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DEVELOPMENT OF AN EFFECTIVE SIX SIGMA IMPLEMENTATION MODEL FOR APPAREL INDUSTRY IN CHINA

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Development of an Effective Six Sigma Implementation Model for Apparel Industry in China

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Abstract

The 1970s to 1990s mark the rapid development of various quality tools and techniques. These revolutionary quality development helps enterprises from all sectors enhance their operational efficiency and quality standard. In the meanwhile, the improved product and service performance leads to better fulfillment in customers' ever-increasing quality expectation and requirements. Among these quality tools and techniques, Six Sigma gradually becomes a popular quality management approach in most manufacturing sectors. Six Sigma is both a business strategy and a systematic quality management methodology that was first introduced at Motorola in 1987. The purpose of Six Sigma is to reduce cost by minimizing the variability in the processes (Näslund, 2008), with the aim to reduce the number of defects to as low as 3.4 parts per million opportunities (Antony and Banuelas, 2002). The organizations that have adopted Six Sigma declare that Six Sigma helps focus on increasing the wealth of the shareholders by improving bottom-line results and achieving high quality products and services (Saadat and Antony, 2007). More importantly, it helps improve the process by eliminating root causes, and controlling the process to make sure defects do not reappear (Pyzdek and Keller, 2003).

Since Motorola introduced Six Sigma, other companies such as Texas Instruments, Allied Signal (or Honeywell today), General Electric, Sony, Fuji Xerox, etc. have claimed great savings as a result of the implementation of Six Sigma projects. The application of Six Sigma in fast-clock speed industries (Fine, 1998), such as electronics and fashion industries, are particularly important. These fast-clock

speed industries have quick design generation, wide variety of styles in small quantity and labor-intensive production environment, and thus benefit most from quality improvement initiatives. This explains why Six Sigma has started to penetrate in textile and apparel industry in the past decade.

Apparel manufacturers in China are also showing growing trend of making higher value products with new technologies. This trend is particularly important when the manufactures in China are facing fierce competition in the lower-end market from the ASEAN countries (e.g. Vietnam, Bangladesh). Thus, an effective Six Sigma implementation can help China factories in apparel supply chain maintain their competitive advantage over their respective competitors.

Based on a set of traditional critical factors for successful Six Sigma implementation, this study investigates how the identified Six Sigma implementation elements (3 major elements) and factors (11 critical success factors) affect the major anticipated favorite outcomes (4 desired implementation outcomes) of Six Sigma. According to the data collected from the apparel industry in developing county (i.e., China), being a research context that was uncovered in the literature, it is found that top management's intention and commitment have significant positive impact on continuous improvement, customer and employee satisfaction upon Six Sigma implementation. Another implementation element - organizational ability in adopting Six Sigma approach is the most critical aspect for the whole process. It is because it affects all the outcomes of Six Sigma implementation, such as cost and efficiency, and product and service quality. It is also found in this study that top management ability in

Six Sigma is not as important as their intention and commitment. It is noticed that their ability have no influence on all outcomes. As a result it may suggest that the findings of this study are also applicable to most fast-clock speed industries, which share similar characteristics as the apparel supply chain.

This research of the implementation elements and critical success factors for effective implementation of Six Sigma approach for apparel industry not only could provide managerial implications for other apparel manufacturers, but also other manufacturers in fast-clock speed industries. The implementation model therefore established for Six Sigma approach is useful in providing guidance for its effective implementation for fast fashion business model of both manufacturing and servicing industry in the future.

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List of Abbreviations

CSFs – Critical Success Factors

DMAIC – Define – Measure – Analyze – Improve - Control

QMS – Quality Management System

SME – Small and Medium-sized Enterprises

TQM – Total Quality Management

Chapter One – Introduction

1.1 Background

The quality revolution of the past three decades has evolved from its origin of mass production quality control, through the various stages of quality assurance, TQM, business excellence, continuous improvement and, latterly, Six Sigma (Armitage and Keeble-Allen, 2007). In recent years the application of Six Sigma has gained much interest. Six Sigma has written an incomparable success story over the last two decades. Being originated from Motorola in the 1980s, Six Sigma was especially publicized by Jack Welch, the CEO of General Electric (GE) who has established it successfully since 1995. GE is one of the most successful companies in implementing Six Sigma projects. In one of its annual reports in early 2000s, more than a billion dollars were spent in the necessary project resources, as well as in the advanced training of employees in the past years. Nevertheless, an enormous profit in the billion dollar range could be achieved annually (Topfer, 2002). A number of publications introducing this success story have set the basis for the popularity of Six Sigma. It has then been developed as a popular approach in many organizations today to drive out variability and reduce waste in processes using powerful statistical tools and techniques.

The success in GE has motivated many well-known organizations throughout the world, such as Siemens, Nokia, Volvo, Ford, Citibank, ABB, American Express, Bank of America, JPMorgan Chase and so on, to adopt Six Sigma. They have all subsequently realized millions of dollars of value for their customers and

shareholders. Many organizations worldwide (manufacturing companies, service-oriented companies, small and medium-sized enterprises, etc.) have implemented Six Sigma and achieved remarkable improvements in their market share, customer satisfaction, product reliability, service quality, etc. with impressive financial savings (Harry and Schroeder, 2005).

Despite its popularity, if you ask users what Six Sigma means, you will find different opinions. Some often mention that Six Sigma is the "modern form of quality management". Others consider that Six Sigma can both be a business strategy and a science that has the aim of reducing manufacturing and service costs, and creating significant improvements in customer satisfaction and bottom-line savings through combining statistical and business process methodologies into an integrated model of process, product and service improvement. However, Six Sigma methodology has been widely criticized as difficult to implement, not easy to incorporate into existing QMS. Thomas and Barton (2006) commented that effective implementation of Six Sigma strategy within the manufacturing industries, in particular the SMEs, can be considered to be poor. They emphasized the factors of high costs and complexity of implementation as being the major barriers to its widespread use. "It appears that the majority of SMEs either do not know the Six Sigma approach, or find its organization not suitable to meet their specific requirements", pointed out by Wessel and Burcher (2004). As such, Six Sigma seems to be suitable only for giant organizations where ample resources available for its implementation.

While there are many different pros and cons for Six Sigma approach, a

well-structured generic management model providing guideline on Six Sigma implementation is therefore of utmost needed. As China is becoming an important supplier of products to the global market, it is necessary to understand how product quality is controlled and managed in China (Zu et al., 2011). Further to this, the effectiveness of Six Sigma implementation in China, the world factory, may have critical impact on quality evolution on the global arena. While there have been numerous studies on quality management implementation in China, more research is needed to understand how to build an effective quality management model at companies in China (Zu et al., 2011). Today, the strategic implications of quality and quality management practices are gaining recognition from all over the world (Ahire et al., 1995; Ahire et al., 1996; Dean and Bowen, 1994; Obert and Spencer, 1996). Quality is a key competitive weapon in the marketplace (Lee and Zhou, 2000). As mentioned by Romano and Vinelli (2001), the quality issue is particularly relevant in the textile apparel industry. This is a sector where quality is one of the key competitive factors (Romano and Vinelli, 2001).

Despite the rapid development of quality technique and tools in the entire manufacturing industry in the past few decades, the general application of quality assurance concept in apparel business still stays behind the macro environment. It is noticed that except those multi-national or giant organizations, most apparel and apparel-related business seldom adopt or implement formalized quality management practice in the companies. The management approach in the apparel industry retains in similar style as few decades ago. The application of modernized management system or technique like ISO 9001 quality assurance

system and quality control tool is rare in this field. Managerial staff of this industry are generally promoted from operational level that they are normally not well trained for nowadays' management concept and technique. This causes the adoption and development of advanced quality tools in apparel sector is behind the overall industrial status. Although there seems a gradual change of the apparel business that more of its organizations have applied more sophisticated quality management technique over past decade, the overall upgrading pace in this industry is still slow. In the new competitive situation that has been developing within the sector, quality can no longer be considered the preserve of high fashion or expensive clothing, but must be a feature of all market segments and meet the specific requirements and tastes of all types of customers (Romano and Vinelli, 2001; Forza and Vinelli, 1996; Itex, 1997).

