth adoption of the supply chain integration solution, the management team of TSMC and ASE not only actively participate the activities of Rosettanet but also purchased US$ 1 million of server licenses and provided to the early adopter for free.

4.1.5 Transition

(Define new BP deployment plan): Based on the development blueprint defined in the full-scale implementation stage, a detailed project plan including transiting to 35 companies both upstream or downstream of the value chain was established. As shown in Table 14, the BPR project first started as a simple two-company integration project in 1988 and would gradually deploy to TSMC and ASE joint 35 customers in four years. As the data exchange standard definition completed in 2004, the whole semiconductors would be beneficial from the convenient data exchange protocol and proved supply chain integration solution.

Table 14 e-SCM BPR roll out and transition plan

Time	Activities	Participant
1998	Established the B2Bi platform	■ TSMC, ASE
1999	■ Piloted B2B integration with proprietary formats: Yield File Engineering Test Data, Bonding Diagram Data ePO (electronic Purchase Order) Ship-Out-Date Data, WIP (Work-in-Process) data	■ TSMC, ASE
2000	■ Added B2B integration with proprietary formats: Event Data, Finished Goods Bank Data InSlip Data, Shipout Data	■ TSMC, ASE
2001-2002	■ Deploy B2B integration with proprietary formats with selective customers ■ Define the RosettaNet standards: 3A4: Purchase Order, 3D8: Work-In-Process 7B5/6: Work order, 3B2 Ship Notice	■ TSMC, ASE, Fabless/IDM, ■ TSMC, ASE, RosettaNet
2003-2004	■ Continued expansion B2B integration with more business partners with RosettaNet standard, including 25 customers of TSMC and 10 suppliers of ASE Define the RosettaNet standards: 7C7 Testing data, 2A10 Engineering	■ TSMC, ASE, Fabless/IDM, Backend supplier ■ TSMC, ASE, RosettaNet

(Ask feedback from user groups and modify the deployment plan): The original target of deploying the supply chain integration solution was to the customers with single foundry source due to their less complexity of supply chain relationship. As a result the first wave of customer list had more fabless than IDM companies because that fabless companies were relatively young and economical in the semiconductor industry and tend to engage business with few suppliers for maintaining its agility. However, the implementation progress was not as smooth as expected due to primitive IT system and inadequate e-commerce experience of Fabless companies. Therefore, the BPR team decided to engage IDM companies with more advanced IT system and more collaboration commerce experience. The result was turn out to be good and the successful implementation experience could help expediting the subsequent roll out of supply chain integration.

(Deliver training and education): Once deployment plan was confirmed, a series of training program were conducted for customers. The training program included why and how to implement the value chain integration and detailed process integration content and procedures. Figure 19 is part of the training material that shows the high-level implementation plan and Table 15 shows the data elements required to implement WIP process.

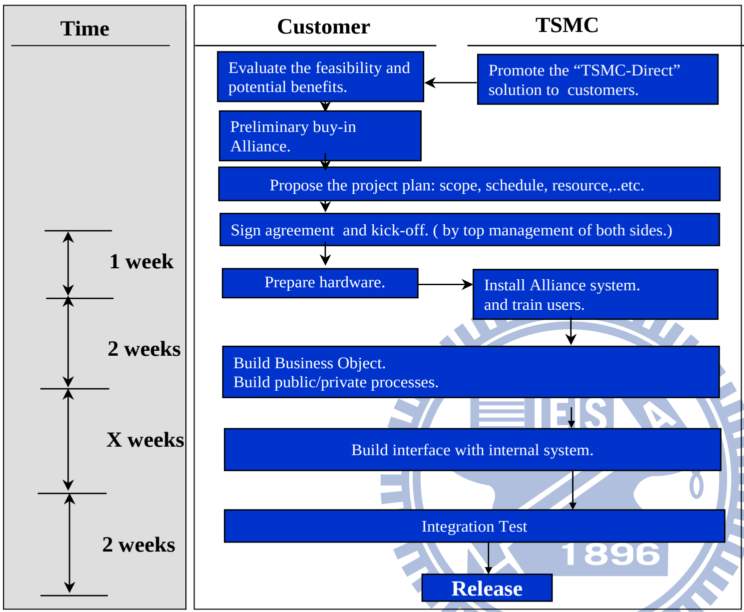

Figure 19 e-SCM BPR high-level implementation guideline

Table 15 e-SCM BPR-detailed process data elements case

Standard Offering						
Items	Example		**Resource Needed (MM)**			subtotal
			IT		**Business**	
			tsmc	outsourcing	CS, PC …	
Standard	Current_Process_Flow Current_Stage_Name Customer_LotID Customer_PO_Line Customer_ProdID Lot_ID PO_Committed_Date Customer_PO Product_ID Projected_Out_Date Projected_Out_Qty Fab_Name Run_priority	Run_Type ShipToCode Ship_Date Stage_Start_Date Total_Die_Qty UoM Wafer_Start_Date Wafer_Start_Qty Wafer_Qty Hold_Flag **Report_Generation_Date** **Plan_Wafer_Start_Date** **Wafer_Status**	0.6	0.4	0.5	1.5
subtotal			1		0.5	1.5
Add-on Customization *(Commonly requested)						
Items	Example		**Resource Needed (MM)**			subtotal
			IT		**Business**	
			tsmc	outsourcing	AM, CS, PC ..	
Special Biz Rules	Hard-Peg vs Netting		0.3~0.5	0.1~0.2	0.3~0.5	0.7~1.2
Others	Customer System Constraint Different Teminology Data Field Swap		0.3~0.5	0.1~0.3	0.3~0.5	0.7~1.3
subtotal			0.8~1.5		0.6~1	1.4~2.5
Total Resource Needed (MM)			1.8~2.5		1.1~1.5	2.9~4

(Source: TSMC)

(Conduct organization change): To align with the new business process of value chain integration, TSMC conducted the following two main organization changes: one was to form a new organization in charge of the operation and implementation of customer-related information service requests; this organization provided 24x7 e-process operation support and a single-contact window to monitor the status of online transaction and problem solving. The other change was to form a virtual Engineering and Logistic Collaboration committee responsible for evaluating the new value chain integration opportunities, promoting the existing solution, and setting the project implementation priority. The constitution of the virtual team was senior mangers from business (sales & marketing), manufacturing, and IT. Figure 20 shows the team organization of the Engineering and Logistic Collaboration Committee.

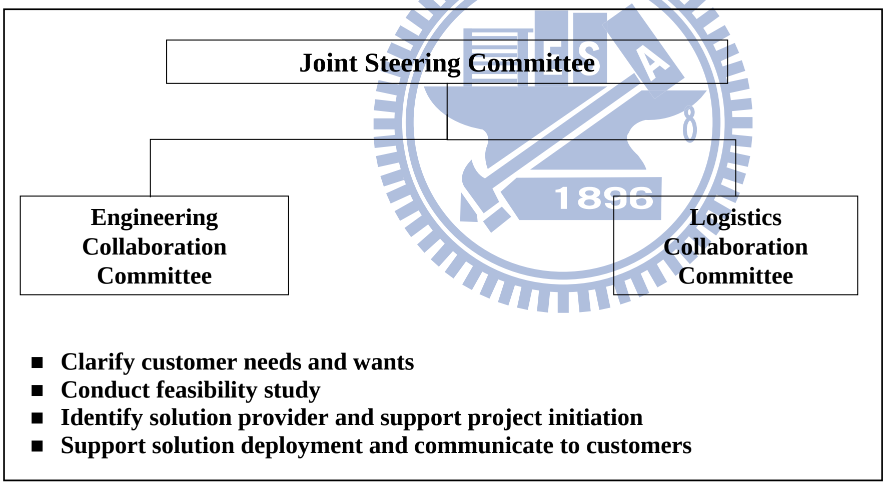

Figure 20 New organization after e-SCM BPR

(Transfer to new working environment): As described earlier that there are two approaches to manage the working environment transfer, one is to have the old and new process operate in parallel for a certain period of time to ensure the effectiveness of the new process before cutting off the old one; the other is to switch to the new process and obsolete the old ones immediately. The former one was adopted in supply chain integration BPR project because that the information exchanged among TSMC, ASE, and their joint customers were

so critical that they can't afford any business operation interruption. The coexisting of old (manual mode) and new process (system mode) was last for 2 months. In the first month, the data exchanged through manual process was the primary one where the data through automated process was verified in the testing environment. In the second month, the role of manual and system process switched until the 100 percent accuracy was reached.

