Chapter 9

The Integration of TQM and Six-Sigma

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1. Introduction

Since the 1980s, several important quality management systems, or programs, such as ISO 9000, TQM, Six-Sigma program, Reengineering, and Toyota production system (or lean production), have been launched. Most of these quality imperatives have been widely adopted by industries around the world. All the firms expect good results from the implementation of these quality programs. But the prerequisite is that the employees are familiarized with the quality systems and know how to implement the related practices as a firm plan to adopt these quality systems. In order to help the industries, we will describe the meanings of 'quality,' the evolution of quality management, and the content and practices of some important quality imperatives.

Usually, some firms will adopt several quality programs simultaneously. If a firm implements several quality programs separately, the employees, especially the managers and staff, will encounter some trouble. Among the quality management imperatives, the TQM and Six-Sigma program are widely adopted by the industries around the world; many organizations even implement both of these quality management systems. In order to implement these two quality management programs effectively, it is necessary to integrate TQM with the Six-Sigma program, or even with other quality practices. After the Malcolm Baldrige National Quality Award (MBNQA) and European Quality Award (EQA) were launched, many organizations consider MBNQA and EQA as the 'business excellence model' and use these systems and the related evaluation items to perform self-assessment. Based on the integrated model of TQM and Six-Sigma, and referring to the constructs of MBNQA and EQA, a holistic business excellence model can be developed.

2. What is 'quality'

There are many scholars and practitioners who have given definitions of 'quality.' In this section, we will mention several representative examples. Edward defined 'quality' as the capacity of a product or service to satisfy the consumer requirements in [1]. Usually the

consumer's wants are complex and multi-faceted, thus it may not always be satisfied in a particular way. Juran defined quality as being 'fitness for purpose of use,…, it is judged by the users, not the manufacturers, or the merchants' in [2]. Juran also asserted that each product/service has multiple quality characteristics, which can be divided into two kinds: the features desired by customers, and the freedom from deficiencies. Thus Crosby defined quality as 'conformance to customers' requirements' from the viewpoint of the customers, he also emphasized the ideal of 'zero defects' or 'meeting all the specifications of product/service all the time' in [3].

The definitions mentioned above are not mutually exclusive, they are almost the same. There are several researchers who have given similar definitions, for examples, see [4, 5, 6]. Japanese Industrial Standard (JIS Z8101) and International Standard Organization (ISO 8402-1986) give the same definition of 'quality' as the totality of features and characteristics of a product/service which determines the ability to satisfy the customers' needs and expectations in [7]. Thus, the providers of products/services need to determine the specifications upon these features and characteristics which can meet the customers' requirements and expectations.

There are some critical concepts of quality to be emphasized. Japanese quality philosophy is 'zero defects - doing it right the first time.' It means that quality is the result of doing the right thing and doing the thing right the first time, 'doing the right thing' is to meet the customers' needs and expectations, and doing the thing right' is to follow the standards of the totality of quality. The definition of quality by Crosby has the same concept. Deming's quality concept is customer-focused; he emphasized that quality is only assessed by customers; the quality is surpassing customers' needs and expectations throughout the lifetime of product/service in [5, 8].

We can summary the meanings of quality as follows.

1. Quality is conforming to the standards and specifications of a product/service.
2. Quality is zero defects or meeting the specifications 100%.
3. Quality means that product/service possesses the fitness for purpose of use based on its functions.
4. Quality is the ability of a product/service to meet the customer's needs and expectations.
5. Quality is assessed by customer only borne upon the critical features and characteristics of a product/service considered by customer.
6. Quality is determined by the deviation of the measures of quality characteristics of a product.
7. Quality is customer satisfaction.

3. The evolution of quality management

Quality, price, product function, delivery, and reliability are the competitive aspects for any industries, of which quality has become the most important one in [9] since customers only

buy the goods with accepted quality. In order to assure the delivery of good quality products to customers, industries have adopted many actions to control the quality of the products during the manufacturing process. These actions are somewhat different due to the change of the quality concept. In the beginning, the major quality concepts were product-focused and manufacturing-focused and then changed to user-focused, customer-focused, and value-focused. The evolution of quality management is coincidental with the change of quality-focused, which consists of several stages.

3.1. Inspection quality control (IQC), since 1910~

Ford Company created the assembly line in 1913 due to the influence of the scientific management of Frederick W. Taylor. The implementation of the assembly line led Ford to reduce manufacturing costs significantly. Therefore the assembly line and the resulting volume production became very popular among the manufacturing industries. But it caused the issue of quality control. In this period, inspection activities were formally recognized as the popular control of product quality in [10]. In most manufactures, the foremen are responsible for the inspection works. Thus, it is also called foreman quality control.

Engineers and management level design the standards of the quality upon the critical attributes of the product, and set up the process standards and the related task specifications. Workers are requested to perform the tasks according to the standards and specifications. The inspectors will check the dimensions and characteristics of products, detect the errors and failures, and take the necessary steps to improve the quality.

3.2. Statistical process control (SPC), since 1930~

Inspection quality control is costly since it fails to effectively control the process quality. Walter Shewhart thus created the quality control tool 'control chart' as he had worked in Bell Labs as a quality control inspector in [11]. He suggested using a sampling inspection method instead of 100 percent inspection to reduce the amount of inspection, due to his study of chronic variation of production. The control chart is used to monitor the quality performance of the process by using the sampling methods upon the critical aspects of the process and the attributes of the product in [10].

Since many statistics tools are used in the statistical process control, we also call the quality control method 'statistical quality control (SQC)' Using sampling inspection will cause fewer defective products to be shipped and result in some extra costs, but Shewhart argued that if the missed number of defects is small, then the savings in inspection costs make it worthwhile in [11].

3.3. Total quality control (TQC), since 1950~

Starting in the early 1950s, J. M. Juran propounded the concept of quality costs. He addresses the economics of quality in the book 'Quality Control Handbook' in 1951 in [9]. It is often that the losses due to defects were more than the costs of quality control. Thus the

model of 'costs of quality,' which is subdivided into prevention, appraisal, internal failure and external failure costs, is proposed. The way of SPC can't effectively reduce the quality costs, especially the costs caused by internal failures and external failures.

Armand Feigenbaum joined General Electric since 1944 in [9]. He used the statistical techniques to improve the product quality while he was working in the jet engine factory. But Feigenbaum also used the concept of cost-of-quality and adopted a user-based approach to quality. He thought that this approach requires the management and employees to have an understanding of what quality means and its relation to the company's benefits. He emphasized that quality assurance cannot be achieved by the control just on production process. Thus he propounded the concept of Total Quality Control in 1956 in [12]. This means that the quality is determined at all stages of the whole product lifetime, and all the functions are included in the quality control. The quality activities start with the product design, incoming quality approval, and continue through production control, product reliability, inventory, delivery, and customer service. Actually, Feigenbaum's quality concept and ideas are similar to those described by Deming, Juran, and Crosby in [12].

3.4. Company-wide quality control (CWQC), since 1970~

After World War II, the Union of Japanese Scientists and Engineers (JUSE) was formed in 1946. Its members were constituted of scholars, engineers, and government officials in [13]. They devoted themselves to improving Japanese productivity and product quality in order to enter the foreign markets, especially the American market. In 1950, JUSE invited Deming to Japan to introduce the quality concepts and statistical quality methods to the top managers of Japanese industries in [11]. Juran also visited Japan in 1954 and instilled the concepts of quality control, costs of quality, and the strategic role of management in the quality activities for the Japanese industries in [11]. The concept and approach of TQC were introduced to Japan during 1960. JUSE synthesized the concepts, principles, and approaches of statistical process control and total quality control.

During this period, Japanese industries realized the concepts of TQC. All the departments and employees, from the operators, first-line supervisors, engineers, managers, and top managements, participated in the quality programs and activities. Thus, we called this Japanese TQC company-wide quality control (CWQC). Japanese industries emphasized the education and training of quality for all employees and the cultivation of quality culture intensively. Kaoru Ishikawa, a pioneer in quality control in Japan, advocated the use of statistical methods. But his largest contribution was to promote the realization of total quality and continuous improvement. He contrived the Quality Control Circle (QCC) activity, and used the seven QC tools and improvement tools to apply the QCC improvement activities in [9].

3.5. Total Quality Management (TQM), since 1985~

The realization of CWQC led Japanese industries to possess core competitiveness and quickly move into western markets that were once dominated by western companies by

providing the customers with high quality products at lower prices in [14]. The western firms, especially the American companies, encountered serious global competition from Japanese and Asiatic competitors. The western companies saw their shares eroded by foreign competitors. This situation caused American and western industries to benchmark Japanese CWQC performance and learned the management of quality control from Japan. As a result, total quality management (TQM) was developed and widely adopted by the industries around the world. The industries considered TQM as a powerful tool that can be used to regain the competitive advantage.

The development of TQM was also influenced by the western quality gurus: Deming, Juran, Feigenbaum, and Crosby in [15]. TQM is thus an integrated model of management philosophy, quality concept, and set of practices. However, to implement the TQM successfully it is necessary to integrate the so-called 'hard side' of the system (that is, the technical aspects of quality control) with the 'soft side' of the program (that is, the aspects associated with 'quality concept, culture, and people factors') in [16]. Statistical methods, quality control tools, process standardization, and improvement are the elements of 'hard side,' and quality concept, employees' participation, education and training, and quality culture are included in the 'soft side.'

From the mid-1990s onward, several important quality programs were being launched. Besides the development of TQM, the ISO system and Six-Sigma program, which was initiated by Motorola, were started in 1987. Until now, ISO system has had three revisions in 1994, 2000, and 2008 respectively. The Six-Sigma program was being widely imitated by GE in 1995 in [17], while most were copying from Motorola. The successful implementation of Six-Sigma by Motorola and GE caused this improvement methodology to become popularly adopted by the industries around the world.