In view of the above-mentioned situation, this research is therefore to develop an effective implementation model for Six Sigma that can be conveniently adopted by user organizations, especially for those China apparel enterprises, on their quality improvement journey and meanwhile appropriately applying Six Sigma methodology. The model is capable of identifying the readiness of an organization for Six Sigma adoption and, more importantly, serves to provide a guideline for its optimal application solution in achieving its desired implementation outcomes.

1.2 Aims and Objectives

There has been a lot of interest in Six Sigma approach in recent decade. Within

an organization chief executive officer or managing director are hearing about the monetary rewards that other companies have achieved through Six Sigma implementation and are thus eager to enjoy the similar benefits. There are many genuine successes but, as with all quality bandwagons, also a lot of hype. It goes without doubt that the decision for Six Sigma implementation needs to be evaluated as carefully and objectively as possible, and the top management probably needs to prepare for full commitment of its adoption in order to ensure it is a worthwhile project.

A major issue here is the apparently high entry cost of Six Sigma adoption, while another issue to successful implementation of Six Sigma goes to the huge investment in human and time resources. The potential long-term value of Six Sigma is enormous, both in terms of customer satisfaction and cost reduction. Most important of all, there is a lack of generally accepted implementation model for Six Sigma approach.

The objectives of this research are:

a. To study current Six Sigma development, its challenges and CSFs for its effective implementation, especially for organizations in China;

b. To investigate the major implementation elements and success factors affecting apparel organizations in China to effectively implement Six Sigma; and

c. To develop an effective Six Sigma implementation model for apparel industry in China.

1.3 Scope of Study

1.3.1 Target Area

Six Sigma has been one of the main quality improvement approaches since its inception by Motorola in 1987. Many scholars and consulting experts have discussed the CSFs of implementing Six Sigma management, but most of them are based on related theories or qualitative analyses (Ma et al., 2008). In addition, there is a number of research studies focused in reviewing the launch and implementation status of Six Sigma approach in various overseas countries except China.

As China is becoming an important supplier of products to the global market, it is anticipated there is increasing interest for how product quality is controlled and managed in China. As a result of China's rapid growth and integration into the global economy, research on business issues in China, particularly those related to production and operations management, is becoming increasingly important to the business and academic world (Jiang et al., 2007; Zhao et al., 2007). This research study will therefore focus on investigating the underlying success factors for Six Sigma implementation in China and that how this approach can be effectively implemented for China enterprises.

1.3.2 Target Industry

Motorola was the first company to launch a Six Sigma program in the mid-1980s (Rancour and McCracken, 2000). In 1988, Motorola received the Malcolm Baldrige National Quality Award, which led to an increased interest of Six Sigma in other organizations, see Pyzdek (2001). Today, a number of global organizations have developed Six Sigma programs of their own and Six Sigma is now established in almost every industry. Apparel industry is selected as the target field of investigation because of its special industrial nature and there is only a few academic study or business research in this field over years, particularly for its implementation status in China.

Textiles and apparel is a major sector for both the industrialized and the lesser developed economies, contributing both to wealth generation and employment (Margaret et al., 2004). This is especially the case for current situation in China. The apparel industry is highly diverse and heterogeneous. In addition, the apparel industry is characterized by a number of factors, namely a trend for short lifecycle, high volatility, low predictability, and high impulse purchase (Fernie and Sparks, 1998). As Margaret (2004) mentioned the sector has extremely low profit margin so that producing and even holding small quantities of stock is not commonly a viable option. Therefore companies in the sector have to produce products rapidly to fulfil these orders. Six Sigma approach may be the best possible strategy for adoption by these companies as quality management. This research targets at identifying a proper implementation model for adopting Six

Sigma in meeting the unique need of the apparel industry.

1.4 Methodology

This study adopts a number of previous research outcomes and analysis methodologies for developing the survey questionnaire, conducting the mass survey and performing the subsequent data analysis. This section gives a brief review of the methodologies used in this process, with full explanation provided in Chapter Four.

Following the literature review and past research study on quality management and Six Sigma, the research model and related propositions are established. Based on these initial works and review on current Six Sigma application situation for apparel industry in China, a survey questionnaire is designed. The questionnaire covers general Six Sigma implementation elements and the most widely addressed CSFs for effective Six Sigma implementation for apparel industry in China as advocated in previous literature and research.

Focus group discussion was then arranged with quality management and Six Sigma consultants/ experts in order to gather their comments and suggestions for the proposed research model and the draft survey questionnaire.

Following the focus group discussion, the questionnaire was revised to fit for the research approach and mass survey purpose. An industry survey targeting at apparel and apparel-related industry in China was conducted in the first half of

2014. There were 10 organizations participated in the survey and a total of 160 completed questionnaires were collected for conducting data analysis and investigation.

Several statistical analysis methods were performed afterward. The collected data was used for confirming tests including factor analysis and reliability testing. After the Six Sigma implementation elements and CSFs are confirmed on their categorizations and reliability, regression model analysis was employed to predict and confirm the correlation of the propositions in the research model. The hypotheses were tested to understand their significance and influence to the desired implementation outcomes of Six Sigma approach. Based on the findings in the survey and data analysis, the implementation model of Six Sigma for apparel industry in China is confirmed and finalized.

An illustration of the summarized research flowchart is given in Figure 1-1 below.

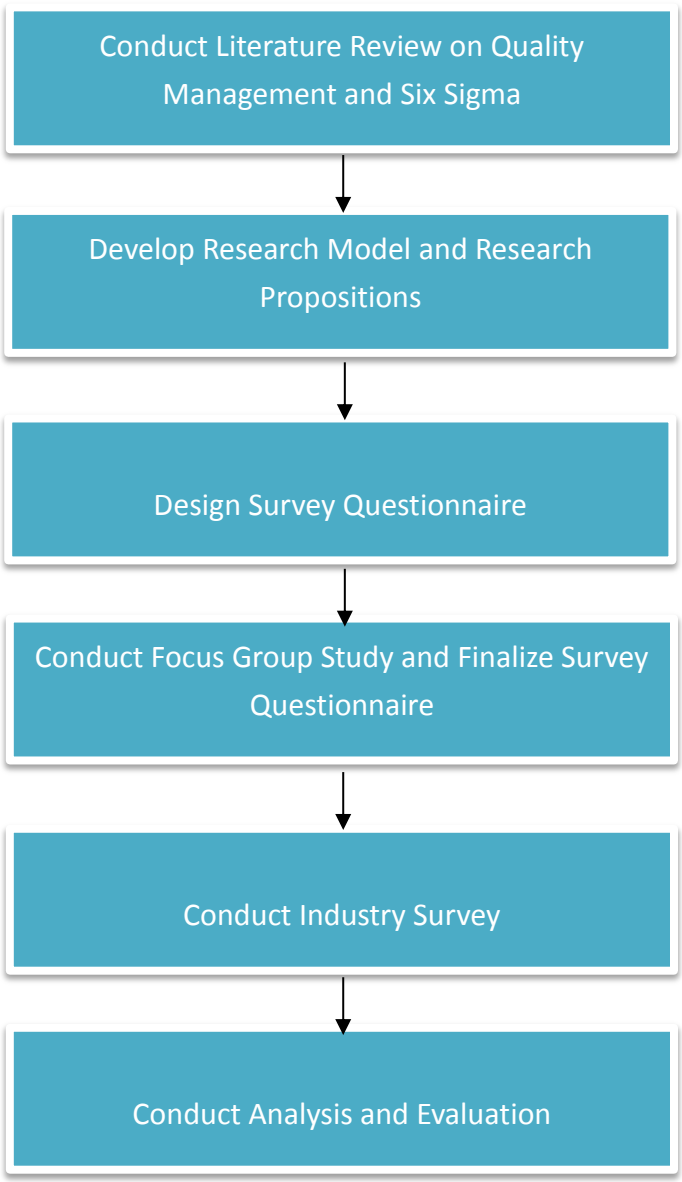


Figure 1-1: Summarized Research Flowchart

1.5 Significance of This Study

Implementing Six Sigma has been a great success to many organizations. However, people also expressed difficulties in launching it within company, or some are not able to earn relevant benefits as mentioned by others. People have expressed the keen desire for a formal study that will help management execute Six Sigma strategy and guide them through the process.

From a theoretical point of view, this project takes a pioneering role in exploring a management model for Six Sigma implementation for an organization, starting from its readiness self-assessment stage to project implementation and lastly on its overall implementation outcome evaluation. In the past, there are abundant studies for describing what Six Sigma is and what its key success factors for implementation are. Nevertheless, there seems to have no research study for analyzing and developing a management model for effective implementation of Six Sigma projects, nor a comprehensive review of the key success factors in correlation to that of its implementation outcomes.