(Measure overall performance goals): The benefits of the value chain integration were realized through shorter data transmission time, timely information delivery, and increased data transparency and accuracy due to standardization of data exchange protocols and formats. Time was saved with less data collection, verification and correction, which shortened the time to market and improved employee productivity, and lowered the entire supply chain operational cost. Customers can now take part in various operational processes via the Internet, including real-time order placement, inquiry on production progress and testing results, forecast of product delivery, and so on. All this information, when received timely and accurately, greatly expedites the R&D, design, or other operational activities of the clients, and thereby contributes to increased customer satisfaction and the overall competitiveness of the industry. It is estimated that more than US$10 million has been jointly realized by TSMC and ASE, compared with the US$ 2 million total investment. The overall benefits and investments included all the major e-business processes integrated, such as e-order, work-in-process, inventory entry, inventory of finished products, shipment, engineering data, and testing results. The overall benefits for the 11 e-processes in the two collaboration groups are shown in Table 16. It is worthwhile to note that the above figure is only the "direct" benefits achieved by TSMC and ASE internally. As mentioned in previous sections, more than 30 companies in semiconductor industry have joined the e-Supply chain network ever since. More companies in the high-tech industry adopted the WIP, work order/work order acknowledgement data exchange format after these three

standards were verified and published by RosettaNet. The “indirect” benefit brought to the whole industry value chain could be in the order of 10X.

Table 16 e-SCM BPR benefits summary

	1998	1999	2000	2001	2002	2003	Total (US$, K.)
Logistics collaboration	7	515	1,481	1,836	1,852	1,955	7,645
Engineering collaboration	0	250	463	536	617	576	2442
Total	7	765	1,944	2,371	2,468	2,531	10,087

As to the achievement of the customer satisfaction, according to an annual study of client satisfaction conducted by a neutral, third-party institution, TSMC lead its closest rival by far over the overall performance of e-commerce and other individual items, as shown in Figure 21.   A major factor for the high satisfaction level is the successful integration of the processes and information data of players in the up-, mid-, and downstream sectors as demonstrated by the TSMC/ASE value chain integration project.

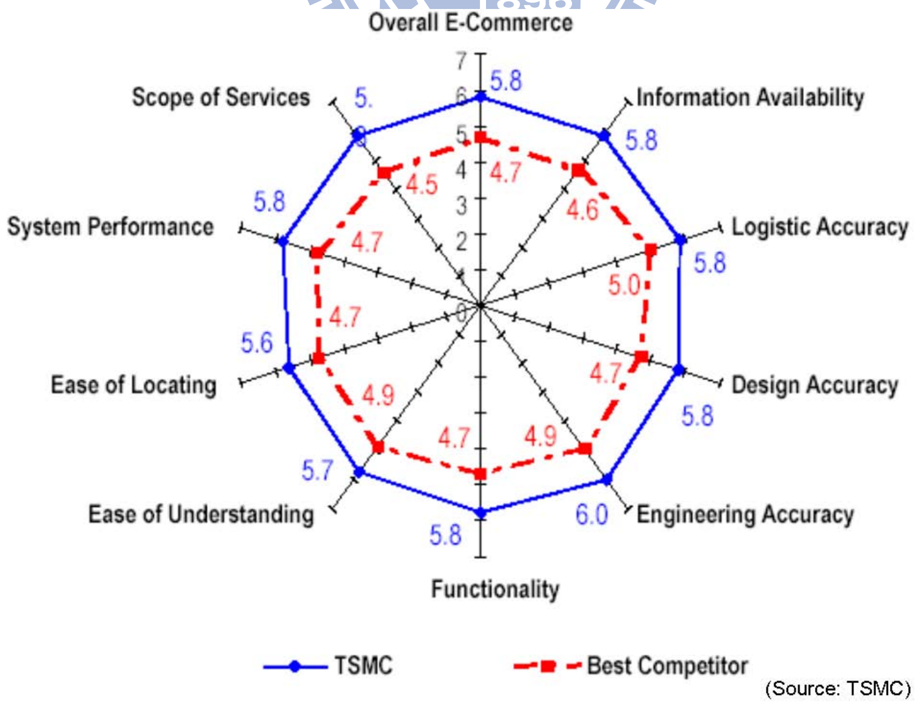

Figure 21 e-SCM BPR customer satisfaction result

(Continuous monitoring and improvement): Six years after project initiation, a solid foundation has been in place by TSMC and ASE to re-integrate the semiconductor industry value chain virtually. Going forward, the project will focus on the following:

1. Extending e-Supply-Chain to more partners both up and down the value chain

   After completing the integration between TSMC,ASE and 35 up- and down-stream patners, TSMC and ASE plan to extend this capability to other partners. In particular, TSMC planned to complete integration of these processes with its top 20% customers by 2005, which contribute more than 80% of its business. ASE would extend the BPR result to its manufacturing sites in Malaysia and Korea to improve productivity and increase customer satisfaction through the standardization of business process and data exchange protocols.

2. Continuing to Shape Industry Standards Through RosettaNet

   In addition to the completed RosettaNet standards for work-in-process (PIP7B1), e-ordering (PIP3A4), and outsourcing orders (PIP7B5/7B6), TSMC and ASE are actively participating in the on-going formulation of RosettaNet Semiconductor Test Data Exchange (SCTDE). This standard would enable Foundry and Assembly Test Partners to deliver summarized chip data to chip designers for data analysis. The test data included in-line test (PCM), wafer test (Sort), and module (Final) test. TSMC, as the co-leader of the joint international team, has also committed the validation with 4 different partners including IBM, Motorola, National SPIL, Agere. The SCTDE project completed in the first quarter of 2005, the project further contributed to the competitiveness of the entire semiconductor industry.

4.2 Case2: Pricing Management BPR

For confidentiality reasons, the fictitious name HiCom is used in this case study to represent one of the international leading companies in the electronic industry. The electronic industry is known as capital-intensive and fiercely competitive. There is constant pressure on electronic companies to develop superior products or technologies at ever cheaper prices. It's not uncommon that the price of an electronic product would fall up to 50% after a few months when new technology is introduced to the market.

Amid increasingly fierce competition, effective pricing is one of the most powerful levers to improve profit margin. However, strategy alone does not yield value without effective execution. This case illustrates how HiCom achieve better pricing performance by conducting a business processes reengineering that streamline activities of multiple functional departments within the company in 2005. The new-defined pricing process and implementation guidelines effectively manage the pricing life cycle; from price plan setting, execution, to performance analysis and monitoring.

4.2.1 Initiation

(Challenges and Problems) Thanks to the innovative business mode, leading technology, and agile manufacturing, HiCom had enjoyed high growth, high revenues and high profits. However, the increasing number of new competitors and sluggish demand growth caused its profitability decline. In addition to pressure of declining profit margins, another driving force to urge HiCom to re-examine its pricing execution performance was the pass of the Sarbanes-Oxley Acts (SOX) in 2002. As a public company listed in the US, HiCom was required to be SOX compliant by 2006. HiCom needs to ensure the accuracy and integrity of its financial results, evidenced by internal process control. As a result, HiCom decided to conduct a corporate-wide pricing BPR project in 2004.

(Identify the bottleneck process and select the ones to be re-engineered) The HiCom's pricing process before re-engineered comprised of two main levels: the planning level from the macro perspective and the operational level from the micro perspective. The planning level was market-driven, strategy-oriented and evolved over years. On the other hand, the operational level was sales-driven, detail-oriented, with deep focus on individual transaction; and was executed on a daily basis. HiCom first examined the effectiveness of its pricing process from three measurement indices; ie, accuracy, completeness, and responsiveness. A score from one to five was assigned to the two levels of "planning" and "operation". Table 17 summarizes the scoring and indicates that both two pricing levels required improvement. It was decided that the "operation" would take the higher priority due to the lowest score on accuracy, which would have the immediate impact upon a company's price performance.