3.6. Business Excellence Model, since 2000~

The rapid development and application of technology and internet have caused significant changes in market environments in [18, 19] and, consequently, in business management in [15]. In particular, the effects of the borderless global economy are clearly evident in virtually every aspect of business activity in [20]. The increased competitive pressure from both domestic and forei gn competitors has forced businesses to pursue speed, innovation, quality, and value in [21, 15]. In the past two decades, the industries adopted several strategic actions: Total Quality Management (TQM), ISO system, Reengineering, Six-Sigma program, Toyota production system (TPS), etc. in [22, 15]. But in today's world of serious competition, implementing these actions may not be enough to possess the competitiveness.

The enterprises need to develop their core competencies and core capabilities in order to excel at the contrivance of core competitiveness and then develop the innovative business model in [23-27]. The integrated system of these critical ingredients, in order to pursue the long-term high profits and development, can be called a business excellence model. But there is no coincidence of the formal 'business excellence model.' Several scholars and practitioners consider the model of Malcolm Baldrige National Quality Award (MBNQA) or

the model of European Quality Award (EQA) as the 'business excellence model' in [9]. Kanji developed a business excellence model that was suitable for organizations that incorporate the critical success factors of TQM in [28]. Based on this business-excellence model, Kanji then developed a 'business scorecard' in [28]. Kanji & SÂ later developed a 'Kanji business excellence measurement system' by integrating the business excellence model and Kanji's business scorecard in [29]. Yang also developed an integrated model of a business excellence system in [30].

4. The development and implementation of TQM

TQM began in the mid-1980s and was based on benchmarking and learning from Japanese CWQC. In the beginning, there was a lack of consensus on the content and practices of TQM. But several gurus, like Deming, Juran and Ishikawa have contributed much to the development of TQM, especially the Deming 14 points and Juran quality trilogy in [31, 9, 32]. Additionally, the characteristics of CWQC also affected the content of TQM.

4.1. The fundamental concepts of TQM

Now we state the concepts, practices, and characteristics as follows.

4.1.1. Deming 14 points:

1. Create constant purpose toward quality improvement of products and service.
2. Adopt the new concept of 'zero defect' that we no longer accept the commonly accepted levels of delays, mistakes, and defective products.
3. Stop the dependence on mass inspection of quality control to achieve the quality assurance; instead, set up the built-in quality system in the production processes.
4. Cease the practice of material purchases based on the decision of the price alone.
5. Use statistical methods to find the root causes of the problems and ultimately eliminate these problems.
6. Institute modern methods and systems of employees' on-job training.
7. Execute new methods of leadership for the supervision of workers.
8. Drive out fear, so that every employee can work effectively.
9. Break down barriers between departments; instead, team-work can be realized.
10. Eliminate slogans and the exhortations by numerical goals for the workforce; instead, encourage employees to challenge high levels of quality and productivity.
11. Eliminate only work quotas without accounting quality and remove the obstacles that prevent employees from achieving their challenge.
12. Remove barriers that rob people of their pride of workmanship.
13. Develop and execute a complete program of education and training for all employees.
14. Perform all above actions and push for continuous improvement.

4.1.2. Juran quality trilogy

Juran divided quality management system into three stages, which are

1. Quality planning:

The firms first identify the focused customers and their needs and set up the goals to satisfy customers and achieve excellent business results based on the development of new products and strategic processes. This planning stage also attempts to eliminate problems which may become chronic as the process was designed that way.

2. Quality control:

The firms need to establish a control system to monitor the quality, evaluate the process performance, and compare the operating results with the goals. It is also critical to discover the problems, especially the chronic problems.

3. Quality improvement:

In this stage the firms will identify the improvement projects and teams and analyze the root causes and eliminate them. After the problems are solved, the firms will standardize the new process and establish the mechanisms to control the new process in order to assure the quality.

4.1.3. Characteristics of CWQC:

1. Customer-focused and quality-first.
2. Full participation and teamwork.
3. Education and training of quality for all employees.
4. Cultivation of quality culture.
5. 'Continuous improvement' is the key quality activity.
6. Concept and realization of 'zero defect.'
7. Realization of 'do the right thing first time.'
8. Everyone is responsible for the quality.
9. Emphasizing on the prevention activities and quality assurance.

4.2. The content and framework of TQM

During this period, the ISO 9000 quality system was launched and Motorola implemented Six-Sigma improvement projects in 1987. The USA also started the Malcolm Baldrige National Quality Award (MBNQA) in 1987, which was based on the referring to the Japanese Deming Award. After MBNQA launched, many countries also developed their national quality awards based on the MBNQA system. The development of TQM is displayed in Figure 1.

Additionally, many researchers and experts on quality management have been eager to study the essentials of TQM. The development and implementation of TQM today has become a very consistent consensus on the content in [33, 34, 15] as follows:

1. Customer focus – To understand the requirement of customers proactively, take proper actions to fulfill the customers' needs, and the aim to satisfy customers.

2. Continuous improvement – To discover problems, analyze the critical root causes, and eliminate those barriers completely.
3. Employees' participation – Every employee is accountable with one's responsibility for quality, and also everyone needs to be involved and commit oneself to every quality activity.
4. Teamwork–It is necessary to overcome sectionalism and to realize the teamwork and cooperation for improving quality and embark on quality activities.

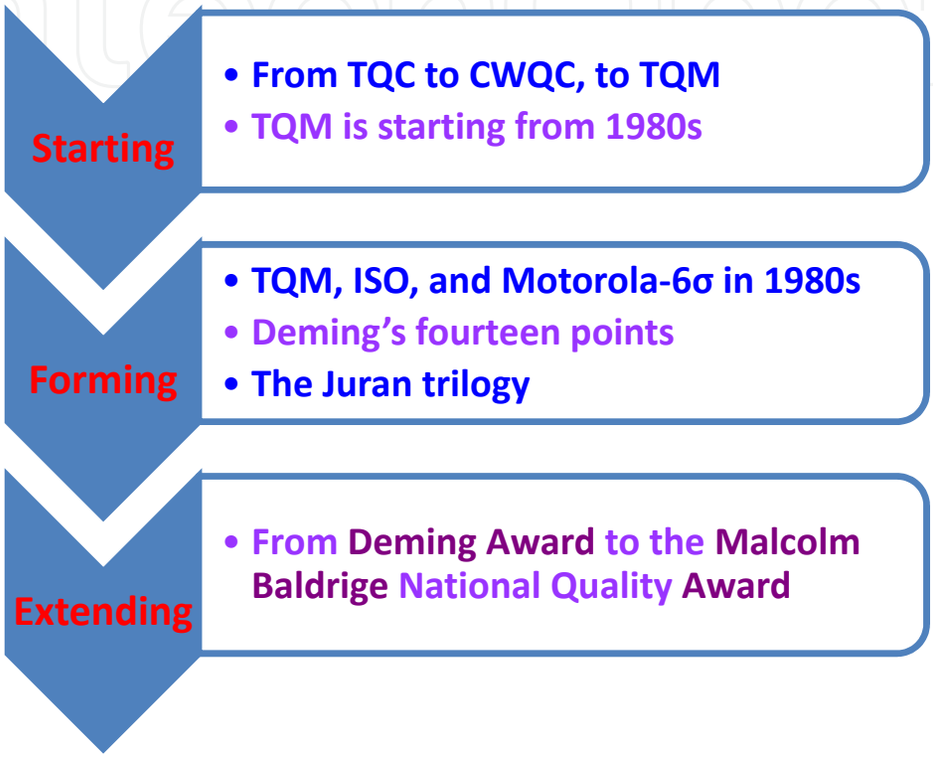

Figure 1. The development of TQM

5. Process focus – Standardizing the processes and taking proper quality control in the key steps of the operation procedures to prevent any defects occurring in processes.
6. Systemization – For bettering the prevention and control of quality, all the quality activities should be conducted and implemented systematically.
7. Empowerment – It is critical that every employee can be autonomous to do the right thing the first time in order to get good quality performance. Therefore, it is necessary to empower the employees.
8. Leadership – During the implementation process of TQM, the top management should play a key role. The top management should be a coach, to teach and influence the subordinates.
9. Management by facts – For the sake of quick decision and solving problems, it is necessary to use numerical methods and statistical tools effectively. It is also essential to develop the quality information system and powerfully apply this system.
10. Training and education – Japanese industries emphasize the training and education for the employees, which is focused on the quality concepts and the improvement tool, and

the implementation of quality practices. Thus, employee training and education is the fundamental activity for the adoption of TQM.

11. Corporate quality culture – In order to successfully perform the above imperatives, the top management needs to cultivate the organization quality culture, and all the employees can maintain it forever.

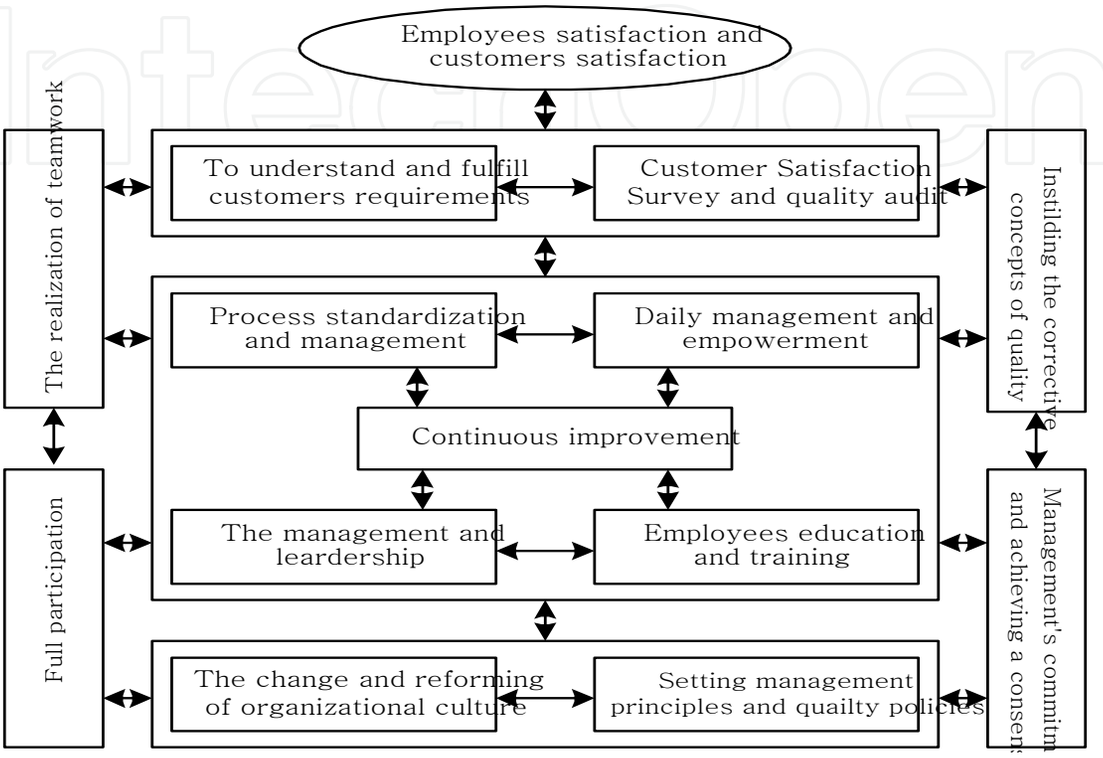

Figure 2. The framework of the implementation of TQM

Based on these imperatives, we can develop the framework of the implementation of TQM, see Figure 2.