Moreover, the research is also the first study that investigates the Six Sigma application in apparel industry in China. There are studies regarding the launch and development of Six Sigma in China. In addition, some research had investigated the Six Sigma implementation status in China, and how successful it is. Nevertheless, there is no comprehensive study about Six Sigma approach adopted in apparel enterprises, an industry that is considered to be a major industrial sector in China economy. Therefore, this research is intended to

initiate a study in this area and set up a platform for further discussion in the future.

From academic point of view, this research will also be a step forward in creating an implementation model for facilitating Six Sigma application in China. There are plenty of studies relating to quality management, lean manufacturing and Six Sigma implementation in the industry. Vast discussions and analysis of the relationship among these management approaches were carried out over past years. Although the theories and principles of these quality improvement strategies are well interpreted, little research has been conducted to generate a Six Sigma implementation model to serve as a guideline for companies, especially for apparel industry in China, as a foundation for adopting and applying Six Sigma approach. Thus, this study can serve as a starting base for building up such a model platform for future research and furthering related study.

1.6 Thesis Outline

The purpose of this paper is to develop an implementation model for Six Sigma for apparel industry in China. Six Sigma is not a new topic but is seldom discussed its proper approach for effective implementation in China. This thesis is organized in a six-chapter format to state how this thesis objective is to be achieved.

Chapter One provides background information on the evolution of quality and Six Sigma concept, how it becomes popular in the industry and the need for

developing a proper model for the sake of its effective implementation. It also formalizes the basic intents of the thesis's aims and objectives. Scope of study is stated and brief introduction to the methodology adopted is given in this chapter. Based on previous researches and studies, the highlights of significance of this study are justified and a thesis outline is presented at the end of this chapter.

Chapter Two reviews the relevant literature concerning Six Sigma and its application status. Pertinent prior reviews on its implementation effectiveness and shortcomings are addressed as foundation for initiating the needs for this study. As a result of studying literature and review of previous papers relating to Six Sigma approach, a number of research propositions are therefore developed in subsequent chapters that lead to implementation model development at the latter part of the study.

Chapter Three discusses the research model design and elaborates the various models contributing to the effectiveness implementation of Six Sigma program. Key elements, factors and the overall implementation outcomes of Six Sigma are presented among the models and related hypotheses are set up for further analysis and confirmation.

Chapter Four reviews and justifies the research methodology and data analysis techniques used in this study. This review includes an explanation of the research method outline and pertinent focus group discussion procedure prior to main research study. Details of quantitative data collection methods, the instrumentation employed, the sampling strategy and the data analysis techniques

performed are thoroughly addressed. The results of the focus group discussion and industry questionnaire survey are reported in Chapter Five. Each of the hypotheses set up and related testing results are presented for discussion in this chapter. For the sake of establishing the implementation model of Six Sigma approach and drawing the conclusions of the research in next chapter, a thorough discussion of the survey findings is presented in this chapter. The relationship of the implementation elements, factors and Six Sigma outcomes is reviewed in details for facilitating the development of research implications and suggestions in the next chapter.

Chapter Six, the last chapter of this thesis, includes an introduction to the developed Six Sigma implementation model for apparel industry in China. The model for Six Sigma is concluded based on the current research outcomes with a hope to facilitate effective Six Sigma implementation by apparel industry in China. Last but not least, research implications, limitations and suggestions for future research are also highlighted at the latter part of this chapter. A brief conclusion on the whole research project will be drawn then, and a list of related publications by the author is given at the last section of this chapter.

Chapter Two – Literature Review

In Chapter One, a brief overview of this research is provided. Chapter Two will present a review of the literature relating to quality orientation, evolution, and in particular, Six Sigma development and its application in various industries. The content is divided into ten sections.

The first section (Section 2.1) provides a review of quality concept evolution and the development of QMS. The second section (Section 2.2) introduces the quality management application in apparel industry. The third section (Section 2.3) describes the origin of Six Sigma and how it grows up. The fourth section (Section 2.4) examines the motivation and reasons for Six Sigma adoption. Then, the development and diffusion of Six Sigma are explained in section five (Section 2.5). Previous studies regarding Six Sigma implementation effectiveness and pitfalls are explored in section six and seven (Section 2.6 and 2.7) respectively. As Six Sigma approach is always regarded as one of the quality management strategies, the relationship of QMS and Six Sigma is studied and summary provided in section eight (Section 2.8). Then, a review of the Six Sigma application and implementation status in various industries is conducted in section nine (Section 2.9) to provide a research foundation in subsequent chapters of this research. Finally, a chapter summary for the literature study is concluded in the tenth section (Section 2.10).

2.1 Quality Evolution and Fundamentals of Quality Management System

The origin of high performance working can be traced back to the quality gurus such as Feigenbaum, Deming, Crosby and Juran who believed that organizations must embrace a wide range of quality approaches to remain competitive. (Quality World, December 2007).

Quality management in general deals with permanently redirecting an organization's macro and micro operations towards the needs of internal and external customers (Wessel & Burcher, 2004). To maintain and extend competitive advantages in all dimensions and markets, companies shift increasingly from defining quality as a task that can be run by a quality department, to seeing it as the overall long-term umbrella objective of their business.

In the past few decades, many of the product manufacturers decided to implement QMS in order to ensure their process and product quality. Therefore, certain level of know-how on the use of quality management methods already exists in these organizations. In its broadest term, quality management deals with permanently redirecting a company's macro and micro operations towards the needs of internal and external customers. To maintain and extend competitive advantages in all dimensions and markets, companies shift increasingly from defining quality as a task that can be run by a quality department, to seeing it as the overall long-term umbrella objective of their business.

QMS helps enhance operation efficiency, product quality, and provide

organizations with means to achieve higher quality processes. As a direct consequence of this, customer satisfaction will be improved (Pfeifer, 2002). The development of QMS is normally supported by the use of standards. Standards do not describe a QMS, but formulate requirements which have to be fulfilled by the processes. By far, the most popular and world-wide known standards of QMS are the standards of the ISO 9000 family. The ISO 9000 family of standards, published originally in 1987, was revised in 1994 and further amended in 2000, and the last update in November 2008. By the end of 2013, over 1.1 million ISO 9001 certificates had been awarded in 175 countries / economies (The ISO Survey of Certification 2013, International Organization for Standardization). The ISO 9000 standard series have gained tremendous success in promoting quality management and quality assurance, especially in China. Over 300,000 certificates were granted there by the end of 2013, being the top country in the number of awarding ISO 9001 certificates. One of the reasons of achieving this popularity is that ISO 9000 standards apply uniformly to organizations of any size or nature of business.

An analysis of the aspects and success factors of QMS is described by Tilo, Reissiger and Canales (2004) as follows:-

a. Customer focus
b. Leadership
c. Involvement of people
d. Process approach
e. System approach to management

f. Continual improvement

g. Factual approach to decision making

h. Mutually beneficial supplier relationships

ISO 9001 quality assurance standard is a management approach that emphasizes standardization of all internal operations within an organization. All operation procedures should be clearly defined and they should be documented appropriately accordingly to ISO 9001 standard requirements. It is therefore, as what the Japanese quality guru Ishikawa famously said: "If standards and regulations are not revised every six months, it's proof that no one is using them seriously" (Quality World, February 2008).

In comparison with the six sigma methodology, QMS permits an entire and coherent overview of the interaction of processes within an organization. Every quality related aspect within the organization-wide environment will be incorporated into the QMS. To ensure an effective and efficient QMS to be developed, the eight QMS principles as mentioned above should be fully adopted.

While published QMS standards encourage a systematic analysis and mapping of processes, not all quality relevant problems can be solved using QMS (Tilo, Reissiger and Canales, 2004). According to a survey from Fraunhofer-Institute for Production Technology (IPT) (Pfeifer, 2002) dealing with the quality by German manufacturers, 423 enterprises took part in the enquiry and the following disadvantages of QMS were summarized:

a. High documentation and administration effort;

b. Costs;

c. Time efforts; and

d. Fixed system.