Table 17 Pricing process performance appraisal before BPR

	Completeness	Accuracy	Responsiveness
Planning	3	3	3
Operation	2	1	2

To further identify the pricing operation bottleneck, HiCom adopted two analytic methods: pocket price and price band analysis. Pocket price is the final transaction price after various discounts. Price band analysis further explores the pricing pattern by distributing the pocket price over the range of sales transaction number. The shape and the width of the price band indicate the price visibility and competitive intensity of a market. The first step was to review the pocket price and margin of its products from HiCom's three major product groups. Those three product groups contributed 60 per cent of HiCom's revenue. One product was from the mature product group having the least product differentiation with its competitors; another was from a specialty group having the strongest differentiation and market competitiveness; and the other was from a 'threshold' group which is in between mature and specialty ones. HiCom compared the ratio of pocket price to the list price against the sales transaction number for each of these three products (as shown in Figure 22). As the figure indicates, the mature product had the narrowest price band whereas the specialty product had the widest one. The high competition within the mature product market, with its low tolerance for price variation, generally explains why it has the narrowest price band. On the other hand, HiCom's management team was concerned with the extremely wide price band distribution of the specialty product group. The strong competitive advantage of HiCom's specialty product ought to have yielded better price performance, and it was apparently not reflected in pricing. HiCom then explored the price band distribution for all customers purchasing the specialty products. Surprisingly, the management team found that not all cases followed the pricing policy that only customers with large revenue contribution deserved higher price discounts. As Figure 23 shows, quite a few customers (depicted in the shaded area) were within the section of low sales revenue and low price. After further investigation, HiCom discovered that beyond the initial price discounts, a variety of incentive programs had been extended to those customers, which collectively contributed to the low pocket prices.

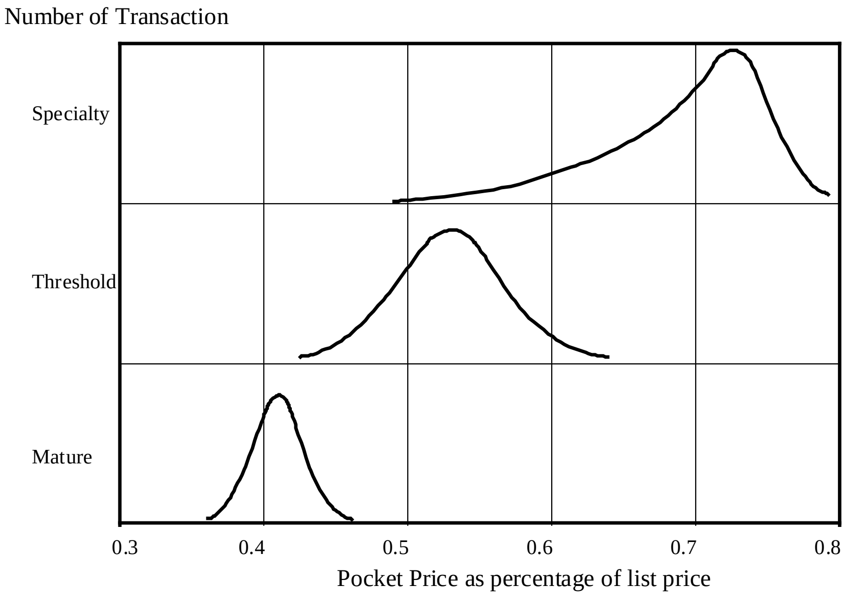

Figure 22 Pricing BPR- pocket price band analysis by product groups

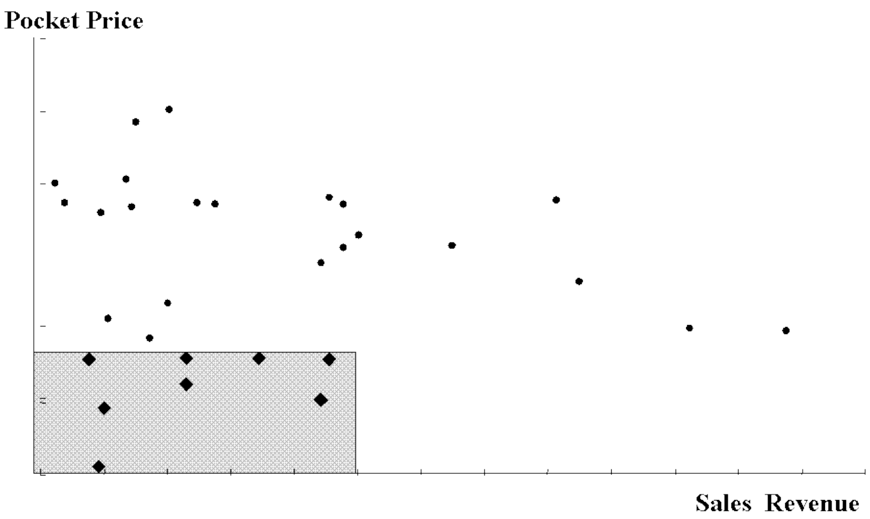

Figure 23 Pricing BPR- contribution analysis by customers

(*Set BPR objective and designate process owner)* The objectives of the pricing BPR were defined as improve the pricing operation accuracy and eliminate any deficiency exposed to SOX regulative risk. The process owner was assigned to the senior VP of World Wide Sales & Marketing.

(Secure commitment from top management) The commitment from HiCom top management to the pricing BPR was strong due to severe consequence if fail the BPR. From the short-term perspective, the deficiency identified by the external accounting auditor, if any, would impact the company rating in New York Stock Exchange (NYSC). From the long-term perspective, the slumping ASP would gradually erode the financial performance of the company and consequently jeopardize the company's market value.

4.2.2 Study

(Organize the BPR team) The pricing BPR project was kick off in 2005 with the project team comprised of business and IT organization (as shown in Figure 24). The business site, including members from field sales representatives, corporate pricing organization, and finance, were responsible of identifying the problems and proposing the solutions. The IT

organization was responsible of building the automatic system according to the business user requirement. The project was managed by the corporate business process integration organization and supervised by the head of World Wide Sales & Marketing.

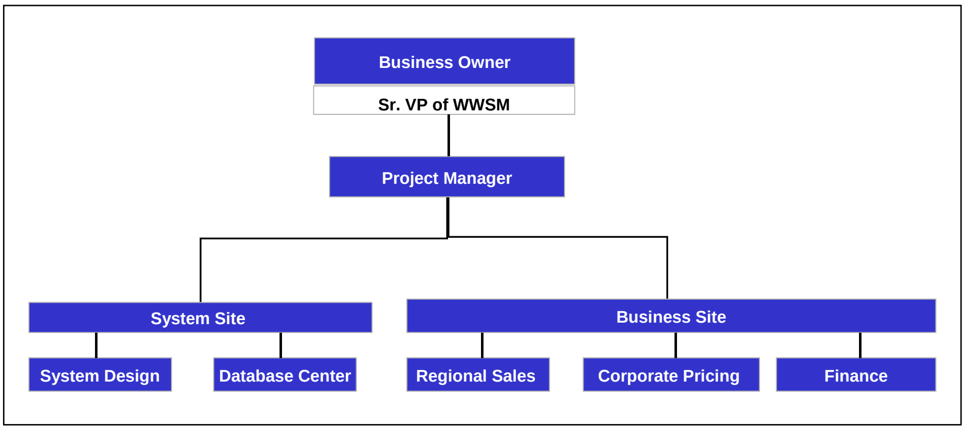

Figure 24 Pricing BPR team organization in HiCom

(*Delineate, measure, diagnose the existing process)* The existing the pricing operation process is illustrated in Figure 25. Some problems identified are illustrated below in the sequence of activities.