5. The development and implementation system of Six-Sigma program

The Six Sigma program was first espoused by Motorola in the mid-1980s. The Six Sigma architects at Motorola produced results far more rapidly and effectively. The successful implementation of the Six Sigma program in Motorola led to several famous companies following Motorola in successfully implementing the Six Sigma program in [17]. In this section, we first introduce the development of Six-Sigma program.

5.1. The development of Six-Sigma program

By the end of the 1970s, Japanese industries possessed strong competitiveness; their competitiveness was based on the ability to develop the core competencies with lower costs, higher quality, and greater speed than their competitors, which could be utilized to contrive the core products. The core competence is the effective integration of technologies,

specialized knowledge, skills, techniques, and experiences, and the core capability is the unique management ability of core competencies to develop core products and new business and then enter the new markets. Eventually, the firms will heighten their competitive advantage and result in business benefits and long-term development, which will exceed their competitors' in [35, 25].

In this period, Motorola encountered intense competition from their global competitors, especially from the Japanese competitors. The threats caused Motorola to execute the benchmarking from the Japanese electronics industry and found out that many Japanese electric products were with 6σ quality level, but Motorola's products were with 4σ quality level only. The weakness in quality led Motorola to initiate the Six-Sigma improvement programs. The aim was to achieve 6σ quality level in a 5-year period. The Six Sigma architects at Motorola focused on making improvements in all operations within a process—thus producing results far more rapidly and effectively.

The successful implementation of the Six Sigma program in Motorola resulted in huge benefits. Motorola recorded a significant reduction in defects and manufacturing time and also began to reap financial rewards. Within four years, the Six Sigma programs saved the company $2.2 billion in [36]. The crowning achievement for Motorola occurred when it was the winner of the Malcolm Baldrige National Quality Award in 1988 in [37]. IBM, Sony, and Allied Signal followed Motorola in successfully implementing the Six Sigma program. Allied Signal began its Six Sigma activities in the early 1990s and attained savings of US$2 billion during a five-year period in [37]. Such impressive results induced General Electric (GE) to undertake a thorough implementation of the Six-Sigma program (GE-6σ) since 1995 in [17].

GE implemented 6σ programs and reaped huge financial benefits. The 1999 annual report of GE showed that the implementation of GE-6σ produced more than US$2 billion in benefits in that year in [38]. The impressive benefits of implementing a Six Sigma program in Motorola, Allied Signal, and GE led to the Six Sigma methodology being widely adopted by industries and non-profit organizations throughout the world. Within a short time, the Six Sigma program thus became one of the world's most important tools in quality management in the last two decades.

5.2. The implementation system of Six-Sigma program

The huge contribution of the implementation of the Six-Sigma program is due to the realization of better practices and operation systems. In the initiative stage, Motorola and GE designed a complete implementation system. The main features of the system are discussed below under the following headings:

1. Implementation steps;
2. The support from organization;
3. Investment in training.

1. Implementation steps

There have been many improvement models for process improvement or re-engineering. Most of their implementations are based on the steps introduced by W. Edwards Deming, which can be characterized as 'Plan,' 'Do,' 'Study,' and 'Act' (PDSA) in [39]. The Six-Sigma program has a five-phase cycle: 'Define,' 'Measure,' 'Analyze,' 'Improve,' and 'Control' (DMAIC) for process improvement that has become increasingly popular in Six Sigma organizations. There is another cycle characterized as 'Define,' 'Measure,' 'Analyze,' 'Design,' and 'Verify' (DMADV) for process design (and redesign) in [17]. Like other improvement models, the DMAIC (or DMADV) model is grounded in the original Deming PDCA cycle. Table 1 describes the specific tasks in each step, and the tools and techniques used in the DMAIC steps. The tasks and tools used in the DNADV steps are similar to those used in the DMAIC steps.

Step	Specific tasks	Tools and techniques employed
Define	• Analyze voice of customers (VOC) • Identify improvement issues • Organize project team • Set-up improvement goal • Estimate financial benefit	• Customer complaint analysis • Cost of poor quality (COPQ) • Brainstorming • Run charts, control charts • Benchmarking
Measure	• Map process and identify inputs and outputs • Establish measurement system for inputs and outputs • Understand the existing capability of process	• Process map (SIPOC) • Cause and effect matrix • Gauge R&R • Control charts • Process capability analysis • Failure models and effects analysis (FMEA)
Analyze	• Identify sources of variation in process • Identify potential critical inputs • Discover the root causes • Determine tools used in the improvement step	• Cause-and-effect diagram • Pareto diagram • Scatter diagram • Brainstorming • Analysis of variance (ANOVA)
Improve	• Create the strategic actions to eliminate the root causes • Conduct improvement actions • Use experiments • Optimize critical inputs	• Design of experiment (DOE) • Quality function deployment (QFD) • Process capability analysis • Control charts
Control	• Standardize the process • Maintain critical inputs in the optimal area • Verify long-term capability • Evaluate the results of improvement projects	• Standard operation procedure • Process capability analysis • Fool-proofing (Poka Yoke) • Run charts • Failure models and effects analysis (FMEA)

Table 1. DMAIC steps and tools usage

2. The supports from organization

Along with the systematic implementation steps described above, the design of specific roles and their effective operations are important factors of the Six-Sigma program. Top management is ultimately responsible for the success of the projects through the provision of sufficient support, resources, and strong leadership. The implementation of the Six-Sigma program is thus top–down. The chief executive officer (CEO) is usually the driving force who sets up the vision, develops the strategies, and drives the changes. Apart from the critical role of the CEO, other players also have their specific roles: (i) the senior managers are the 'Champions,' who are the sponsors of the projects and responsible for success of Six-Sigma efforts; (ii) the 'Master Black Belts' (MBBs) are the full-time teachers and consultants; (iii) the 'Black Belts' (BBs) have the key operational role in the program as full-time Six Sigma players. They are the leaders of the Six-Sigma improvement projects, and therefore they need to show the best leadership; and (iv) the 'Green Belts' (GBs) are the part-time participants who, led by the BBs, work on Six Sigma projects while holding down their original job functions in the company in [40]. Additionally, other departments need to support the Six-Sigma teams as requested.

3. Investment in training

In Japan, employee education and training is a key ingredient in achieving success through QCC (quality control cycle) improvement. In the implementation of Six-Sigma, education and training is also an important success factor, thus Motorola, Allied Signal, and GE have invested heavily in employee training for the Six-Sigma programs in [17]. For example, GE has designed a complete training plan for the various roles described above—from the CEO, to the 'Champions,' 'MBBs,' 'BBs,' and 'GBs.' In addition, the training program extends to all other employees in the organization. The training courses are comprehensive and cover team leadership skills, the method of project management, measurement and analytical tools, improvement tools, planning and implementation skills, and so on. For example,

i. **Champions** have one week of champion training related to Six-Sigma development, leadership, and the implementation plan.
ii. **MBBs** take over the responsibility of the training for all the BBs and GBs. They are promoted from **BBs** based on the successful leaders of at least ten Six-Sigma projects.
iii. **BBs** spend about four to five weeks to receive the intensive, highly quantitative training, roughly corresponding to the five steps of the implementation of Six-Sigma project. Thus, the length of training is approximately 16-20 weeks.
iv. **GBs** receive training for six to ten days. The courses include the statistical tools and the use of statistical software, the detailed modules of five steps, the innovative and improvement tools, and project management skills.

5.3. The features and CSF of the Six-Sigma program

In order to successfully implement the Six-Sigma program, the firms need to possess the related critical success factors (CSFs). The CSFs are dependent on the features of the Six-Sigma program.

1. The features of the Six-Sigma program.

Based on the above descriptions of the implementation of Six-Sigma, and several researches related to Six-Sigma issues in [41, 17, 42], we can summarize the major features of GE-6σ program as follows:

i. GE-6σ projects are integrated with the company's visions and strategies;
ii. Most GE-6σ projects are created from the 'voice of customers';
iii. All GE-6σ projects are rigorously evaluated for financial results;
iv. All employees, from top management to the workers, participate in the progress of Six-Sigma program;
v. GE-6σ is a top-down program, top managers are the sponsors of the projects, and major managers are responsible for success of Six-Sigma efforts;
vi. GE invested heavily in the employee education and training for the Six-Sigma program;
vii. The five implementation steps (DMAIC, or DMADV) are rigorously followed and result in significant benefits;
viii. Everyone who contributes to the success of the program receives significant rewards, especially in terms of staff promotion;
ix. Significant financial incentives (representing 40% of all bonuses received by employees) are tied to results of the GE-6σ projects;
x. Many management, analysis, and improvement tools, especially the advanced statistical methods, are used in the implementation of GE-6σ projects;
xi. Almost all projects are completed rapidly (usually within 3–4 months); and
xii. The bottom-line results are expected and delivered.