One of the critics of the ISO 9000 QMS is that it would only create unnecessary paper work (Douglas et al., 2003; Poksinska et al., 2002). Even though documentation requirements in the standard have been slightly reduced in latest version, ISO 9000 QMS is still commented to be highly documentation-driven. These documentation requirements often exceed the documentation practices prior to certification (Poksinska et al., 2002; Dziwetzki, 2004). For most organizations, the establishment and maintenance of a documented QMS can be a costly and time-consuming undertaking.

Nowadays QMS standard emphasizes on continuous process improvement. The necessary internal audit performs a major role to keep this being implemented properly. Nevertheless, the audit has some flaws (Tilo, Reissiger and Canales, 2004). There is a lack of available literature or standard on the effectiveness of QMS audits. The ISO 19011 for QMS auditing does not even explicitly mention "audit effectiveness" or "quality assurance of audits" (Beckmerhagen et al., 2004).

The QMS standard provides comprehensive overview of all processes that should be considered in an organization. It is kept generic and not industry-specific (Douglas et al., 2003). As such it gives neither proceedings nor convenient instruments for supporting operationally the improvement of quality, as needed to

optimize single process steps in the vertical process level (Tilo, Reissiger and Canales, 2004). To this end, it can be concluded that a big flaw of the standard is the omission of methodological assistance. Methods like FMEA (failure mode and effect analysis) or other statistical methods are rarely mentioned and applied under the standard requirements.

2.2 Quality Management in Apparel Industry

The new wave of quality awareness and emphasis has had a significant impact on business operations in the world (Lee and Zhou, 2000). The rapid development and evolution of quality concepts and quality tools over the past few decades have created new challenges and opportunities for all sectors of the industry, including the apparel business chain. Being mentioned by Jiang et al. (2007) and Zhao et al. (2007), the rapid growth of China and its integration into the global economy have led to the increasing need and importance to the business and academic world for research operations management.

Manufacturing industry in China had primarily relied on using specially trained quality inspectors to control product quality, and not until in the 1950s, some modern quality management concepts and techniques were first introduced to China (Zu et al., 2011; Lau et al., 2004; Liu, 1994). This situation is particularly obvious for apparel manufacturing that is widely regarded as labor-intensive industry. The common practice for quality control and management in apparel business is comparatively primitive and manual-based. The situation had been maintained for a long period until the last few decades that more and more quality

management tools have arisen and their impacts gradually penetrate into various fields of the industry.

The same happens to apparel industry that causes a chain effect in the quality revolution in textile and clothing business. Nowadays, the apparel manufacturing process is still in labor-intensive approach, which involves high-degree of manual operations. The challenges for apparel industry are to capture the current fashion trend – that is, customer orders come in quickly with tightened requirements. The shortened delivery time, vast diversified product styles and features, small order quantity with fast changing styles made quality management a difficult task for all apparel and fashion accessories manufacturers. As a quality improvement program, Six Sigma focuses on continuous and breakthrough improvement projects that are driven in a wide range of areas and at different levels of complexity, in order to reduce variation (Andersson et al., 2006). Reducing variation is the key to satisfy customers in apparel industry, and this explains why Six Sigma is increasingly popular among China apparel manufacturers and suppliers.

Nowadays, the growing trend of fast fashion has led to the phenomenon of shorter order lead-time and increased demands of various styles in textile and apparel industry. It made apparel factories along the fashion supply chain harder to standardize their products in such fluctuating business environment. The fast fashion business model is also becoming more popular in other manufacturing sectors, e.g. consumer electronics and information technology arena.

In textile apparel chain, it is important to look into the quality level of each element of the supply chain in order to achieve the desired product and service delivered to customer. This issue is particularly relevant in the apparel industry (Romano and Vinelli, 2001). Most people mentioned that the manufacturing industry in China is now in a critical stage of its development. Facing keen competition from most developing countries in South-east Asian region, China enterprises, especially the traditional manufacturing business mainly relying on manual operation like apparel factories, have to find ways to meet with these challenges. Chinese organizations have to pay more attention to quality management (Stephens, 1989). Therefore, many Chinese companies now try to implement quality management practices, such as TQM, as part of their manufacturing/ business strategies (Zhao et al., 1995). Investment in quality management will continuously be increased as quality becomes more critical for them to survive in today's competitive global markets (Lee and Zhou, 2000). This is particularly the case for apparel business in China. This also explains for why the modern quality management approach like Six Sigma and Lean manufacturing get increasing exposure and applications in nowadays' China enterprises. As quality management improves organizational performance, new opportunities and eventually new strategies are likely to emerge (Lee and Zhou, 2000). This means that there exists a relationship between quality management and strategies, and consequently, business practices and performance in an organization (Ahire et al., 1996; Dean and Bowen, 1994; Obert and Spencer, 1996; Roth and Miller, 1990; Vickery et al., 1992).

According to Romano and Vinelli (2001), the quality level of apparel products

delivered to the final customer is the result of the quality management practices of each link in the supply chain of the business, thus each actor is responsible for the final result. As most processes of the apparel production are completed manually, a sound quality management practice within the organization is gradually recognized and eagerly demanded. Quality for apparel industry can no longer be restricted to the area of perceived quality, but must also take even more operational aspects into account (Romano and Vinelli, 2001). It is therefore addressed by Romano and Vinelli (2001) that the requirements for supplier quality assessment, raw materials, in-process material quality control and quality procedures of the apparel enterprises, must also be defined. An integrated approach to manage and improve the quality level of apparel companies is seemed to be needed.

2.3 Six Sigma

The concept of implementation of Six Sigma methodology was pioneered at Motorola in the 1980s with the aim of reducing quality costs, that is, costs of not doing things right first time, costs of not meeting customer requirements, etc. (Jiju and Ricardo, 2002). Bill Wiggenhorn is senior vice president of Motorola Training and Education, and president of the distinguished Motorola University (Breyfogle et al., 2001). By that time he delivered a foreword for the newly released book on Six Sigma, *Implementing Six Sigma: Smarter solutions using statistical Methods*.

Six Sigma concept was introduced by Bill Smith in 1986, a senior engineer and

scientist within Motorola's communication division, in response to problems associated with high warranty claims (Jiju, 2006). Motorola launched its "Six Sigma Quality Program" on January 15, 1987. The program was kicked off with a speech by Motorola's chief executive officer, Bob Galvin, that was distributed in the form of both a letter and a video-tape (Breyfogle et al., 2001). There was a five-year program set up to execute Six Sigma approach. Breyfogle et al. (2001) stated that by March 1988, Motorola University had begun offering a course on implementing Six Sigma that was aimed primarily at services rather than products. It was reported that after a few months' initial training, teams started to run the improvement projects to meet their new corporate quality goals.

Six Sigma is both a philosophy and a methodology that improves quality by analyzing data with statistics to find the root cause of quality problems and to implement controls (Reinforced Plastics, July/August 2004). Six Sigma has quickly been advanced to a major method of quality management (Watson, 2003). The basis for Six Sigma is the sigma level, which is described in numerous publications. From the statistical basis, the strategy for Six Sigma initiatives can be derived so that all products and processes reach this high quality level. By raising the fulfillment of customer requirements, a detectable monetary benefit in a manageable time frame should be achieved. Six Sigma stresses the application of statistical and problem-solving tools and techniques in a methodical and systematic fashion to gain knowledge that leads to breakthrough improvements with dramatic impact on the bottom-line results (Jiju and Ricardo, 2002). The statistical objectives of Six Sigma are to centre the process on the target and reduce process variation (Reinforced Plastics, July/August 2004). Within the Six

Sigma regime, it straightly follows a formal and disciplined methodology for improving organizations' processes, based on rigorous data gathering and analysis, following the well-known strategy – DMAIC – "define-measure-analyze-improve-control" process. The strategy takes an organization's key business processes through five phases to deliver breakthroughs in performance:

- Phase 1: define – involves defining the scope and goals of the improvement project in terms of customer requirements and the process that delivers these requirements

- Phase 2: measure – involves measuring the current process performance – input, output and process – and calculating the sigma capability for short and longer-term process capability

- Phase 3: analyze – involves identifying the gap between the current and desired performance, prioritizing problems and identifying root causes of problems. Benchmarking the process outputs, products or services, against recognized benchmark standards of performance may also be carried out

- Phase 4: improve – involves generating the improvement solutions and fixing problems to prevent them from reoccurring so that the required financial and other performance goals are met

- Phase 5: control – involves implementing the improved process in a way that "holds the gains". Standards of operation will be documented in systems such as ISO 9000 and standards of performance will be established using techniques like statistical process control (SPC). After a "running-in" period, the process capability is calculated again to establish whether the performance gains are being sustained. The cycle is repeated, if further performance shortfalls are identified.