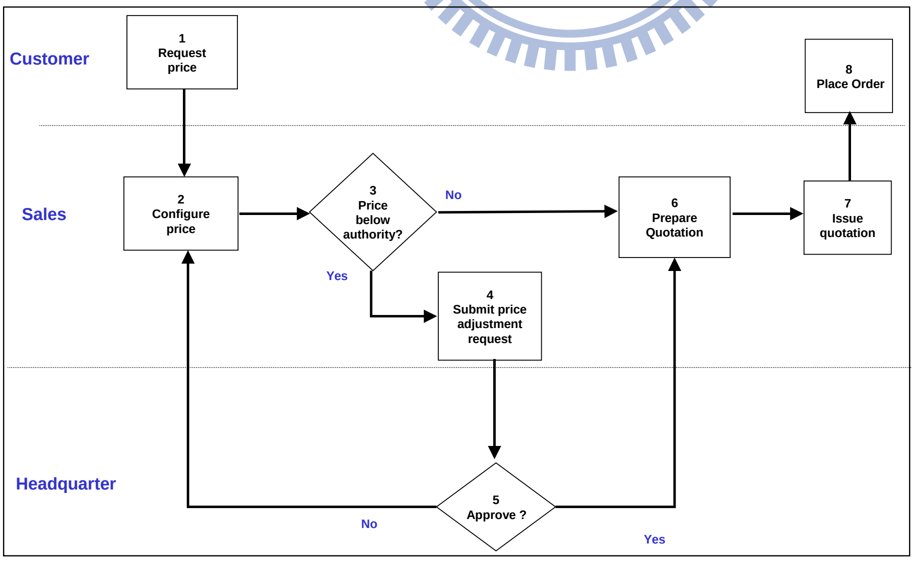

Figure 25 Pricing process before BPR

(1) Incorrect price assessment (activity 2)

Initial price assessment was performed by sales representatives when they made the first contact with customers or prospects. Due to various product lines, complex price structure, and a large customer base, it was difficult for a sales representative to determine product configuration and to accurately deliver corresponding price proposals. Even if the price appraisal was correct for one customer, it ‘s complicated to maintain price consistency and integrity when offering largely varying prices to multiple customers within the same market segmentation.

(2) Discrepancy in quotation, order and actual price (activity 6,7,8)

Once a final price has been approved, customers received a formal quotation and then placed a purchasing order based on the stated terms and conditions. The challenges were to ensure that the quotation price was within the headquarters’’ approval, and that the order price was complete and consistent with the quotation price. One identified serious problem was “revenue leakage”. It was mainly caused by loosely controlled price reductions, leaving value on the table for the customer. Under certain conditions, a special price was awarded in the forms of a cash rebate, volume rebate, bundled sales, payment discounts, cooperative advertising allowances, bonuses, or different payment terms. These conditions were not easily tracked and their exercise period can often last several months or quarters. It was estimated that the potential revenue leakage was more than US$30 million annually. The absence of detailed analysis on the final pocket price usually caused over-estimation of the average selling price (ASP), which in turn mislead the pricing committee to offer less profitable or even unprofitable prices to customers.

(3) Incomplete pricing data

Historically, pricing transaction data had not been properly collected and stored in IT system: the data was either not available, available but not organized in a usable format, or was of poor quality. The absence of complete price data and price point comparisons among customers caused inconsistent price parity across market segments. Furthermore, incomplete data also limited price analysis insights and missed opportunities to adjust pricing strategy in a timely manner.

(Propose the concept of new business process) To address the issues above, a set of business and system initiatives was proposed by the pricing BPR team.

- Build a pricing transaction management system:

  This system would be responsible for processing all pricing operation activities. It would populate the latest price information, calculate the accurate price by product configuration, validate and route price approval to appropriate management levels, and perform price integrity and consistency checks. The Figure 26 shows the high-level prototype of such system. To achieve quick responsiveness, the pricing transaction management system would refer to the central cost, product, and customer master data in a real time manner.

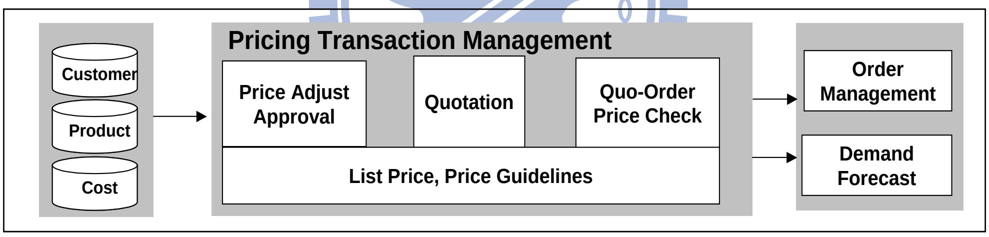

Figure 25 Concept of Pricing Transaction Management System

- Tighten control of sales incentives:

  Tighter control would be enforced on the types of incentives that are offered to customers. All incentives item details were loaded into a central database to better monitor the final pocket price. For low-margin and low-sales customers, incentives were prohibited unless special approval was obtained.

(*Ask feedback from user group)* Sales representatives play a key role in the pricing business process as they are responsible for delivering the price quote to customers, requesting price reduction for customers, negotiating price, and completing sales orders with final approved price. Although sales representatives welcomed an IT system to support them improve their work quality and they also agreed with the concept of tighten sales incentives, they complained the inefficient price adjustment approval process. In general, the sales representatives were delegated with a limited pricing authority. When a customer's requested price discount was beyond the field sales' authority, they forwarded the price adjustment request to headquarters for approval. In some cases, the pricing decision requires complex cost analysis, competition analysis, demand forecast and capacity allocation assessment. There were often tension occurred between headquarters and field sales. The pricing committee in headquarters needed adequate evaluation time to analyze and reach a decision, while field sales staff frequently believed they were in the best position to assess the market conditions and gave the most appropriate offer to secure business. The long cycle time frustrated sales representatives and customers.

(*Design the prototype and ask feedback from user group)* The pricing BPR team developed a Pricing Management System prototype that would automate the activities from price adjustment request, quote issuance, and order link. The function itself was quite straightforward that user groups can easily comprehend. However, one serious problem being identified was the quality of the data referred by the prototype. For example, the customer master, one of the major database referred by the Pricing Management System, stored all the customer information. There were some global customers operated in different areas worldwide had two level of customer information defined: one was "Customer Family" stored the high-level information, such customer family name, headquarters address and contact; and the other was "Individual Customer" stored the detailed information, such as customer name in its operation area and billing address. The price specified in the price adjustment request applied to the level of "Customer Family" because all individual customers under the "Customer family" can use the same discounted price; however the price specified to the quote applied to the level of "Individual Customer". Without properly maintained and correctly referred by in the Pricing Management System, the system would create more problems than it's meant to solve.

(*Report BPR study result to senior management)* After reviewing the pricing operation issues and corresponding solutions proposed by the BPR team, the senior management made the following two important decisions:

(1) Modify the performance measurement criteria for sales representatives:

In the past, the sales performance measurement was primarily based on sales revenue and market share. To align with corporate goals of increased pocket price, the refined performance measurement of sales representatives increased the weight of pocket margin (pocket price divided by operating cost).

(2) Appropriate delegation of pricing authority to corporate pricing officer:

To shorten price reduction approval cycle time, the manager of corporate pricing office was delegated a certain degree of pricing authority. As long as a customer's requested price was within the authorized margin guidelines, the price reduction request would be approved by the pricing manager without submitted to senior management for approval, as had been done before.

4.2.3 Full-scale implementation

(Define the full scale BPR development plan): The full scale development plan consisted of two tracks: business and system track. The business track was to define business rule and policy that would govern filed sales' behaviors. The key tasks include:

- Define Key Performance Index for sales representatives
- Define pricing authority delegated to corporate pricing officer
- Define guideline of sending business incentives to customers
- Define pricing SOP to fulfill SOX requirement

The system track was to develop a system with embedded business rule that could ensure the execution effectiveness. The two major system components are:

- Pricing transaction management system. This system is mainly designed for filed filed sales representatives to process all pricing operation activities.
- Pricing online analytical system. This system is mainly designed for corporate planning staff to monitor and analyze the price trend and propose short-term remedy action and long-term pricing strategy to top management.

The Figure 27 illustrates the tracks and associated time line.