2. The critical success factors of the Six-Sigma program

Though the Six-Sigma program has been widely adopted by manufacturing and service industries, as well as non-profit organizations and government institutes in [43, 15], the failure rate of the implementation is very high. There are several obstacles that cause the high failure rate. For example, top management provides insufficient support to the Six-Sigma projects, lack of sufficient training for the employees, the financial incentives tied to the results of the Six-Sigma projects are deficient, etc.. Thus, it is worthy to investigate the critical factors for the successful implementation of Six-Sigma projects.

There are several researchers who have studied the critical success factors (CSFs) for the implementation of Six-Sigma in [40, 37, 43-46]. Yang et al. also investigated the CSFs for the Six-Sigma implementation in Taiwan using an empirical study. In this section, we integrate these studies in [47].

i. Top management commitment and involvement.
ii. Full support from the organization.
iii. Cultural change—customer-orientation and quality-first.
iv. Communication with all employees to achieve congruence on the Six-Sigma program.
v. Employee education and training in Six-Sigma.
vi. Linking Six Sigma to the corporate vision and business strategy.

vii. Linking Six Sigma to customers' needs (focused on the voice of customers).
viii. Familiarizing and implementing the methods, tools and techniques within Six Sigma.
ix. Complete evaluation system of project performance.
x. Project prioritization and selection, and successful usage of project management.
xi. Organization infrastructure—the design of Champions, MBBs, BBs, and GBs.
xii. Employees' promotion and incentive compensation tied to the results of Six Sigma projects.

6. Integrated model of TQM and Six Sigma

In the last two decades, the public interest in TQM has declined. In contrast, the Six Sigma improvement method, especially in its form implemented by General Electric (GE-6σ), has become a popular management tool in the world. As a result, some researchers and practitioners assert that firms should implement Six Sigma in preference to TQM. Why have these kinds of contentions appeared? The literature contains reports of several cases in which the implementation of TQM has failed. Hubiak & O'Donnell, for example, have asserted that approximately two-thirds of the companies in the United States have either failed or stalled in their attempts to implement TQM in [48]. Many of these TQM programs have been cancelled, or are in the process of being cancelled, as a result of the negative impact on profits. The failure implementation of TQM is due to several factors. Besides the difficult achievement of TQM practices, one of them is that TQM has been a rather diffuse concept with many vague descriptions but few more graspable definitions, and the management does not have a complete picture of what TQM really means in [49]. Another one is that organizations around the world do not realize that implementation of TQM means a cultural change in [50]. In fact, academic discussion of TQM and its implementation has suffered a similar decline in recent years.

Is this trend really due to poor corporate business performance as a result of the implementation of TQM, with a consequent decline in the implementation of TQM, as has been asserted? Yang asserted that this is not an accurate reflection of the current status of TQM in [15]. Reports of instances of failed TQM implementation are only part of the explanation for the apparent declining trend in TQM. In reality, TQM has been so prominent for about twenty years that many firms and institutions have incorporated TQM into daily management activities. The result is that a well-established model of TQM has been so much a part of the routine business activities, that the 'decline' in discussion and implementation of TQM is apparent, rather than real.

6.1. The contentions related to the relations between TQM and Six-Sigma

Actually, the conspicuous success of the Six-Sigma program by GE (as GE-6σ) has gained great popularly in recent years in [38, 51]. It has even been suggested that TQM will be replaced by Six Sigma as the main strategy for successful business management. However, such assertions reveal a fundamental misunderstanding of the nature of TQM and its relationship with GE-6σ. For example, Pande et al. have asserted that TQM is less visible in

many businesses than it was in the early 1990s, pointing to several major TQM gaffes as reasons for this apparent decline in [17]. According to Pande et al., these problems include a lack of integration, leadership apathy, a fuzzy concept, an unclear quality goal, failure to break down internal barriers, inadequate improvements in performance, and so on. They conclude that Six Sigma can overcome many of the pitfalls encountered in the implementation of TQM and, hence, that Six Sigma's expansion heralds a 'rebirth' of the quality movement in [17]. However, Klefsjö et al. and Lucas have a different perspective. Klefsjö et al. assert that Six Sigma is a methodology within – not alternative to – TQM in [37]. Lucas asserts that Six Sigma is essentially a methodology for disciplined quality improvement in [51]. Because this quality improvement is a prime ingredient of TQM, many firms have found that adding a Six Sigma program to their current business system gives them all, or almost all, of the elements of a TQM program.

It can be concluded that the approach of Lucas is correct, and that the TQM pitfalls noted by Pande et al. are not essential features of TQM in [17]. Rather, they are caused by incorrect practices adopted by firms, especially the lack of proper endeavour shown by management in the implementation of TQM. As a result, several assertions related to the relationship between TQM and GE-6σ have appeared, especially the treatise that TQM will be replaced by GE-6σ. However, there are very few studies in the literature that directly compare TQM with GE-6σ completely, and in the limited studies that do exist, conclusions on the relationship between TQM and GE-6σ have differed significantly.

Harry has claimed that Six Sigma represents a new, holistic, multidimensional systems approach to quality that replaces the "form, fit and function specification" of the past in [52]. However, it is not readily apparent from Harry which aspects of this multidimensional systems approach are presumed to be absent from TQM in [52]. Breyfogle et al. have stated that Six Sigma is more than a simple repacking of the best from other TQM programs in [41]. In view of a lack of consensus on the relationship between TQM and GE-6σ, Yang (2004) compared TQM and GE-6σ by using complete perspectives in [15]. The author reviewed several studies in [31, 53, 54], and selected the appropriate criteria used in these studies and then integrated them into 12 dimensions. They are: (i) development; (ii) principles; (iii) features; (iv) operation; (v) focus; (vi) practices; (vii) techniques; (viii) leadership; (ix) rewards; (x) training; (xi) change; and (xii) culture in [15].

6.2. Integration of TQM and GE-6σ

Based on the comparison between TQM and Six-Sigma conducted by Yang in [15], it can be concluded that there is congruence among the quality principles, techniques, and cultural aspects of TQM and GE-6σ, and only a little difference between their management principles. As a result, the integration of TQM and GE-6σ is not as difficult as it might seem. The critical task is to combine the best aspects of TQM's continuous improvement with those of GE-6σ's re-engineering. Although the activities of a quality control cycle (QCC) and quality improvement team (QIT) cannot achieve significant effects in themselves, they can cultivate quality concepts and team awareness among employees, and hence the quality

culture. Therefore, QCC and QIT can be performed by the operators and junior staff members to progress continuous improvements while focusing on daily operations and processes. GE-6σ projects can be applied by engineers and senior staff members to the key processes and systems that are related to customer requirements and the provision of performance in products and services. For GE-6σ projects, some aggressive goals can be set in conjunction with rapid project completion times. The target performances can be set according to the criteria of the critical-to-quality (CTQ) of key process—which are, in turn, determined according to the voice of customers (VOC). In TQM, the improvements are based on a customer satisfaction survey and an understanding of customers' requirements in [55]. In this fashion, these two ways of understanding customers' needs and expectations can be combined. See Figure 3 for a depiction of the model.