Implementing a typical Six Sigma program begins at top management level with training in fact-based decision-making and evaluation of a company's strategic goals…(Reinforced Plastics, July/ August 2004). According to Jiju Antony (2006), the objective of Six Sigma strategy is to understand the process which creates the defects and devise process improvement methods to reduce the occurrence of such defects which improve the overall customer experience. He said the focus must be on four issues:

- What are the nature of the defects which are occurring in the process?

- Why such defects are occurring and at what frequency?

- What is the impact of defect on customers?

- How these defects can be measured and what strategies should be implemented to prevent the occurrence of such defects?

The Six Sigma method is a project-driven management approach to improve the organizations' s products, services, and processes by continually reducing defects in the organization (Kwak & Anbari, 2006). The Six Sigma approach works. While the original goal of Six Sigma was to focus on manufacturing process, today, front-line selling, marketing, purchasing, billing and invoicing functions are also embarked on Six Sigma strategies with the aim of continuously reducing defects throughout the organization's processes.

2.4 Motivation of Six Sigma Adoption

Since Motorola invented Six Sigma and received Malcolm Baldrige National Quality Award in 1988, Six Sigma as a quality improvement framework has been gaining increasing attention and acceptance in industry and academic (Haln et al., 2000). It is particularly from 1995, a number of prestigious global firms, such as General Electric (GE) and Honeywell (previously Allied Signal), have launched a Six Sigma program and made a great success. For many large corporations like GE, Six Sigma has become the centre of nearly every business activity, and a very important step to ensure long-term competitiveness (Wessel & Burcher, 2004). Other companies such as Honeywell, Texas Instruments, Sony, Caterpillar, ABB, Dow Chemicals, etc. have also reported their success stories of Six Sigma implementation and credited Six Sigma with several millions of dollars in savings (Jiju, 2006).

With the numerous successful cases of Six Sigma application in manufacturing industry, this powerful business management strategy has been gradually

exploited by many world class service oriented companies such as JP Morgan, American Express, Lloyds TSB, Egg, City Bank, Zurich Financial Services, BT, and so on. Its application has extended from manufacturing to services, health, public administer and software development (Ehrlich, 2002). Six Sigma today has evolved from merely a measurement of quality to an overall business improvement strategy for a large number of companies around the world (Jiju, 2006).

In the business world, Six Sigma is defined as a "business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer's needs and expectations (Antony and Banuelas, 2001). The Six Sigma approach was first applied in manufacturing operations and rapidly expanded to different functional areas such as marketing, engineering, purchasing, servicing, and administrative support, once organizations realized the benefits (Kwak & Anbari, 2006). In 2000, Johnson Controls embarked on Six Sigma, the first company embarked on Six Sigma simultaneously worldwide across all sectors of business, including the automotive components manufacturing, the control product manufacturing, sales and service arm, and the facility management service business across the globe in over 70 countries (Woo, 2002).

In fact, the widespread applications of Six Sigma were always said to be best explained by the truth that organizations are able to articulate the benefits of Six Sigma presented in financial returns by linking process improvement with cost savings.

According to Woo (2002), financial performance is a major driver for Six Sigma, but the commitment goes well beyond the bottom line considerations. At other Six Sigma successful companies, like GE, Motorola, Honeywell and ABB, etc., Six Sigma has resulted in dramatic improvements to product and service quality, productivity, and work processes. In 1997, Motorola published their outstanding performance results of applying Six Sigma for ten years – sales up by five times to US$29.8 Billion, while profit up by six times to US$1.18 Billion, and stock value up by seven times in the period (Woo, 2002).

In Table 2-1 below, it can be noticed the significant financial benefits of implementing Six Sigma programs in two Fortune 100 companies during 1990s (Woo, 2002):

Table 2-1: Financial Saving and Performance of General Electric and Honeywell

	General Electric		**Honeywell**	
	1995	**1999**	**1995**	**1999**
Six Sigma Savings	-	US$2.1B	-	US$0.6B
Margin Expansion	18%	22%	13%	18%
Stock Price	US$32	US$135	US$22	US$57
Cash Flow Multiples	13	34	9	15
Sales/ Share	US$21	US$33	US$25	US$28

There are also many research conducted in previous literature that organizations that implement Six Sigma generally perform better than other companies in the same industry. In a research study conducted by Shafer and Moeller (2012), Six Sigma companies outperformed their respective industries on most of the performance variables all surveyed years including both the years prior to implementing Six Sigma and the years after Six Sigma implementation. They addressed that on average, companies that adopted Six Sigma performed better than the industry prior to their announcement and they maintained their significantly better performance after adoption. These apparent benefits are the major motivator for companies of all sizes and from all industries taking the initiative in taking part in Six Sigma adoption.

Therefore, in relative to their respective industry, it was found that the Six Sigma organizations are better performers both prior to and after the adoption of Six Sigma (Shafer and Moeller, 2012). Particularly their research provided evidence that the organizations implementing Six Sigma have the rate of improvement in terms of employee productivity significantly better than that of their industry and related counterparts.

The overall results from previous researches suggested that better performing companies adopt Six Sigma and that they continue their performance advantage after adopting Six Sigma (Shafer and Moeller, 2012). Furthermore, these researches indicated that Six Sigma implementation creates significant impact on employee productivity. While employees are properly deployed with Six Sigma approach, their work performance and contribution will be greatly enhanced

positively. This favorable outcome also shows similar study result in most Six Sigma's effectiveness investigations. Last but not least, these studies do not provide evidence that there is negative impact on corporate performance after launching Six Sigma programs.

2.5 Six Sigma Diffusion

Six Sigma as a powerful management strategy has evolved from being exclusively about the original goal of a target of less than four failures or defects or errors per million opportunities, to encompass a broad range of approaches for incorporating quality into products and services from the early design and development stages and throughout their lifetimes (Jiju, 2007). Behind the exponential nature of the spread of Six Sigma among global corporations, there has also been a strong deployment into vast number of large, medium and small sized enterprises (Ma et al., 2008). Six Sigma has quickly become a main method of quality management (Watson, 2003). Up to now, articles, instructor's manuals, audio and visual tapes, and CD in relation to Six Sigma, have a trend of exponential growth (Goh, 2002). The idea of Six Sigma has been adopted widely. Six Sigma management has become a metric, a methodology and a philosophy for quality improvement (Yue and Ma, 2006).

According to Jiju (2007), he commented that there have been three recognizable generations of Six Sigma.

- First Generation: the first generation of Six Sigma lasted for a period

of 8 years (1987-1994) and the focus was on reduction of defects. Motorola was a great example of a successful first generation company.

- Second Generation: the second generation of Six Sigma spanned the period from 1994 to 2000 and the focus was on cost reduction. GE, Du Point and Honeywell are good examples of successful second generation companies.

- Third Generation: the focus of third generation is on creating value to customers and the enterprise itself. The first companies to embrace third generation of Six Sigma are foreign. Examples of third generation of Six Sigma companies include Posco, Samsung, etc.

Being arisen in large organizations, Six Sigma is undoubtedly one of the most comprehensive approaches for company development and performance improvement of products and processes. For many large corporations like GE, Six Sigma has become the centre of nearly every business activity, and a very important step to ensure long-term competitiveness. In today's highly competitive environment, it is also becoming increasingly important for SMEs. Nevertheless, it appears that the majority of SMEs either does not know the Six Sigma approach, or find its organization not suitable to meet their specific

requirements (Wessel and Burcher, 2004).

The quality management development in China has been following closely the world-wide trend over the past years. Since 1988, China government has, with the participation of 100 enterprises, made use of the ISO 9000 series for pilot testing in pursuit of better quality production and enhancement of international trade (Tuan & Ng, 1997). In 1992, the ISO 9000 series was formally adopted as national standard to promote quality enhancement and to facilitate the development of QMS certification in China.

After China became a member of the World Trade Organization in 2001, China companies are under more pressure to improve the quality of their products and services in order to be competitive in the global market (Zu et al., 2011). Since China enterprises started to adopt more quality management methods during the period, researchers have made attempts to assess the status of quality management implementation at China firms (Zu et al., 2011; Lee, 2004; Lee and Zhou, 2000; Li et al., 2003).