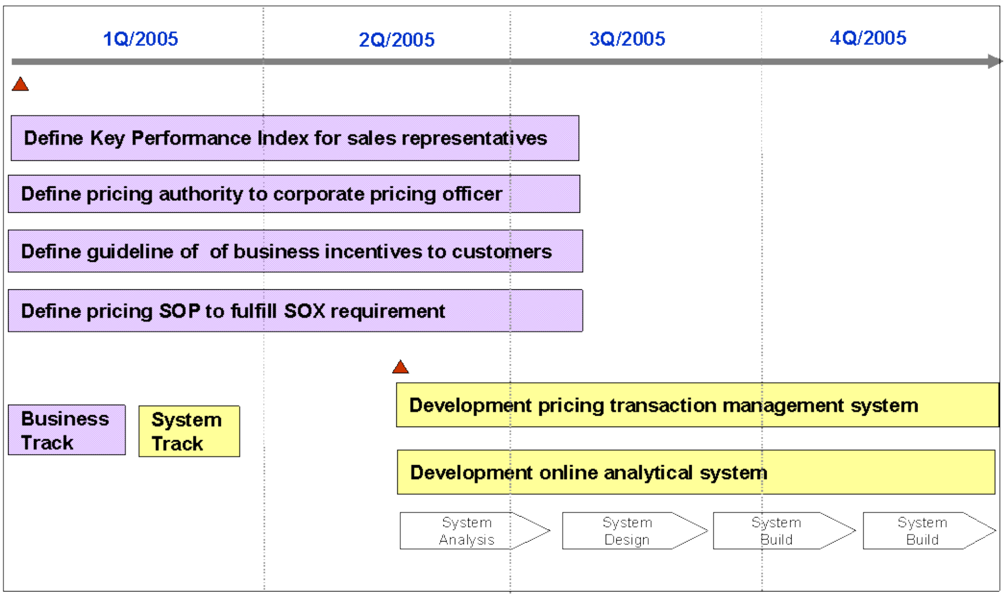

Figure 26 Pricing BPR project tasks and timeline

(Detailed design new BP): The new pricing management process was designed to consist of a set of business rules and operating procedures that would enable the company to set and implement pricing strategy, and to monitor pricing performance. The new process comprises three phases: Planning, Execution, and Analysis. As shown in Figure 28, the Planning phase defines the pricing objectives, strategies and pricing programs under the guidance of the company's overall business plan. The Execution phase implements the pricing strategies to achieve the defined objectives. There are numerous business transactions and associated pricing decisions conducted by field sales representatives and other support teams on daily basis in the Execution phase. The Analysis phase measures pricing performance by investigating historical data and recommends subsequent pricing decisions. Additionally, pricing analysis can uncover potential problems and opportunities to be considered in both Planning and Execution phases. The activities in these three phases are organizationally interdependent. The activities highlighted in grey are pricing accuracy related that concerned SOX compliance.

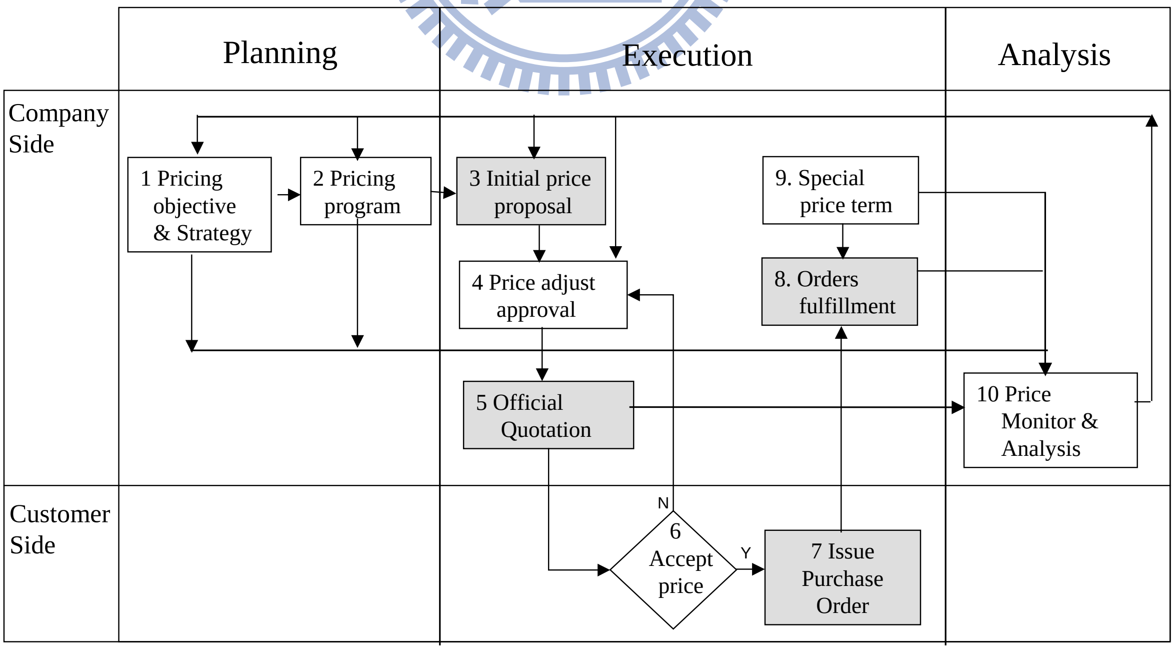

Figure 27 Pricing process after BPR

To effectively implement the pricing processes, a set of principles, i.e. accuracy, completeness, responsiveness, and flexibility are defined. Table 18 illustrates the detailed implementation guidelines and main considerations for each individual pricing phase.

Table 18 Pricing process implementation guidelines by pricing process phases

	Accuracy	**Completeness**	**Responsiveness**	**Flexibility**
Planning	● Alignment between pricing objective and strategy ● Quality assurance of collected pricing related data ● Proper industry trend and underlying assumptions	● Consideration of overall economic, market, and competition dynamics ● Comprehensive pricing history ● Full development of price setting and change procedure ● Definitive pricing key performance indicators	● Constantly surveillance for market changes ● Quick response to market change with different pricing strategies (e.g., skim, value, penetration, or competition pricing)	● Potential government intervention ● Price sensitivity of customers ● Market competition conditions
Execution	● Correct product & price configuration ● Price integrity from quotation to invoice ● Price consistency among customers	● Optimal price/value positioning for all product lines ● Appropriate pricing authority delegation ● Potential revenue leakage control	● Quick response to quotation & price change requests ● Fast remedial action for poor pricing performance	● Price customization according to customer's location, volume, or product's life cycle
Analysis	● Quality assurance of pocket price and price band calculation ● Correct interpretation of price band ● Identification of customers with low pocket margin	● Comprehensive historical transaction data ● Close-loop feedback to price planning and execution	● Real time price performance monitoring ● Prompt root cause analysis and proposed solutions	● Scenario-based price modeling and simulation capability ● Dynamic result display and query function

(Ask feedback from user groups and modify process design): To ensure the pricing data integrity as mandated by Sarbanes-Oxley (SOX) Act, the top management requested field sales representatives and supporting organizations strictly follow (1) authorization of quotation price before issued to customers and (2) ensure correctness of all order price entries to prevent any billing errors. However, the unique foundry business model made it difficult to maintain the accuracy from quote to order price for sales representatives. HiCom provides a variety of process technology selections to fulfill different customer needs. One customer might have multiple end products in the market but all those products use similar process technology in HiCom. The business practice to implement such one technology process supporting multiple product relationship (one-to-many) is to issue one master quotation specifying the prices of mandatory and optional technology processes to customers; and customers places orders for each of individual product with corresponding price. The process needs significant manual effort to check the price accuracy and easily causes billing error if the one-to-many relationship is not maintained right in the first place. To ensure the quote and order price accuracy, the sales representatives requested a systematic approach without consuming too much of their manual efforts. Per user groups' request, the BPR team then designed an automatic solution that converted and populated the quotation price to all products that belong to the same technology, as shown in Figure 29. The accurate price for each product item would be ready in the system for sales to choose in stead of calculation on the fly so that manual price configuration effort and potential billing error would be decreased remarkably.