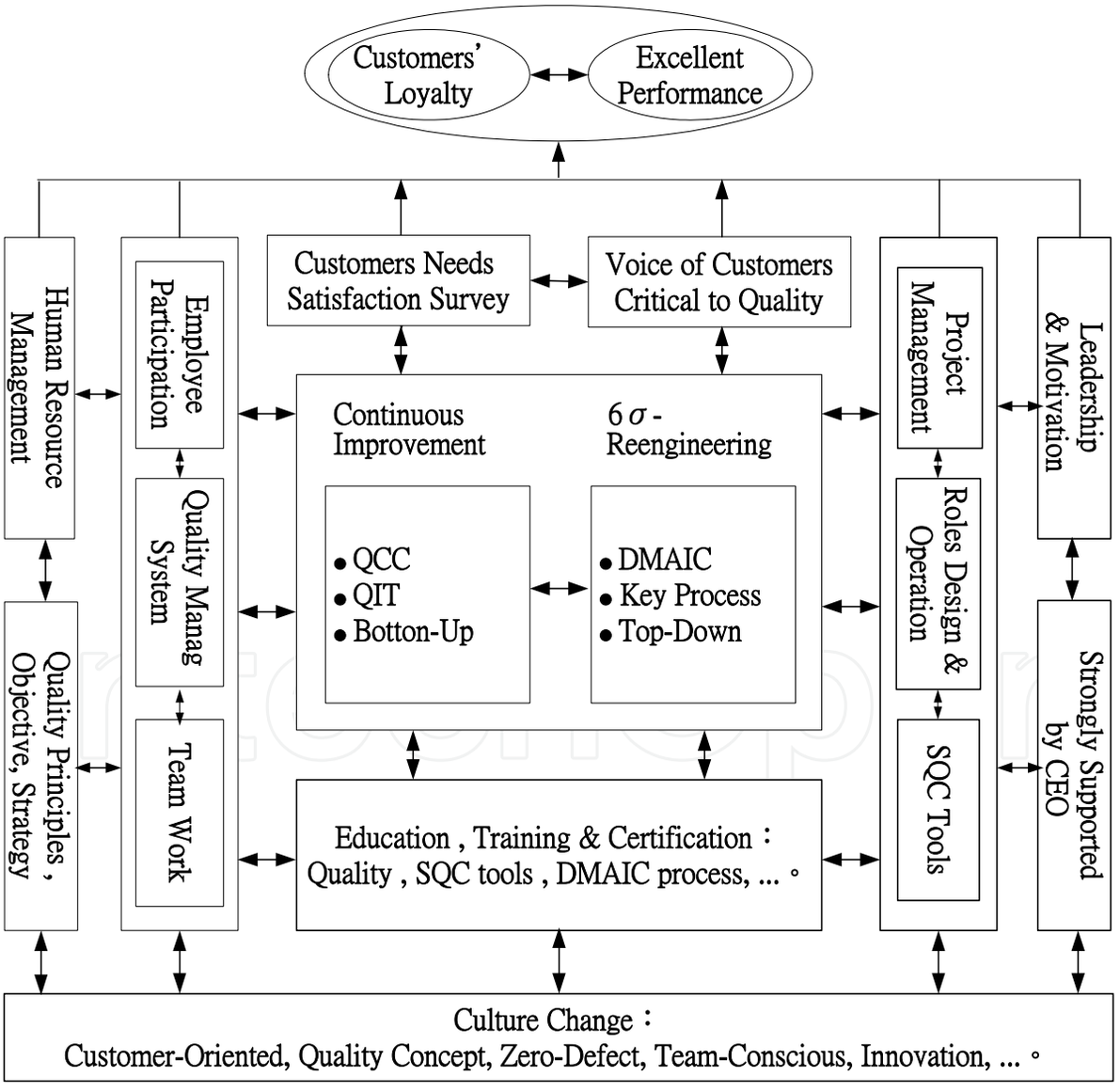

Figure 3. The integrated model of TQM and Six-Sigma program

It has been suggested that the implementation of TQM results in an over-emphasis on customer satisfaction, with a relative neglect of the pursuit of profits. Indeed, several empirical studies have asserted that implementing TQM might not achieve any significant positive effect on profitability in [56, 52, 41]. Furthermore, Harry (2000a) has noted that "What's good for the customer is not always good for the company" in [57]. In contrast, it is argued that GE-6σ achieves both customer satisfaction and excellent financial performance. The major problem with TQM is that there is a disconnection between management systems designed to measure customer satisfaction and those designed to measure business profitability, and this has often led to unwise investments in quality in [41]. It should be recognized that the objective of TQM is to achieve customer satisfaction in order to increase customer loyalty. To sustain competitiveness and long-term profitability, companies not only devote themselves to attracting new customers, but also to retaining old customers in a continuous business relationship with incremental additional purchasing. For these reasons, increasing customer loyalty should be one of the main concerns of all companies in [58]. Any assessment of the effectiveness of TQM thus requires a system to measure customer loyalty.

If a management system cannot raise business performance and profitability, it will obviously be abandoned by firms. It is therefore apparent that indicators of customer loyalty and business performance should be added to TQM measurement systems. It is well known that GE-6σ pursues both customer satisfaction and high profits. If an integrated model of TQM and GE-6σ were developed, synergistic effects could be anticipated. In the integrated model proposed here, two major indicators are included—customer loyalty and high profit performance.

7. The development of a business excellence system

In section 3 we discuss the evolution of quality management, and state that now is an age of pursuing business excellence. In this section, we will develop a more comprehensive model, called a 'Business Excellence System,' based on an integrated model of the TQM and Six-Sigma programs developed in the above section and referring to several related researches. We also provide an example case, which is a good company that won the Deming Award in 2011.

7.1. Malcolm Baldrige National Quality Award and European Quality Award

Several studies in [59-62, 29] have suggested their own holistically strategic management system or business excellence system. These holistically integrated models can be used in association with the frameworks of the Malcolm Baldrige National Quality Award (MBNQA) or the model of European Quality Award (EQA), see Figure 4 and Figure 5. MBNQA was initiated by the USA in 1987 and is a framework of seven constructs: leadership, strategic planning, customer and market focus, information and analysis, human resource development and management, process management, and business results in [9]. The first six constructs are the critical management systems; the successful implementation

of these systems will result in excellent business performances. Thus, MBNQA can be used to assess the performance of an organization, based on the realization of TQM and strategic management in [9].

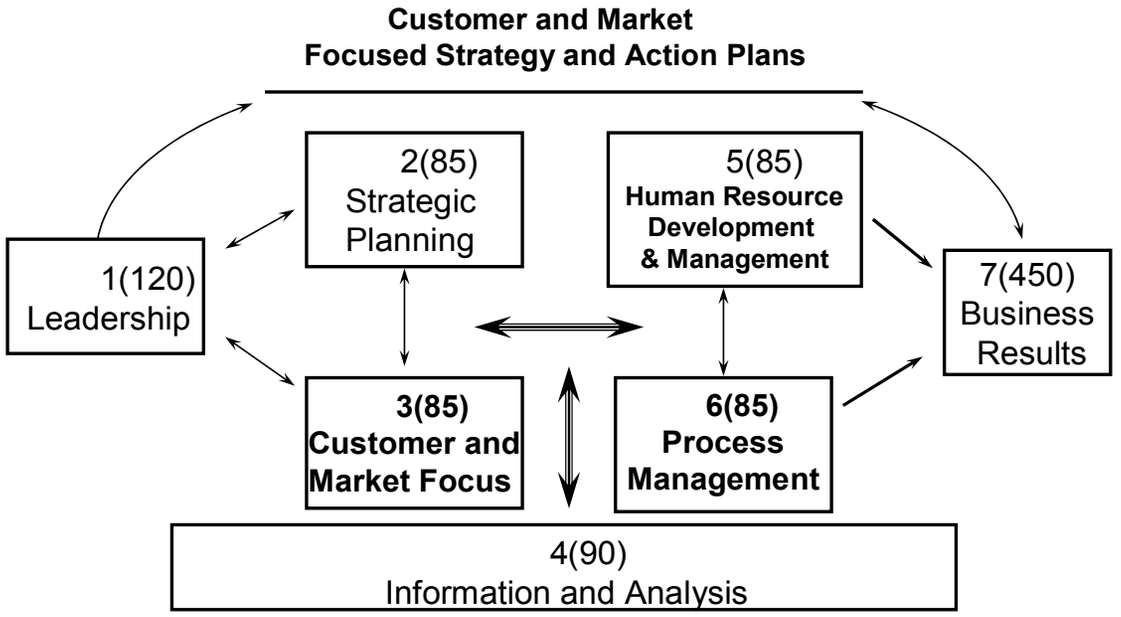

Figure 4. Framework of MBNQA

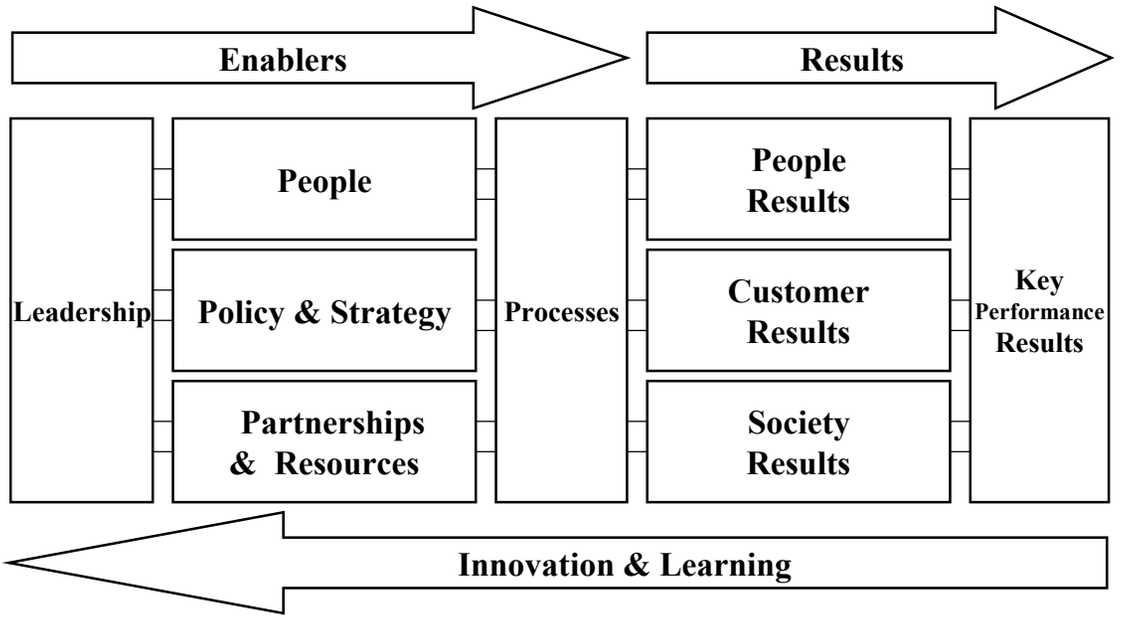

Figure 5. Framework of EQA

In 1992 European Foundation for Quality management (EFQM) launched the European Quality Award (EQA). EQA is a framework constituted by two parts: enablers and results in [9]. The enablers include the operation processes of leadership, people, police and strategy, and partnerships and resources, which are the means by which an organization can achieve

the key performance results: people results, customer results, and society results. It is recognized that the frameworks of the MBNQA and the EQA are based on the 'holistic TQM system' and the enablers, especially the strategic management systems in [63, 21], and that the key metrics of the MBNQA and EQA models can thus be used to assess how well a firm is implementing the TQM system and the total business performances. As a result, many countries developed their National Quality Awards based on the Japanese Deming Award, MBNQA and EQA models before developing their business excellence model.

7.2. Strategic map of enterprise's long-term development

In order to pursue long-term profitability and successful development, a firm needs to develop core competencies and capabilities and possess core competitiveness. Therefore we suggest a 'strategic map of enterprise's long-term development,' which describes how a firm operates its core competencies and capabilities to achieve its 'vision: customer loyalty, successful development, and long-term profitability.' It consists of four constructs, and each construct includes several key essentials. They are stated in the following.

1. Growth force

It includes the business performances that will result in huge contributions to the firm, For example, increasing market share, entering new markets, new business development, and raising profits. Therefore, the firms need to successfully implement an integrated performance management system which is constituted of strategy management, Hoshin management, and a balanced scorecard.

2. Core competitiveness

This construct consists of the business model, management systems, or strategic actions which will form the core competitiveness for the firm, such as leader of core (innovative) products, capturing the customers' needs, high quality customer service, development of specialized technologies, and core business development.

3. Critical drivers

How to heighten the core competitiveness? The firm needs to effectively execute the critical drivers to attain the competitive advantage. The critical drivers are top management leadership and support, human resource management, total quality management, customer relationship management, the development of core competencies and capabilities, implementation of an IT and knowledge management (KM) systems. The drivers are almost always included in the constructs of MBNQA or in the enablers of EQA.

4. Fundamental field

Fundamental field is the imperative resource which causes the firm to create the drivers. There are several critical ingredients of the fundamental field, which are realization of mission and value, innovative environment, investment in R&D, sufficient supporting systems, and a good organization culture.