While there have been numerous studies on quality management implementation in China, some important issues relating to Six Sigma adoption remain unclear. As shown in previous studies (Lau et al., 2004; Zhao et al., 2004), there are substantial differences among companies in China in their maturity of implementing various kinds of quality management practices, particularly for apparel and related manufacturing industry. Although there are more than 600 enterprises have implemented Six Sigma in China (Ma et al., 2008), very few

studies have been done.

The emphasis of higher value production now in China requires more advance QMS, and the variables in processes should be straightly controlled. Advanced quality management methods, such as quality circles, ISO 9000, total quality control, total preventive maintenance, TQM, Lean manufacturing and Six Sigma, have been increasingly adopted by the companies in China to improve their capabilities of quality control and management for better competitiveness (Hopkins et al., 2004; Lau et al., 2004; Xu et al., 2006).

Stemming from the principles of TQM, the application of Six Sigma has been blooming in the western world over the past decade. This trend has been spreading quickly to Asian region over the past five years. During the last few years, a few major big corporations in China, following the successful implementation of the above mentioned QMS, have adopted Six Sigma approach to further their quality improvement journey. These companies, namely Haier, TCL, ZTE, Midea, Gree, Chunlan and Hainan Airlines, started implementing Six Sigma in the past years. Implementing Six Sigma projects in these organizations are relatively easier as they have abundant resources to support this campaign. They can afford to employ experienced consultants who have extensive Six Sigma implementation experience working for overseas Six Sigma corporations. With the assistance from these external consultants, they can effectively develop Six Sigma approach and gain the benefits from this practice.

Some studies that compared the status of quality management in China and other

countries found that in general, the application of quality management practices in China was similar to the developing countries such as India and Mexico, and was even comparable to the developed countries such as the USA and Norway, but Chinese companies had different beliefs and focus in their implementation (Zu et al., 2011; Ahmed et al., 2005; Hopkins et al., 2004; Raghunathan et al, 1997; Rao et al., 1997; Solis et al., 2001; Sun, 2000; Zhao et al., 1995). Furthermore, a number of studies that investigated the efficacy of quality management implementation in China suggested that a company's effort in improving product and service quality can help to enhance its operational and business performance (Zu et al., 2011; Lee and Zhou, 2000; Su et al., 2008; Yeung et al., 2005).

Some scholars argue that Six Sigma is merely a fad (e.g., Caudron, 2002) and Six Sigma projects are narrowly defined for its continuous improvement efforts (Hammer, 2002). Proponents claim that it is more than just a quality system that could lead to benefits in the financial ends (Arnheiter and Maleyeff, 2005; Spector, 2006). Nevertheless, the common thought among practitioners is that Six Sigma has been successful implemented in many organizations today, and positive impacts in China manufacturing sectors are observable.

Over the past three decades, China has gained remarkable economic growth. In 2007, China became the third-largest economy in the world behind the U.S.A. and Japan with a gross domestic product (GDP) of RMB25.731 trillion (Wu, 2009). China has achieved about 9.8 percent average annual growth in GDP during the past 30 years (The People's Daily, 2008), which accounted for 17.5 percent of the growth in the world GDP and 29 percent of the total growth in manufacturing

output, making a vital contribution to the growth dynamics of the global economy (Zhao et al., 2006). China, being the world factory, is an important supplier of products to the global market. China has emerged from a supplier of low-end products such as toys and textiles to a producer of almost all types of products including those of higher value and technology (Jiang et al., 2007).

Nevertheless, only very few organizations involve in the Six Sigma implementation in China. These are mostly large corporations and market leaders. According to the latest industrial survey conducted by the National Bureau of Statistics of China, there are more than 7.6 million SMEs in China employing over two-third of the total people working for China industrial economy. Furthermore, the success of large corporations' quality programs is critically dependent on the supply of high quality goods and services from suppliers, which are now most likely to be SMEs. Therefore, a logical consequence is that more and more large organizations encourage the application of well-proven quality management tools like Six Sigma among their suppliers, which are mostly the aforesaid SMEs. To this end, it is foreseeable that, even though the implementation of Six Sigma is mainly confined to a few large corporations in China today, the Six Sigma wave will be extending promptly to medium and also even small sized enterprises in the industry.

2.5.1 PROBLEMS FACING CHINA COMPANIES IMPLEMENTING SIX SIGMA

The following issues are considered to be common problems for China companies,

especially for SMEs, intending to implement Six Sigma:

a. Low Education and Lack of Intellectual Capacity

The general academic background of China labor market is low. Employees of junior or lower level education occupies 76.57%, while with high school or diploma level and graduate level education are only 21.37% and 2.06% respectively (Sung, 2000). For most of the SMEs in China, it is also hard for them to employ external experts to assist them in Six Sigma implementation.

b. High Staff Turnover Rate

People are always cited as the most important asset of an organization. This is especially the case for those trained Six Sigma employees in this respect. With the booming economy in China, well trained employees are prone to change their jobs frequently in order to look for better prospectus jobs. This phenomenon causes the difficulty of a company to keep the talent and to implement Six Sigma projects effectively (Chan C.O. and Sun Hongyi, 2004).

c. Financial Limitation

Implementing Six Sigma needs sufficient financial support for staff training and effective Six Sigma implementation. As highlighted by Thomas A. and Barton R. (2006), the lack of financial capacity is being regarded as the primary issue that lead to poor system implementation.

d. Lack of Time Resource

For most of the companies in China, they belong to SMEs that they find it difficult to appoint a facilitator or coordinator on full time basis to operate the Six Sigma project. In addition, they also have limited resources to spare time for providing sufficient internal training. Lack of resources in these aspects leads to ineffective project performance.

e. Lack of Strategic Vision / Long-term Goals Formulation

The primary focus for most of the China organizations adopting Six Sigma only intends to undertake the projects in the most cost-effective manner and, to be able to recoup the initial project costs quickly after the completion of the projects. There is generally lacking of quality improvement commitment and culture within the organizations.

f. Resistance to Change

A number of the companies in China are originated from agricultural industry and are called the "Village Enterprise". Their work and education background contribute to further difficulty in adapting to new management theory and practice (Chan C.O. and Sun Hongyi, 2004).

It is generally agreed that a significant phenomenon observed in practice is that

not all companies can adopt quality management methods at the same pace, nor can they all achieve the same level of effectiveness (Zu et al., 2011). Quality management is considered as an example of administrative innovation since its practices are not targeted at manufacturing and service operations, rather the management and improvement of these operations, involving the policies of recruitment, allocation of resources, and the structuring of tasks, authority and reward, which are related to the social structure of the organization (Ahire and Ravichandran, 2001; Daft, 1978; Ravichandran, 2000; Sila, 2007). It is therefore for a similar reason that to better understand quality management implementation in China, it is important to consider how a company's underlying characteristics affect its adoption and application of the practices (Zu et al., 2011; Zhao et al., 2007).

Jiju (2007) stated that in his opinion as the Director of the Centre for Research in Six Sigma and Process Improvement, Six Sigma will be around as long as it continues to yield measureable bottom-line results in organizations. Although the number of applications of Six Sigma in manufacturing companies has gone down a lot, Six Sigma in other areas such as finance, healthcare, information technology, banking, etc. has gone up significantly in recent years (Jiju, 2007). He explicitly mentioned that the application of Six Sigma in countries such as Thailand, China, Malaysia and India will continue to grow in the next few years.

2.6 Six Sigma Effectiveness

Being mentioned by Breyfogle et al. (2001), a USA Today article presented

differences of opinion about the value of Six Sigma in "Firms Air for Six Sigma Efficiency" (Jones 1998). According to this, one stated opinion was that Six Sigma is "malarkey", whereas Larry Bossidy, CEO of Allied Signal (now "Honeywell"), countered with "The fact is, there is more reality with this (Six Sigma) than anything that has come down in a long time in business. The more you get involved with it, the more you're convinced." The following are some other quotes from the article:

- "Six Sigma is expensive to implement. That's why it has been a large-company trend. About 30 companies have embraced Six Sigma including Bombardier, ABB [Asea Brown Boveri] and Lockheed Martin."