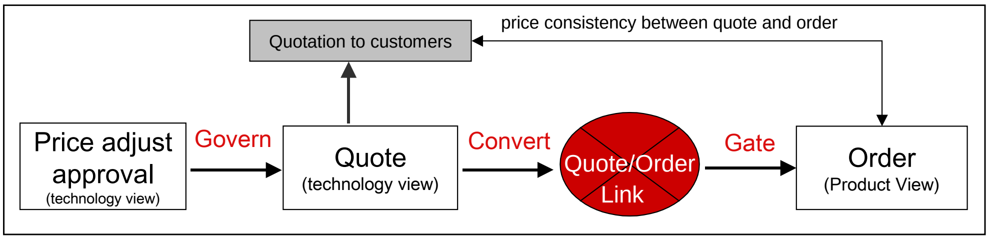

Figure 28 Pricing BPR-Quote and Order link

(Set the new BP performance Target): The goal of the pricing BPR was to optimize the corporate pricing process to assure pricing governance, improve pricing operation efficiency and pricing performance. For pricing governance and operation efficiency, the three objectives are

1. To ensure prices are authorized for quotation
2. To certify quotation completeness for order taking
3. To reduce billing errors from manual wok

The measurements of these three objectives are:

- Consistency ratio of price item in order linked with the one in quote.
- Cycle time of completing price adjustment approval
- Cycle time and quality of generated pricing analytical report

For pricing performance, the measurement metrics were: pocket price and pocket margin. The pocket price is defined as the final transaction price after various forms of discount and the pocket margin is the pocket price divided by operating cost. Pocket price waterfall, as illustrated in Figure 30, shows price cascading from list price, invoice price, to actual pocket price. By analyzing the composition of the pocket price waterfall and the impact of each element, HiCom can better understand how price erodes, and take corrective actions.

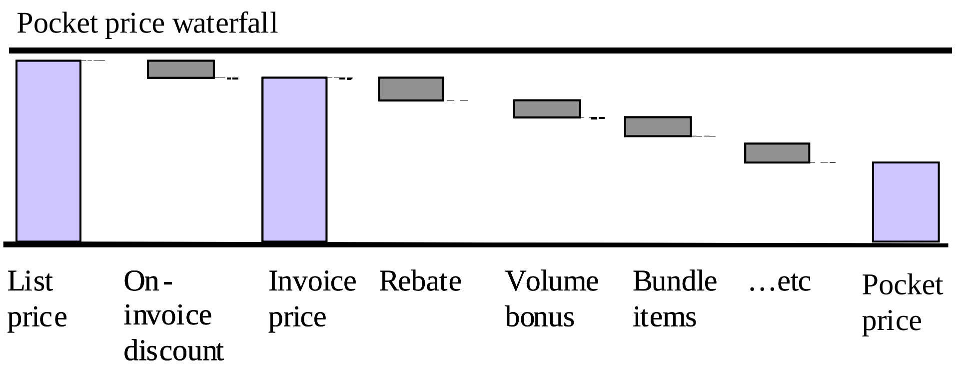

Figure 29 Pricing BPR-Pocket price waterfall analysis

(Determine enabling technologies): The existing proprietary IT system was a combination of home grown legacy and best-of-breed of commercial packaged Enterprise Resource Planning (ERP) solutions. Although each system performed precisely in its defined domain, the heterogeneous IT infrastructure makes integration difficult. Common data redundantly existed in multiple systems and similar data were processed using different application modules. The discrepancies and inconsistency in the databases led to variability in the pricing decision process. To support the realization of effective and efficient pricing management, HiCom IT team decided to adopt a system framework that employs modern EAI (Enterprise Application Integration) and Data Warehousing technology to integrate with the existing legacy and ERP systems.

EAI technology specifically addresses the integration needs from a technical perspective, which is used to incorporate custom applications, package systems into a flexible and manageable business infrastructure. Data Warehousing technology extracted, reconciled, and aggregated data from various application-oriented data sources into an subject-oriented, integrated, nonvolatile, and time variant data warehouse in support of management's decisions.

A schematic overview of this system solution framework is shown in Figure 31. In this four layer architecture scheme, the three main pricing related functions of Supply Chain Planning, Pricing Management, and Order Management are integrated. They in total capture the key components of a company's financial top line, i.e., sales volume, sales price, and sales revenue. The master data that supports pricing management processes; such as Customer, Product, and Price are extracted, consolidated and transformed into enterprise Data Warehouse for further on line analytical processing needs.

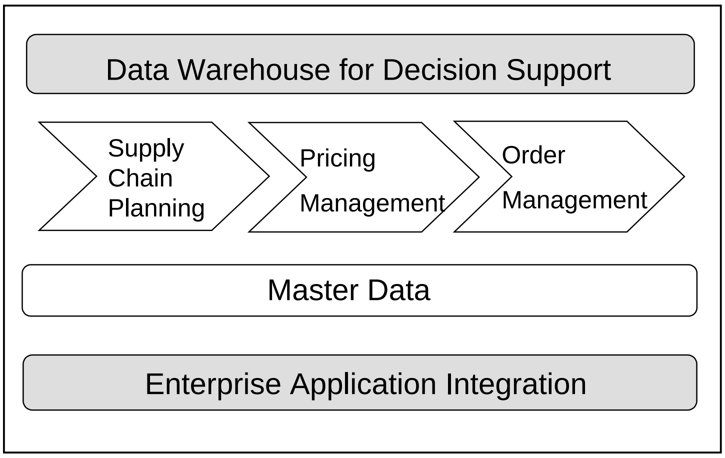

Figure 30 Pricing BPR-Pricing system schematic overview

(Develop IT systems and conduct integration test): To execute this pricing BPR involving multiple departments, an integrated pricing system with transaction management and analytical function was implemented. Figure 32 illustrates the primary function of the pricing management system and its underlying IT infrastructure. The pricing transaction system is responsible for processing all pricing operation activities. It populates the latest price information, calculates the accurate price by product configuration, validates and routes price approval to appropriate management levels, and performs price integrity and consistency checks. To achieve quick responsiveness, the pricing transaction management system refers to the central cost, product, and customer master data in a real time manner. With central storage of historical price, sales volume, and margin information, the IT team developed a series of online analytical capabilities for pricing decision support, such as time series modeling, simulation, competitor pricing, and market segment analysis. It would allow sales representatives and headquarters management teams to perform timely and dynamic pricing analysis for various purposes. Incorporating pre-defined business rules, the system monitors pricing performance and triggers immediate alerts when any abnormality is detected.

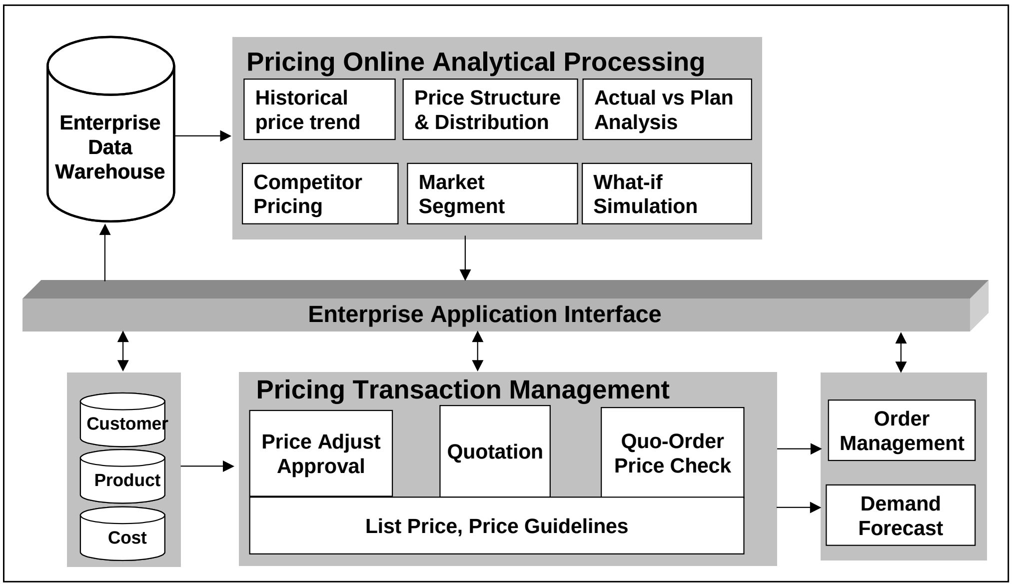

Figure 31 Pricing BPR: Pricing system architecture

Like any major IT system, the IT team conducted a series of test from small scale of unit test, mid scale of module test, and large scale of end-to-end integration test before deployed to user groups. All key processes were first "simulated" by designing and executing scenario-based scripts in a testing environment to ensure the feasibility in real-life operational environment.

(Report BPR result to senior management): As the new business process, supporting IT system, and new performance goal were in place, the management team needed to double confirm the issues would be properly addressed. The BPR team summarized the scope of the pricing BPR initiatives and the corresponding issues they aimed to solve. As the Table 19 shows, most initiatives tackled more than one problem simultaneously. The refined sales performance measurement and pricing management system had the broadest coverage; and all the initiatives collectively addressed issues satisfactorily.