These constructs and their involving items have a cause-and-effect relationship. The items of the 'fundamental field' construct will affect the development of the items in the 'drivers' construct. Effective implementation of the systems in the 'drivers' construct can result in advantage on the items in the 'core competitiveness' construct. As a result, the items in the 'growth force' construct will have the best performance. These relationships are manifested in Figure 6.

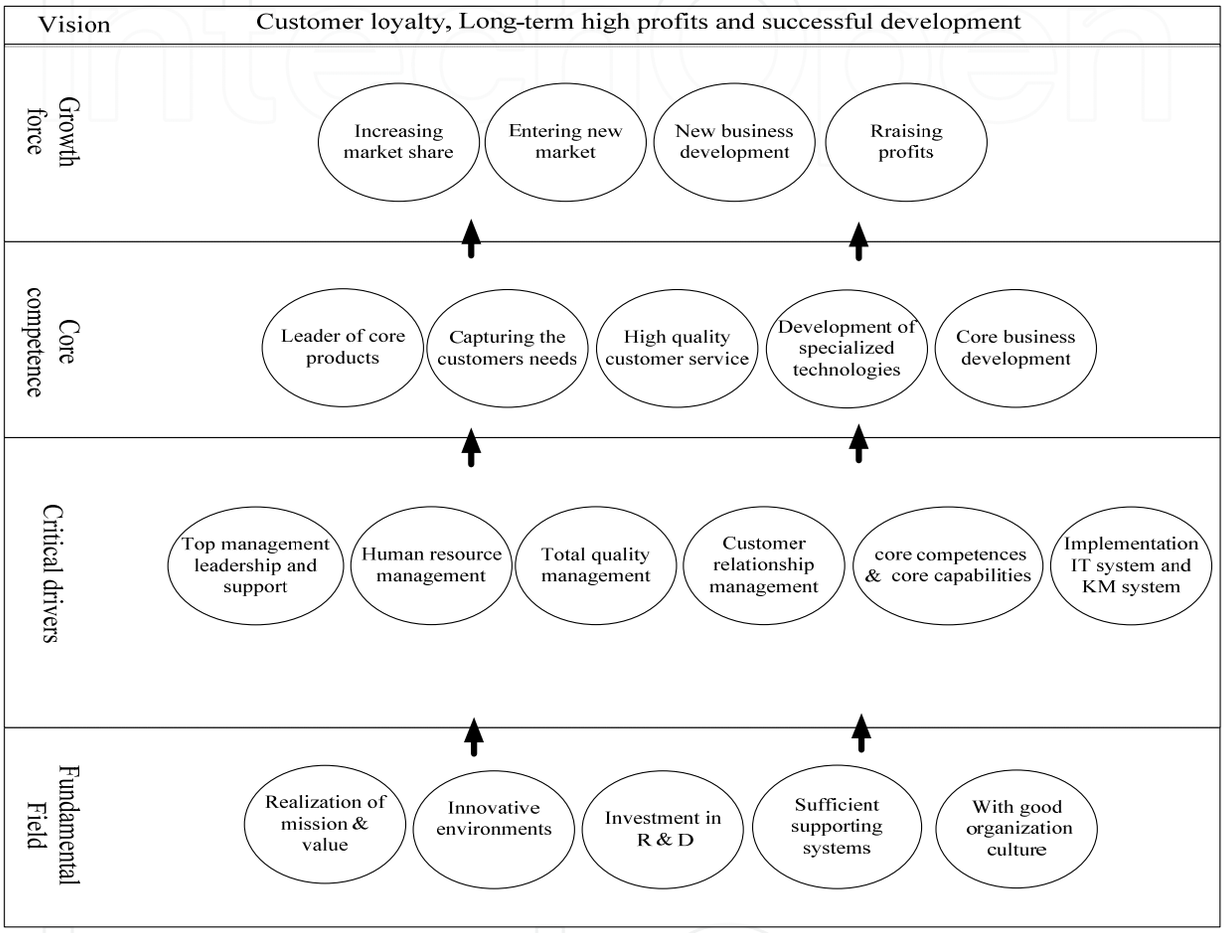

Figure 6. Strategic map of enterprise's long-term development

7.3. The integrated business excellence model

Basically, the business excellence system can be developed by combining 'the integrated model of TQM and the Six-Sigma program' and the 'strategic map of enterprise's long-term development' in [30]. In the integrated model of TQM and the Six-Sigma program, the critical activities are the improvement activities: QIT and QCC, and the Six-Sigma program, which are created by considering the voice of customers and their needs. In the integrated business excellence model, besides the improvement activities, development of core products is also the critical activity; its aim is to achieve the customers' latent needs and then delight the customers. In order to develop attractive and innovative products, the employees must have innovative concepts and lean thinking, then the products/services with attractive quality can be created; see the center part of Figure 7. The success of these

activities is based on the implementation of TQM and the application of IT system and KM system.

Besides these two critical drivers (see Figure 6), the implementation of HRM will train the employees with specialized talents and realize the management of 'empowerment.' The top management leadership and support will lead the realization of 'full participation' and 'team-work'; see the left part of Figure 7. The firms possessing the core competencies and capabilities will develop the core products/services, and then create the related core businesses. Successful implementation of customer relationship management can result in customer service with good quality; see the right part of Figure 7.

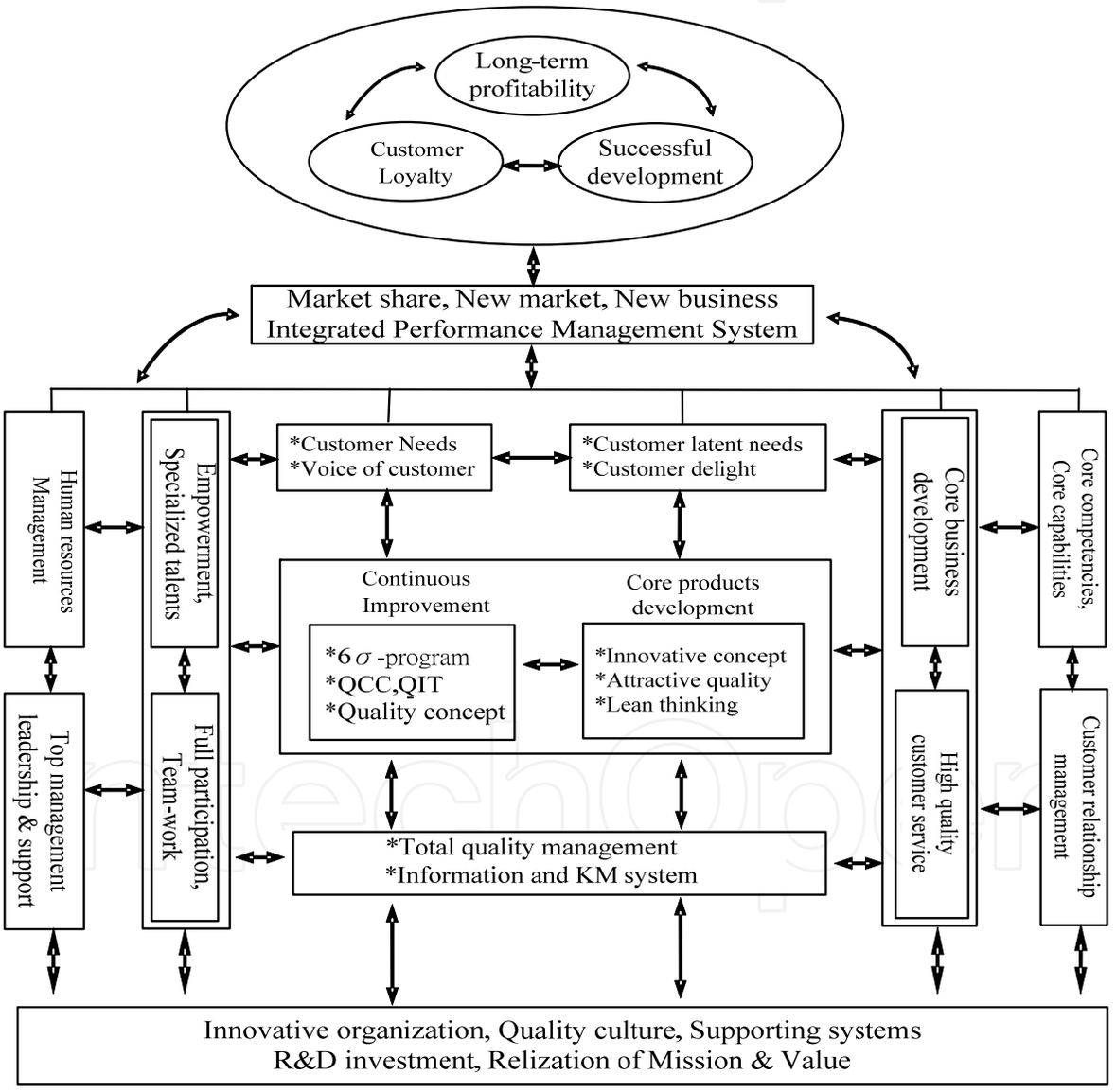

Figure 7. The integrated business excellence model

Drucker stated that the starting point both in theory and in practice may have to be "managing for performance" in [64]. The goal of an integrated business-excellence model is

to go beyond mere 'customer satisfaction' to achieve *customer loyalty* and *excellent performance*, which is represented as long-term development and profitability through the strategies of creating new business, raising market share, and entering the new market (see Figure 7). The management systems, programs, and practices of this integrated model are the tools that can be used to achieve this goal. However, an appropriate performance management system is needed to monitor and evaluate the performance generated by the implementation of this integrated business excellence system.

The performance management system was developed by integrating Hoshin management in [65] with strategic planning and balanced scorecard (BSC) in [66]. We first take the implementation model of strategic planning as its starting-point. Firms commonly perform a SWOT analysis and develop a vision, objectives, and strategies of the whole organization. Having established its vision, objectives, and strategies, the firm can then develop a strategy map and the key performance indicators (KPIs) according to the four perspectives of BSC. The firm can then use the methods of Hoshin management to deploy the organization's objectives and strategies and its resulting performance indicators to the departments or units. During the implementation process, they commonly conduct a quality audit according to Hoshin management to produce progress reviews and an annual review. The organizations thus use an integrated model of performance management to evaluate the performance of TQM in [66].