- "Nobody gets promoted to an executive position at GE without Six Sigma training. All white-collar professionals must have started training by January. GE says it will mean $10 billion to $15 billion in increased annual revenue and cost savings by 2000 when Welch retires."

- "Raytheon figures it spends 25% of each sales dollar fixing problems when it operates at four sigma, a lower level of efficiency. But if it raises its quality and efficiency to Six Sigma, it would reduce spending on fixes to 1%."

- "It will keep the company (Allied Signal) from having to build an $85 million plant to fill increasing demand for caperolactan used to make

nylon, a total savings of $30-$50 million a year."

- "Lockheed Martin took a stab at Six Sigma in the early 1990s, but the attempt so foundered that it now calls its trainees 'program managers' instead of black belts to prevent in-house jokes of skepticism…Six Sigma is a success this time around. The company has saved $64 million with its first 40 projects."

- "John Akers promised to turn IBM around with Six Sigma, but the attempt was quickly abandoned when Akers was ousted as CEO in 1993."

- "Because managers' bonuses are tied to Six Sigma savings, it causes them to fabricate results and savings turn out to be phantom."

- "Six Sigma will eventually go the way of other fads, but probably not until Welch and Bossidy retire."

Since the inception of Six Sigma concept by Bill Smith in 1986, a senior engineer of Motorola's Communication Division, it has long been declared for the success of Six Sigma approach not just on achieving superior quality level but also for reducing defect rate during operation processes through the effective employment of powerful and practical statistical tools and techniques. As a result of this, Six Sigma approach helps lead to improved productivity, improved customer satisfaction, enhanced quality of service, reduced cost of operations or costs of

poor quality, and so on (Jiju, 2006).

For service-oriented business, there are also remarkable benefits derived from the execution of Six Sigma approach as captioned by various published literature:

- Citibank group – (Rucker, 2000)

  Private bank: reduced internal call backs by 80 per cent, external call backs by 85 per cent and credit processing time by 50 per cent.

  Global equipment finance: reduced the cycle time from customers placing an order to service delivery and the credit decision cycle by 67 per cent (i.e. from three days to one day).

- JP Morgan Chase (Global Investment Banking) –

  Six Sigma has enabled JP Morgan Chase to reduce flaws in its customer-facing processes such as account opening, payment handling and cheque-book ordering. This has resulted in increased customer satisfaction and improved efficiency and cycle times by over 30 per cent.

- Utility company

  Annual savings of USD1.7 million from improving service delivery (www.executiveonline.co.uk).

  Within the contract department of a utility company, excavation, cable-laying and re-instatement contract complaints resulted in customer dissatisfaction and high costs. Using the Six Sigma methodology the number of contract complaints has been reduced from 109 to 55 during

2000-2001. (www.sixisgmaqualtec.com).

Nevertheless, according to Mr. Alan Harrison, Head of Kaizen and Continuous Improvement, Weir Pumps, UK (Jiju, 2007), he said that based on his experience, he would say both:

- he have seen Six Sigma effectively and swiftly resolving process problems that were industry wide present since ever – this is a fact!

- he have also seen companies committing to Six Sigma and failing to achieve the expected benefits, they have rather achieved a visible disillusion with Six Sigma approach – nothing else but a management fad.

As apparent from the vast differences in opinion listed, Six Sigma can be a great success or failure depending upon how it is implemented (Breyfogle et al., 2001).

This contrasting result makes the implementation of Six Sigma a complex and challenging process, where the CSFs in its implementation become top interest of the companies running the Six Sigma projects.

As captioned by Breyfogle et al. (2001), "Kodak reports that five factors have been critical to the success of their Six Sigma training initiative:

- Management support

- Quality of the work environment

- Quality of the Six Sigma and quality improvement facilitators candidates

- Consistency across quality programs

- Effectiveness of the program instructors

Coronado and Antony (2002) had conducted an analysis on the CSFs for the successful implementation of Six Sigma projects in organizations. They have identified 12 CSFs in this respect. On the other hand, Tilo et al. (2004) had pointed out 7 success factors to run a Six Sigma project successfully. Furthermore, Caulcutt (2001) investigated the success cases of a few big corporations and has concluded his comments on CSFs. A comparison of their findings is shown in Table 2-2 below.

Table 2-2: Comparison of Critical Success Factors

	CSFs	Coronado & Antony	Tilo, Reissiger & Canales	Caulcutt
1.	Management involvement and commitment	✓		✓
2.	Cultural change	✓		
3.	Communication	✓		
4.	Organisation infrastructure	✓		✓
5.	Training	✓		

6.	Linking six sigma to business strategy	✓		✓
7.	Linking six sigma to customer	✓	✓	✓
8.	Linking six sigma to human resources	✓		
9.	Linking six sigma to suppliers	✓		
10.	Understanding tools and techniques within six sigma	✓	✓	
11.	Project management skills	✓		
12.	Project prioritization and selection	✓	✓	✓
13.	Project feasibility in a limited timeframe		✓	
14.	Evaluation of profitability		✓	
15.	Consequent agreement on objectives & controlling of results		✓	
16.	Consequent enabling of employees and provision of resources		✓	
17.	Focus on process			✓
18.	Management by fact			✓

According to Ma (2008), the CSFs of implementing Six Sigma management in China manufacturing industry can be concluded as Six Sigma leadership, set up and implement appropriate Six Sigma strategy, focus on market and customer, adopt effective evaluation and motivation measures, select, manage and implement Six Sigma projects.

In the light of the above comparison, it clearly illustrates that there are two essential or key ingredients as simultaneously identified by these three papers to be necessary for the effective implementation of Six Sigma projects, namely "Linking Six Sigma to Customer" and "Project Prioritization and Selection".

2.7 Six Sigma Pitfalls

While the original goal of Six Sigma was to focus on manufacturing process, today, front-line selling, marketing, purchasing, billing and invoicing functions are also embarked on Six Sigma strategies with the aim of continuously reducing defects throughout the organization's processes. However, not all companies can claim to have had the same benefits. As what had been mentioned by David Fitzpatrick, worldwide leader of Deloitte Consultant's Lead Enterprise practice:

> "…….fewer than 10 per cent of the companies are doing it to the point where it's going to significantly affect the balance sheet and the share price in any meaningful period of time."

While the Six Sigma concept gains more and more importance on the worldwide arena because of its successful implementation by many giant multi-national companies, it does impose certain drawbacks that need to be considered. According to Schneiderman (1999), he stated that he does not like Six Sigma because "It's neither simple to understand nor, in most applications, an effective proxy for customer satisfaction. Its definition is ambiguous and therefore easily gamed because there is no accepted test for what to include as an 'opportunity' for a defect". Schneiderman (1999) also noted that opportunities are not weighted by importance to the customer in Six Sigma. He explains that ten unimportant defects might improve while five important ones get worse. In the case the sigma metric would improve, but customer satisfaction goes down.

Furthermore, the sigma level can only be acquired for the determination and evaluation of operational process objectives, if failures can explicitly be displayed and the empirical database is big enough for a random sample (Tilo, Reissiger and Canales, 2004). Nevertheless, this is often not the case in external market surveys employed for determining customer satisfaction. In addition to this, it has to take into consideration of project duration determination. Because of the fact that a systematic maximization of customer satisfaction can only be reached by complex and long-term development projects, it is necessary to have a "long breath" for the assessment of the results (Tennant, 2002; Schurr, 2002).

According to Kwak and Anbari (2006), there are three main obstacles and challenges of Six Sigma method:

a. Issues in Strategy

One of the main criticisms is that Six Sigma is nothing new and simply repackages traditional principles and techniques related to quality (Catherwood, 2002). Organizations must realize that Six Sigma is not the universal answer to all business issues, and it may not be the most important management strategy that an organizations feels a sense of urgency to understand and implement Six Sigma. To ensure the long-term sustainability of the Six Sigma method, organizations need to analyze and accept its strengths and weaknesses and properly utilize Six Sigma principles, concepts, and tools.

b. Issues in Organizational Culture

Quality concepts need to be embedded into the process of designing rather than just monitoring the quality at the manufacturing level (McClusky, 2000). Organizations without a complete understanding of real obstacles of Six Sigma projects or a comprehensive change management plan are likely to fail. Senior management's strong commitment, support, and leadership are essential to dealing with any cultural issues or differences related to Six Sigma implementation. If the commitment and support of utilizing various resources do not exist, organization should probably not consider adopting Six Sigma.

c. Issues in Training (Belt Program)

Training is the key success factor in implementing Six Sigma projects successfully and should be part of an integrated approach. It is important to note that formal training is part of the development plan of producing different belt level experts. Participants need to be well informed of the latest trends, tools, and techniques of Six Sigma, and communicate with actual data analysis. As mentioned by Kwak and Anbari (2006), it is found that selection of less-capable employees for Black Belt assignments was associated with challenges to Six Sigma projects.