Table 19 Pricing BPR solution coverage summary

Problem \ Solution	Pricing TX Mgtment Sys	Pricing Analytical Sys	Pricing Authority	Sales KPI
Incorrect price assessment	X			
Discrepancy in quote,order	X			
Slow response to price change request	X	X	X	
Inappropriate sales incentive		X		X

4.2.4 Transition

(Define new BP deployment plan): The pricing process deployment plan was defined for two main users group; one was the field sales representatives who were in charge of the pricing execution and initial pricing planning from the micro perspective and the other was the corporate pricing organization who was responsible for pricing performance monitor, analysis, and pricing planning from the macro perspective. For the filed sales representatives, the deployment plan included key activities of:

- Inform SOX regulations and impact to pricing operation
- Introduce the new performance measurement metrics of pricing execution; ie, pocket price, pocket margin, and pricing consistent rate of order and quote.
- Introduce standard operation procedure (SOP) of pricing transaction
- Introduce the functions of "Pricing Transaction Management System"

For the corporate pricing organization, the deployment plan included key activities of:

- Introduce the performance measurement metrics; i.e., the cycle time of completing price adjustment approval, cycle time and quality of pricing analytical report
- Introduce standard operation procedure (SOP) of pricing analysis
- Introduce the Online Pricing Analytical system functions

The Figure 33 shows the deployment plan activities, owners, and timelines.

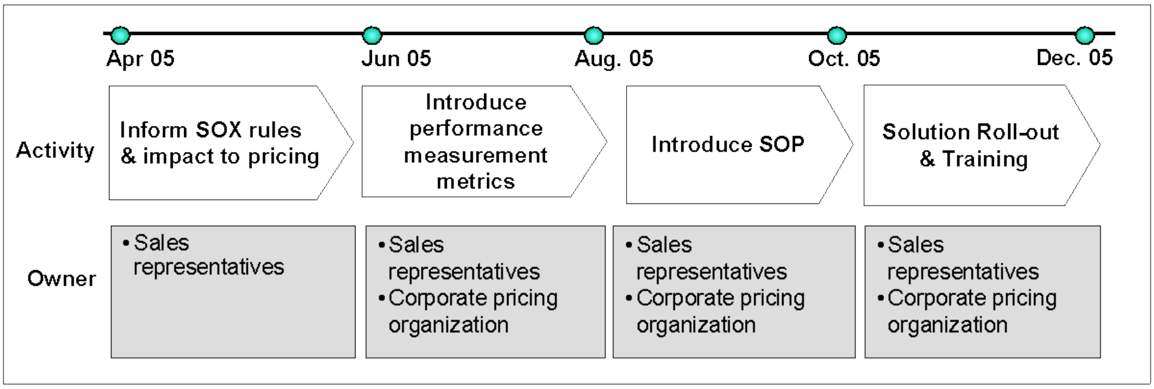

Figure 32 Pricing BPR deployment plan

(Ask feedback from user groups and modify the deployment plan): Customers stand at the other end of the pricing process; they receive quotes, initiate price negotiation, confirm the price, and pay for the orders. Prior to the new pricing business process, some customers (usually major ones) were used to taking manual quote from HiCom with customized format of unit of quantity and product items. To preserve the operation consistency across all sales regions, the new BP requires all the quotes would be processed in the system and no manual quotes would be allowed. However, the original deployment plan did not take into consideration of customers' perspective. Leaning the feedback from sales representatives, the BPR team augmented the deployment plan with the following two items:

- Create a set of standard quotation format for different product group and retire the free-format price quotation gradually.
- Build the price/product information synchronization process between HiCom and major customers whenever there is any change to ensure the updated price could be reflected on the order in a timely manner.

(Deliver training and education): Once deployment plan was confirmed, a series of training program were conducted for sales groups and corporate pricing staff in HiCom and key customers. The training program included why and how to implement the new pricing business process and detailed operation procedures.

(Conduct organization change): To ensure the pricing process execution efficiency and alignment between regional sales offices and corporate pricing organization, a local pricing office was established in each regional sales office. The responsibility of such pricing office was to support the executive of the regional sales office to reach the target margin by watching the price and margin trend and proposed timely pricing strategy. For example, the

pricing manager could compare price trend by customer regions, industry segmentations, or product groups and perform a series of what-if analysis, and communicate the analysis report with corporate pricing organization to propose the alternative price for filed sales instantly. Besides, the pricing office could monitor the price compliance rate and support sales representatives to perform the remedy action once any quote or billing error occurred.

(Transfer to new working environment): Unlike the BPR case of Supply Chain Management described in the last section, adopting the approach of keeping the old and new process operated in parallel for a certain period of time, the pricing management BPR case took the approach of transferring to the new working environment immediately because the pricing management system was newly established. However, it didn't lessen the effort of transferring to the new working environment. One additional task was to migrate all the manual quotes that were still effective into the newly established system; otherwise the quote-to-order process would be interrupted due to missing quotes.

(Measure overall performance goals): All the business and system initiatives were implemented by the end of 2005. The payoff is significant and described as follows. For the pricing data integrity, the high price consistency rate, as shown in Figure 34, indicated that the consistency between order and quote price were reached.

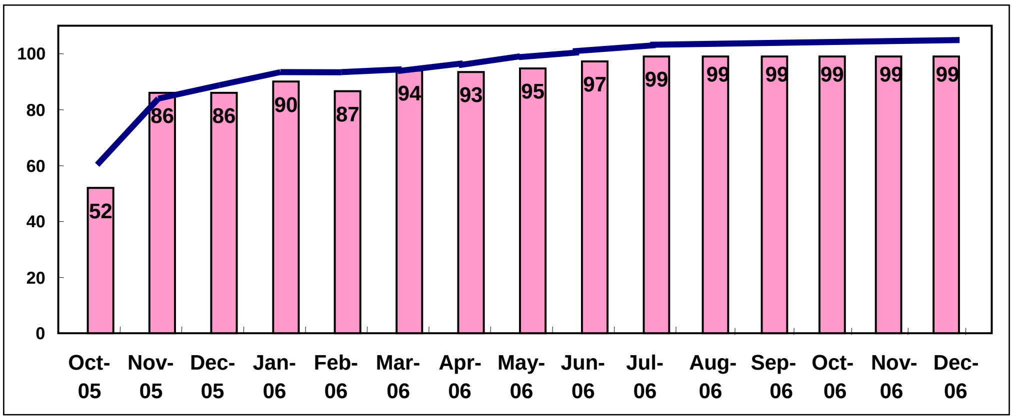

Figure 33 Pricing BPR result: price consistency rate

Besides meeting the SOX compliance requirement, the foremost project goal, the benefits of implementing the pricing BPR also include:

(1) It effectively prevented a potential revenue leakage of US$ 30 million, which contributed to 1% of net income in 2006.

(2) The response time for price adjustment approval was reduced by 40%, and over 90% of the pricing adjustment requests were completed within three days.

(3) The time sales spent on price transaction processing was reduced by 50%.

(4) The average cycle time for generating a full set of price analysis reports was reduced from 2 days to 3 hours. The depth of analysis insight also improved significantly.

(5) Other important benefits such as the mitigation of a long-term price decline trend and better profit margin were partly due to the improved pricing management process.

(Continuous monitoring and improvement): To achieve effective pricing execution, business processes that streamline activities of multiple functional departments within a company is imperative. The pricing performance measurement, such as profit margin and ROE, requires continues monitoring. Due to the successful result of the pricing BPR project, the next improvement opportunity would extend to other business units in HiCom.

5. Findings:

The two BPR program illustrates how the two companies improved their operation performance and competitive advantage in accordance with the steps of the proposed methodology. Table 19 compares the stages and activities carried out by these two BPR cases. The e-SCM case executed all the 5 stages and 36 activities whereas the Pricing Management case executed 4 stages and 31 activities defined in the methodology. The differences are the bypass of Pilot stage and two activities of “Review company vision” and “Search for benchmark” of the Pricing Management BPR.