The success of the implementation of this integrated business excellence model is dependent on the realization of the fundamental principles and conditions, including innovative environment, quality culture, compete supporting systems, R&D investment, and the realization of mission and vision. The top management must bear the responsibility of the cultivation of these fundamental principles and conditions.

8. Case study

Unimicron Technology Corporation, which is located in Taoyuan, Taiwan, was established in 1990 and is the heart of the printed circuit board (PCB) industry in Taiwan. This is currently the top-ranked industry in Taiwan and has been the fifth ranked worldwide since 2003. The company thus invests heavily in leading-edge technologies and its products are in high demand from customers.

The senior management of Unimicron strongly emphasizes the implementation of total quality management (TQM). Management introduced TQM in 1996, at which time the company established a TQM committee which currently has four subcommittees: a Six-Sigma/QIT subcommittee, an education and training subcommittee, a QCC (Quality control circle) subcommittee, and a quality & standardization subcommittee. The company embarked on Hoshin management in 1998 and implemented Six-Sigma programs in 2001. In 2002, the company enhanced the element of strategic thinking in the Hoshin management system by introducing the management of strategic planning. With the increasing popularity of BSC around the world, Unimicron also initiated the implementation of BSC and a strategy map in 2003. Implementation of these systems simultaneously would have

caused significant problems for both management and staff. The company therefore integrated the systems, as shown in Figure 8. Unimicron called this integrated model the 'Excellent Policy Management Model.'

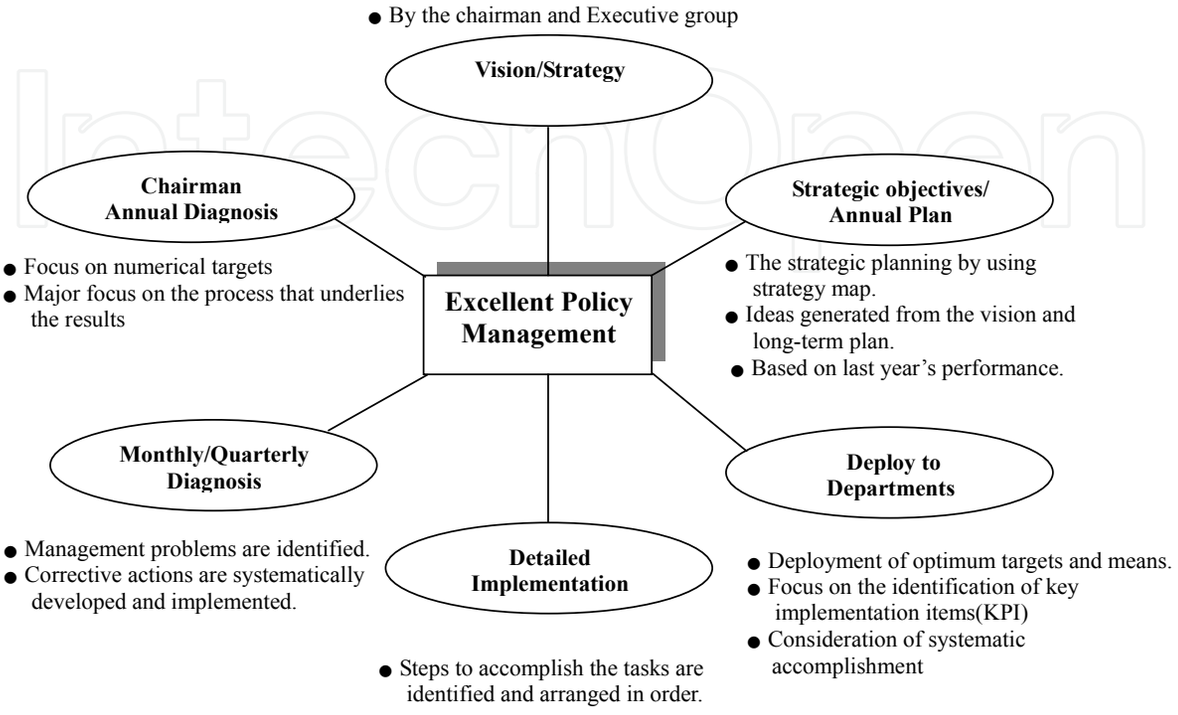

Figure 8. The integrated model 'Excellent Policy Management' adopted by Unimicron

The implementation principles of the 'excellent policy management' model were as follows:

1. PDCA cycle: integrating Deming's 'plan–do–check–act' language;
2. Focus: determining the direction and priorities of the organization's development;
3. Alignment: achieving consensus (regarding vision and strategy) with the employees who are likely to make a contribution;
4. Integration: integrating the 'excellent policy management system' with existing systems;
5. Review & diagnosis: using monthly/quarterly diagnosis to ensure that everyone is cooperating in the execution of strategic targets; and
6. Performance pursuit: ensuring desired performance through a focus on KPIs.

The company also developed a complete implementation model (see Figure 9).

Since Hoshin management was implemented in 1998, Unimicron has experienced strong growth in revenue, from US$0.18 billion in 1999 to US$ 33 billion in 2011. In the same period, profit increased from US$120 million in 1999 to US$3.5 billion in 2011. The company's worldwide ranking rose to No. 1 in 2009 (from No. 35 in 1999). These significant business successes have encouraged Unimicron to implement its 'excellent policy management' model even more comprehensively and thoroughly.

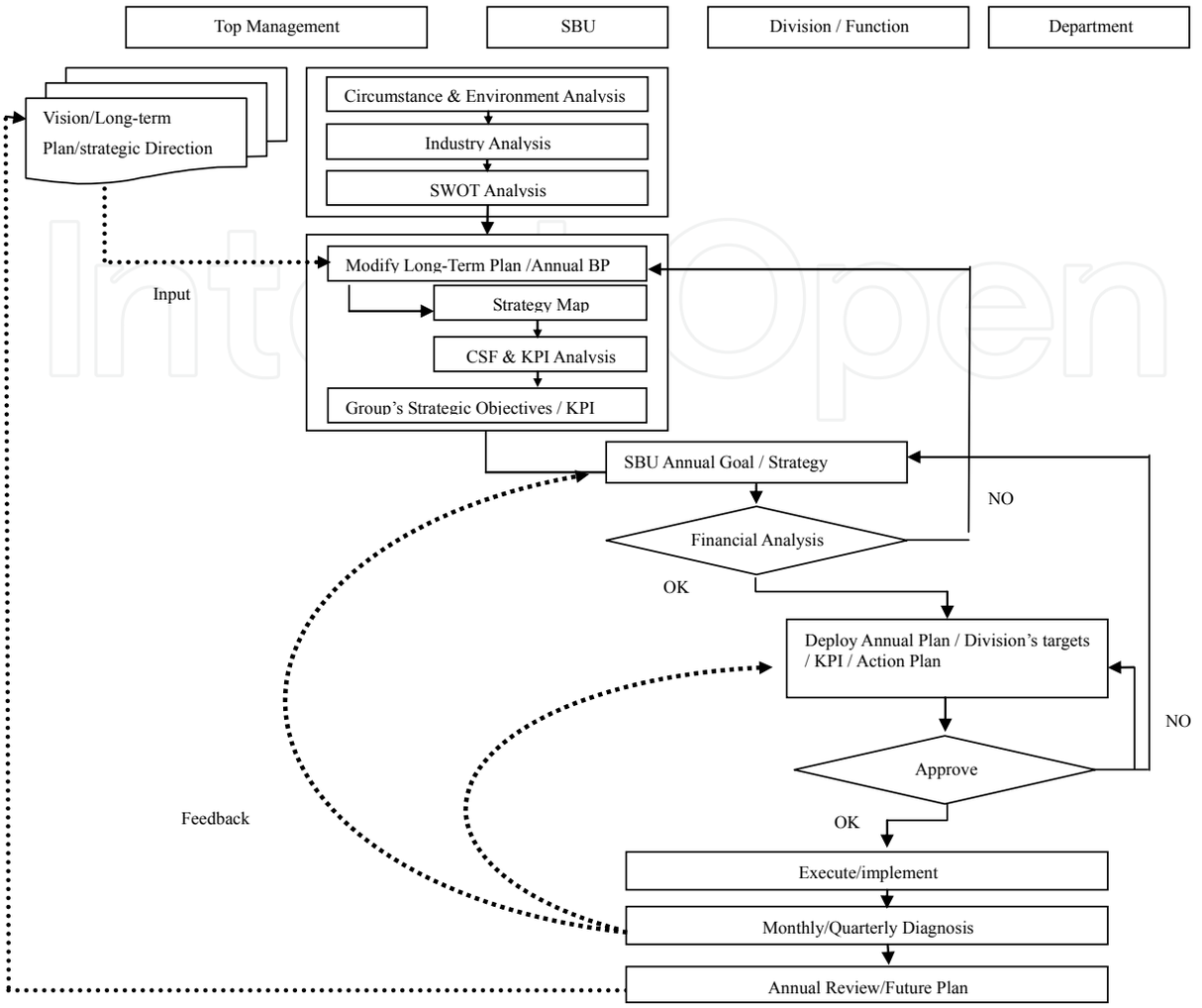

Figure 9. The implementation model of 'Excellent Policy Management' used by Unimicron

Since the business performances are very excellent in recent years, Unimicron applied for the National Quality Award in Taiwan for first time in 2006 and successfully won.

Therefore, Unimicron decided to apply for the Deming Award in 2007. It organized several committees and designed a complete schedule for the preparation. Unimicron aggressively utilized employee participation and team-work. All the employees paid more attention to the top objectives required to win the Deming Award. During the preparation period, they realized the 'Excellent Policy Management' system, effectively implemented quality audits, and took improvement actions immediately. Eventually, Unimicron won the Deming Award in October, 2011.

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9. References

[1] Edvards, C. D., The meaning of quality. Quality Progress 1968; 36-39.

[2] Juran, J. M., Quality Control Handbook 3rd ed. New York: McGraw-Hill; 1974.

[3] Crosby, P., Quality is Free: The Art of Making Quality Certain. New York: McGraw-Hill; 1979.