Table 20 Methodology execution comparison of the two BPR cases

Stages		Activities	e-SCM	Pricing Management
Initiation	1	Identify the challenges and problems company is facing	external	internal
	2	Review company's vision	Yes	na
	3	Identify the bottle business process	Yes	Yes
	4	Select the high-impact BP to be re-engineered	Yes	Yes
	5	Designate process owners	Yes	Yes
	6	Set BPR objectives	Yes	Yes
	7	Search for BPR benchmark target	Yes	na
	8	Secure commitment from top management	Yes	Yes
Study	9	Organize the BPR team	Yes	Yes
	10	Delineate the existing BP	Yes	Yes
	11	Measure and analyze the existing process	Yes	Yes
	12	Diagnose the processes	Yes	Yes
	13	Propose cocept of new BP	Yes	Yes
	14	Ask feedback from user groups	Yes	Yes
	15	Design the prototype according to the proposed concept	Yes	Yes
	16	Develop change management plan	Yes	Yes
	17	Ask feedback from user group and modify the prototype	Yes	Yes
	18	Report BPR study result to senior management	Yes	Yes
Pilot	19	Develop pilot process and small scale implementation of new process	Yes	na
	20	Ask feedback from user groups and modify the pilot	Yes	na
	21	Report BPR pilot result to senior management	Yes	na
Full scale	22	Define full scale BPR development plan	Yes	Yes
implementatior	23	Detailed design new BP	Yes	Yes
	24	Ask feedback from user groups & modify the process design	Yes	Yes
	25	Set the new BP performance target	Yes	Yes
	26	Determine enabling technologies	Yes	Yes
	27	Develop IT systems	Yes	Yes
	28	Conduct integration test	Yes	Yes
	29	Report BPR development result to senior management	Yes	Yes
Transition	30	Define new BP deployment plan	Yes	Yes
	31	Ask feedback from user groups and modify the deployment plan	Yes	Yes
	32	Deliver training & education	Yes	Yes
	33	Conduct organization change	Yes	Yes
	34	Transfer to new working environment	Yes	Yes
	35	Measure overall performance goals	Yes	Yes
	36	Continuous monitoring and improvement	Yes	Yes

The main reasons that cause the difference are described below:

1. Strategic level: the birth of e-SCM BPR project was to respond to the industry trend of value chain integration and in the mean time to realize the concept of "Virtual Fab" for transforming TSMC from a manufacturing-oriented to a service-oriented company. To expedite the integration among key customers along the value chain and to strengthen the leadership in the semiconductor industry, TSMC actively participate the international organization of RosettaNet to lead the worldwide data exchange protocol standard definition. Unlike the potent strategic initiative of the e-SCM project, the Pricing Management BPR project in HiCom is more tactical and emphasize on internal pricing operation discipline and to improve company's financial performance.
2. Project complexity: the e-SCM is an inter-company BPR project that initially integrates 11 e-processes of two companies and extend to more than 30 companies in the semiconductor industry in 6 years. The considerable technical and coordination efforts required by RosettaNet to structuralize, verify, and promote the data exchange protocol even increases the project complexity. By contrast, the Pricing Management in HiCom is an intra-company BPR project that impacts limited number of organizations within HiCom itself.
3. Time constraint: One of main drivers to urge HiCom to conduct the Pricing Management BPR project was to comply with Sarbanes-Oxley Acts (SOX) in 2006, which is 1 year after the project kick-off. The high time constraint demands HiCom to complete the project in 12 months otherwise would expose to SOX regulative risk.

The purpose of building pilot and referencing benchmark is to mitigate the project risk for the project of high complexity. The less project complexity and high time constraint collectively explain why the "Pilot" stage and "Search for benchmark" activity were skipped. The relatively low strategic level of Pricing Management BPR project explains why the activity of "Review company vision" was not executed.

Although the proposed BPR implementation model provides practical guidelines for organizations plan to conduct BPR projects, no two BPR projects are exactly alike. Because of the unique characteristics of the project and amount of change sought in different organizations, the effort dedicated to specific BPR project should be adjusted to maximize effectiveness (Kettinger et al., 1997). The experience of the two illustrated cases indicates that proper use of the model adapted to the project nature is necessary. The strategic level, complexity level, and resource constraint; such as time, budget, human resource, could be import factors to take into account while considering adjusting the proposed implementation model.

In spite of the difference of adjusting the methodology to the project attributes, there are commonalities of these two BPR projects that contribute to the project success.

1. Strong top management support at each implementation stage:

   Both BPR projects were led by senior executives of the company: the e-SCM was led by senior vice president of IT and Corporate Planning and Pricing Management was led by senior vice president of Sales and Marketing. The aggressive participation of the top management not only set clear vision but provide valuable advises at critical point that in turn impact the project result profoundly. In the e-SCM BPR project, the top management sketched the concept of "Virtual Fab" in the project initiation stage and defined the high-level project implementation roadmap for the whole BPR team to follow. One critical decision that accelerated the supply chain integration solution being widely adopted by companies along the semiconductor industry was to join the RosettaNet organization and lead the task of data transfer protocol standardization. In the Pricing Management BPR project, the critical decision made by the top management was to redefine the performance measurement indices of sales representative and delegate different levels of pricing authority to filed sales and corporate pricing organization. Rule and Policy itself does not yield satisfying financial result but need strong enforcement by continuous monitor and corrective actions follow up. The redefined performance measurement indices, delegated pricing authority, and determinate enforcement by top management in total rectify sales behavior, shorten the pricing decision cycle time, and improve the company financial performance.

2. Active user group involvement:

The first-line user groups know the defects of current process and potential risks of future process. The active involvement of the user groups and constructive suggestions made by them help the BPR teams of both projects tackle the critical problems. In the e-SCM project, the user groups requested to incorporate both engineering and logistic key processes to complement the project scope. To multiply the willingness of key customers to implement the value chain integration with TSMC, the user groups suggested design both standard and customized data format in solution and alter the deployment sequence by approaching IDM customers first. In the Pricing Management project in HiCom, the user groups highlighted the complexity of quote-to-order relationship and inconsistent data resolution was the root cause of poor data quality, which directed BPR team to implement an appropriate solution. The field sales representatives also advocated the importance of including the key customers in the overall change management plan. All such important suggestions lead BPR team to do the right thing along the implementation life cycle.

3. Effective IT solution:

Re-engineering serves to streamline and rationalize the business processes that traverse multiple organizations, and also ultimately integrate their operational activities to achieve a seamless interface. The value of automating the reengineered processes through IT is to minimize the manual effort and, more importantly, to provide real time visibility to the status of process operation. In the e-SCM case, the IT system integrating the in-house ERP, MES and Internet Web solutions, which in total enabled real time engineering and logistic information exchange and consequently improve the accuracy and timeliness of value chain integration. In the Pricing Management case, the IT system not only provided comprehensive pricing database and performed timely transaction validation that guarantee the operation accuracy, but also offered sufficient analytical functions that would enable the management team make informed pricing decisions. To ensure the IT solution is operated as effectively and efficiently as it's designed, both BPR cases conducted thorough tests that covered all the critical business scenarios before the deploying the IT system to the production environment.

4. Cross organization team with strong domain knowledge:

Because the process of reengineering involves organizational design around processes, it is important that the team includes representatives from the primary organizational units involved in the process. Both the cases have broad team formation with knowledge team members. In the e-SCM BPR case, the project team is constituted of senior representatives from Demand Planning, Manufacturing, Production Control, and Order Management in both TSMC and ASE. In the Pricing Management BPR case in HiCom, the project team comprised of Finance, Corporate Pricing Planning, and Sales. In addition to team members from various business organizations, there were dedicated BPR experts to ensure the projects were implemented in accordance with the BPR methodology; and IT staff to collect business user requirement collection and build automate system.

6. Conclusion

Recognizing as high as 60-80 percent of BPR projects failing to achieve their goals, this research aims to develop a comprehensive implementation framework outlining the stages and derived activities for BPR project management. The implementation framework provides guidelines for organizations to organize, plan, and monitor their BPR projects. The practical application of this framework is illustrated by two empirical BPR cases, which provides explanations for other companies operating in comparable situations. Future research opportunities based on this framework would be to construct a structured survey examining a larger sample of industrial firms in order to determine the impact and relationship of each framework component on various BPR project charters, such as BPR strategic level, complexity, resource constraints, and industry in which the BPR operates. It would also be valuable to further explore the role of each framework component in securing BPR success.

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