[4] Shetty, Y. K., & Ross, Joel E., Quality and its management in service business. Industrial Management 1985; 27(6) 7-12.

[5] Douthu, Naven, Quality control in services industry. Journal of Professional Services Marketing 1991; 7(1) 31-55.

[6] Edvardsson, B., Quality in new service development: Key concepts and a frame of reference. International Journal of Production Economics 1997; 52 31-46.

[7] Schvaneveldt, Shane J., Edkawa, Takan, & Miyakawa, Nasami, Customer evaluation perspectives and service quality: Evaluation factors and two-way model of quality. Total Quality Management 1991; 2(2) 149-161.

[8] Deming, W. E., Out of the Crisis, MIT Center for Advanced Engineering study. MA: Cambridge; 1986.

[9] Oakland, John S., Total Quality Management, Second edition. Jordan Hill, Oxford: Butterworth-Heinemann; 2000.

[10] Rao, Ashok, Carr, Lawrence P., Dambolena, Ismael, Kopp, Robert J., Martin, John, Rafii, Farshad, & Schlesinger, Phyllis Fineman, Total Quality Management: A Cross Functional Perspective. New York: John Wiley & Sons; 1996.

[11] Mitra, Amitava, Fundamentals of Quality Control and Improvement Second edition. London: Prentice-Hall International (UK) Limited; 1998.

[12] Dotchin, John A., & Oakland, John S., Theories and concepts in total quality management. Total Quality Management 1992; 3(2) 133-145.

[13] Powell, T. C., Total Quality Management as Competitive Advantage: A Review and Empirical Study. Strategic Management Journal 1995; 16 15-37.

[14] Elshennawy, Ahmad K., Maytubby, Venetta J., & Aly, Nael A., Concepts and attributes of total quality management. Total Quality Management 1991; 2(1) 75-97.

[15] Yang, Ching-Chow, An integrated model of TQM and Six-Sigma. International Journal of Six Sigma and Competitive Advantage 2004; 1(1) 97-111.

[16] Sila, I. & Ebrahimpour, M., An investigation of the total quality management survey based on research published between 1989 and 2000. Journal of Quality and Reliability International 2002; 19(6&7) 902-970.

[17] Pande, P. S. Neuman R. P. & Cavanach R. R., The Six Sigma Way. New York: McGraw-Hill; 2000.

[18] Gates, Bill, Business @ the Speed of Thought: Using a Digital Nervous System. New York: Warner Books Inc.1109; 1999.

[19] Martin, Chuck, Get Future. New York: McGraw-Hill Inc.; 1999.

[20] Ohmae, Kenichi, The Next Global Stage: Challenges and Opportunities in Our Borderless World. New Jersey: Wharton School Publishing; 2005.

[21] Tan, Kay C., Wong, Mei F., Mehta, Teena, & Khoo, Hsien H., Factors affecting the development of national quality awards. Measuring Business Excellence 2003; 7(3) 37-45.
[22] Petts, Nigel, Building growth on core competencies – a practical approach. Long Range Planning 1997; 30(4) 551-561.
[23] Prahalad, C. K., & Hamel, Gary, The core competence of the corporation. Harvard Business Review 1990; 68(May/June) 79-91.
[24] Clark, Delwyn N., Implementation issues in core competence strategy making. Strategic Change 2000; 9(Mar-Apr) 115-127.
[25] Almer, Tamar, & Hashai, Niron, The competitive advantage and strategic configuration of knowledge-intensive, small- and medium-sized multinationals; A modified resource-based view. Journal of International Management 2004; 10(4) 479-500.
[26] Laurie, Donald L., Doz, Yves L., & Sheer, Claude P., Creating new growth platforms. Harvard Business Review 2006; 84(May) 80-90.
[27] Zook, Chris, Finding your next core business. Harvard Business Review 2007; 85(April) 67-75.
[28] Kanji, Gopal L., Measurement of business excellence. Total Quality Management 1998; 9(7) 633-643.
[29] Kanji, Gopal K. & SÂ, Particia Moura E., Measuring leadership excellence. Total Quality Management 2001; 12(6) 701-718.
[30] Yang, Ching-Chow, Development of an Integrated model of a business excellence system. Total Quality Management and Business Excellence 2011; 22(1-2) 22
[31] Boaden, R. J., What is total quality management…and does it matter? Total Quality Management 1997; 8(4) 153-171.
[32] Juran, J. M. & Gryna, frank M., Quality Planning and Analysis Third edition. New York: Mcgraw-Hill Inc.; 1993.
[33] Yang, Ching Chow, Quality is the Best Strategy in Competition. Taiwan: APEX International Management Consulting Co.; 1997.
[34] Sureshchandar, G. S., Rajendran C. & Anantharaman, R. N., A Conceptual Model for Total Quality Management in Service Organization. Total Quality Management 2001; 12(3) 341-363.
[35] Barney, Jay, Firm resources and sustained competitive advantage. Journal of Management 1991;17(1) 99-120.
[36] Harry, M. J. & Schroeder, R., Six Sigma: The Breakthrough Management Strategy Revolutionizing the Worlds' Top Corporations. New York: Doubleday; 2000.
[37] Klefsjö, Bengt, Wiklund, Häkan, & Edgeman, Rick L., Six Sigma seen as a methodology for total quality management. Measuring Business Excellence 2001; 5(3) 31-35.
[38] Slater, Robert (2001), Get Better or Get Beaten! New York: McGraw-Hill; 2001.
[39] Deming, W. E., The New Economics, for Industry, Government, Education. Cambridge, MA: Massachusetts Institute of Technology; 2001.
[40] Henderson, K. M., & Evans, J. R., Successful implementation of Six Sigma: Benchmarking General Electric company. Benchmarking: An International Journal 2000; 7(4) 260-281.

[41] Breyfogle III, Forrest W., Cupello, James M., & Meadows, Becki, Managing Six Sigma. New York: John Wiley & Sons Inc; 2001.
[42] Treichler, David, Carmichael, Ronald, Kusmanoff, Antone, Lewis, John & Berthiez , Gwendolyn, Design for Six Sigma: 15 Lessons Learned. Quality Progress 2002; January 33-42.
[43] Sandholm, L., & Sorqvist, L., 12 requirements for Six Sigma success. Six Sigma Forum Magazine 2002; 2(1) 17-22.
[44] Coronado, Richardo Banuelas, & Antony, Jiju, Critical success factors for the successful implementation of Six Sigma projects in organizations. The TQM Magazine 2002; 14(2) 92-99.
[45] Antony, Jiju, & Banuelas, Richardo, Key ingredients for the effective implementation of Six Sigma program. Measuring Business Excellence 2002; 6(4) 20-27.
[46] Yun, Jong-Yong, & Chua, Richard C. H., Samsung uses Six Sigma to change its image. Six Sigma Forum Magazine 2002; 2(1) 13-16.
[47] Yang, King-Jang, Yeh, Tsu-Ming, Pai, Fan-Yun, & Yang, Ching-Chow, The analysis of the implementation status of Six Sigma: an empirical study in Taiwan. International Journal of Six Sigma and Competitive Advantage 2008; 4(1) 60-80.
[48] Hubiak, W. A. & O'Donnell, S. J., Do Americans have their minds set against TQM?(Abstract). National Productivity Review 1996; 15 19-20.
[49] Hellsten, Ulrike & Klefsjö, Bengt, TQM as a management system consisting of values, techniques and tools. The TQM Magazine, 2000; 12(4) 238-244.
[50] Hansson, Johas & Klefsjö, Bengt, A core value model for implementing total quality management in small organizations. The TQM Magazine 2003; 15(2) 71-81.
[51] Lucas, James M, The essential Six Sigma. Quality Progress 2002; January 27-31.
[52] Harry, Mikel J., A new definition aims to connect quality performance with financial performance. Quality Progress 2000; 33(1) 64-66.
[53] Hermel, Philippe, The new faces of total quality in Europe and the US. Total Quality Management 1997; 8(4) 131-143.
[54] Goh, T. N., A strategic assessment of six sigma. Quality and Reliability Engineering International 2002; 18 403-410.
[55] Yang, Ching Chow, Improvement actions based on the customers' satisfaction survey. TQM and Business Excellent 2003; 14(2) 919-930.
[56] Bergquist, Timothy M. & Ramsing, Kenneth D., Measuring performance after meeting award criteria: Study compares perceived success to financial data of award winners and applicants. Quality Progress 1999; 32(9) 66-72.
[57] Harry, Mikel J., The quality twilight zone. Quality Progress 2000; 33(2) 68-71.
[58] Gorst, J., Kanji, G., & Wallage, W., Providing customer satisfaction. Total Quality Management 1998; 9(4 & 5) 100-103.
[59] Ortiz, Angel, Lario, Francisco, & Ros, Lorenzo, Enterprise integration – business processes integrated management: A proposal for a methodology to develop enterprise integration programs. Computers in Industry, 1999; 40 155-171.
[60] Kaplan, R. S. & Norton, D. P., The balanced scorecard-measures that drive performance. Harvard Business Review 1992; January-February 71-79.

[61] Kaplan, R. S. & Norton, D. P., The Balanced Scorecard: Translating strategy into action. Boston, MS: Harvard Business School Press; 1996.
[62] Kaplan, R. S. & Norton, D. P., Transforming the balanced scorecard from performance measurement to strategic management: Part I. Accounting Horizons 2001; 15(1) 87-104.
[63] Puay, S. H., Tan, K. C., Xie, M., & Goh, T. N., A comparative study of nine national quality awards. The TQM Magazine 1998; 10(1) 30-39.
[64] Drucker, Peter F., Management Challenges for the 21st Century. New York: Harper Collins Publishers Inc.; 1999.
[65] Yang, Ching-Chow, Hoshin Management. Taiwan: Chinese Quality Management Society; 1995.
[66] Yang, Ching-Chow, An integrated Implementation model of strategic planning, BSC, and Hoshin managemen. Total Quality Management and Business Excellence 2011; 22(1-2) 22
[67] Kondo, Yoshio, Hoshin Kanri – A participative way of quality management in Japan. The TQM Magazine 1998; 10(6) 425-432.