According to Jiju (2004), he mentioned that just like any other quality improvement initiatives that have seen in the past, Six Sigma has its own limitations. He quoted some of the limitations of Six Sigma as shown in Table 2-3 below:

Table 2-3: Limitations of Six Sigma Approach

1.	The challenge of having quality data available, especially in processes where no data is available to begin with (sometimes this task could take the largest proportion of the project time).
2.	In some cases, there is frustration as the solutions driven by the data are expensive and only a small part of the solution is implemented at the end.
3.	The right selection and prioritization of projects is one of the critical success factors of a six sigma program. The prioritization of projects in many organizations is still based on pure subjective judgement. Very few powerful tools are available for prioritizing projects and this should be major thrust for research in the future.
4.	The statistical definition of Six Sigma is 3.4 defects or failures per million opportunities. In service processes, a defect may be defined as anything which does not meet customer needs or expectations. It would be illogical to assume that all defects are equally good when we calculate the sigma capability level of a process. For instance, a defect in a hospital could be a wrong admission procedure, lack of training required by a staff member, misbehavior of staff members, unwillingness to help patients when they have specific queries, etc.
5.	The calculation of defect rates or error rates is based on the assumption of normality. The calculation of defect rates for non-normal situations is not yet properly addressed in the current literature of Six Sigma.
6.	Due to dynamic market demands, the critical-to-quality characteristics (CTQs) of today would not necessarily be meaningful tomorrow. All CTQs should be critically examined at all times and refined as necessary (Goh, 2002).
7.	Very little research has been done on the optimization of multiple CTQs in six sigma projects.
8.	Assumption of 1.5 sigma shift for all service processes does not make much sense. This particular issue should be the major thrust for future research, as a

	small shift in sigma could lead to erroneous defect calculations.
9.	Non-standardization procedures in the certification process of black belts and green belts are another limitation. This means not all black belts or green belts are equally capable. Research has shown that the skills and expertise developed by black belts are inconsistent across companies and are dependent to a great extent on the certifying body. For more information on this aspect, readers are advised to refer to Hoerl (2001). Black belts believe they know all the practical aspects of advanced quality improvement methods such as design of experiments, robust design, response surface methodology, statistical process control and reliability, when in fact they have barely scratched the surface.
10.	The start-up cost for institutionalizing Six Sigma into a corporate culture can be a significant investment. This particular feature would discourage many small and medium size enterprises from the introduction, development and implementation of Six Sigma strategy.
11.	Six Sigma can easily digress into a bureaucratic exercise if the focus is on such things as the number of trained black belts and green belts, number of projects completed, etc. instead of bottom-line savings.
12.	There is an overselling of Six Sigma by too many consulting firms. Many of them claim expertise in Six Sigma when they barely understand the tools and techniques and the Six Sigma roadmap.
13.	The relationship between cost of poor quality (COPQ) and process sigma quality level requires more justification.
14.	The linkage between Six Sigma and organizational culture and learning is not addressed properly in the existing literature.
15.	The decision of re-design efforts over continuous improvement depends on a number of other variables such as risk, technology, cost, customer demands, time, complexity, etc.

In addition, since the initial investment to provide sufficient resource in adopting Six Sigma is normally very high, for example the training cost involved in conducting mass training for the Six Sigma project teams and mass diversified staffs of the organization as well as employing external professional expertise for leading the Six Sigma projects, it is always negatively commented by the industry that Six Sigma processes often have to be optimized for years.

For those "mature" organizations, the project generally focuses on the maximization of the customer satisfaction by innovations and development of excellent products. These kinds of projects naturally require high standards and costs (Tilo et al., 2004; Pyzdek, 2001).

For those organizations intend to launch Six Sigma strategy, they have to consider and determine the project duration seriously. This is because of the fact that a systematic maximization of customer satisfaction can only be reached by complex and long-term development projects, it is necessary to have a "long breath" for the assessment of the results (Tilo et al., 2004; Tennant, 2002; Schurr, 2002).

Furthermore, the success of improvement projects is based, on the one hand, on the reduction of failures and, on the other hand, on a large increase of process efficiency and productivity by reducing reactive performance (Tilo et al., 2004). Therefore it is aspired to reach a higher customer satisfaction in development projects by increasing the fulfilment of customer requirements (Tilo et al., 2004; Pyzdek, 2001; George, 2002). This is said to be the ultimate desirable effect generated from Six Sigma process and for most companies this has to be achieved

through the effective integration of Six Sigma in existing management systems, which approach is one of the most important success factors for organizations like in German (Tilo et al., 2004; Schmieder, 2003).

2.8 Relationship between Quality Management System and Six Sigma

Since 1920's quality concept has started its evolution in the manufacturing industry. Quality control, quality assurance, quality management, total quality control, TQM, and so on, are some of the major quality terms arisen during the past several decades of years. In the past, many of these enterprises decided to implement QMS in order to ensure their process and product quality (Tilo et al, 2004). Various kinds of quality control tools and techniques are adopted and well exist in these organizations, like FMEA (failure mode and effect analysis) being applied in some quality management standards such as the ISO/TS 16949. The quality control tools help analyze, implement and control the quality improvement programs in the one hand, as well as provide necessary data and results for further improvement on the other.

QMSs belong to the most disseminated approaches (Tilo et al., 2004). The implementation of such systems requires the organization identifying the related business processes at the start of the projects. This is always said to have the similar process for Six Sigma approach as it also needs the creation of a process model prior to the project development and the establishment of a proper analysis approach called SIPOC (supplier-input-process-output-customer), a model used to

visualize and optimize processes (Hammer, 2002).

QMSs help enhance the operational efficiency of organizations and their product and service quality. Normally companies implementing QMS can develop a standardized internal operation flow and all quality-related procedures will be documented. More consistent operations, product and service quality will be resulted. As a direct consequence of this, customer satisfaction will be improved (Tilo et al., 2004; Pfeifer, 2002).

In most cases the development of QMS within an organization is based on the use of a published standard, whether international or national standard. These QMS standards will provide generic guidelines and requirements on how to develop a proper QMS in a company. These requirements set out the assessment methods to evaluate whether the organizations fulfilling the standards and how successful they are performing.

Since 1980's these QMS standards have been developed and published for a number of different business nature industries. Among them the most popular and world-wide recognized QMS standard is ISO 9000 family of standards. Being first published in 1987, ISO 9000 standard series gain tremendous success. Over 1.1 million of ISO 9001 certificates are issued by the end of 2013 (The ISO Survey of Certification 2013, International Organization for Standardization). One major reason for this successful story of ISO 9001 standard series is its universal and generic nature of this standard. It is regardless of the organizational size and business nature for adopting the standard and applying for

certification. The ISO 9001 certification standard, since its original inception in 1987, was revised in 1994, 2000 and most lately, the current version in 2008. The latest version ISO 9001:2008 is developed based on an eight-principle philosophy of quality management as described below:

- Principle 1: customer focus

The standard requires the organization to identify the proper customers and target at their quality requirements in order to achieve customer satisfaction. The success of the organizations will depend upon how success they are able to fulfill customers' expectation.

- Principle 2: leadership

As mentioned in most traditional literature, leadership is the ability to define goals, to direct the team to achieve goals and to ensure the continued achievement of the team. In the latest version of ISO 9001, it emphasizes the importance of leadership and declares that top management should perform the leadership role in an organization.

- Principle 3: involvement of people

The ISO 9001 standard requires company-wide involvement in the QMS development and implementation. This enhances the organization culture in directing to the same common goal for quality standard. This reflects the

internal norm of the ISO 9001 standard that appropriate employee qualification together with their self-initiation for QMS implementation are indispensable for the company's success.

- Principle 4: process approach

The current version of ISO 9001 standard places higher focus on process control and management. It addresses the need to create process work flow and document the process inputs, operation flow and finally the outputs. Related personnel and responsibilities should be clearly defined and deployed.

- Principle 5: system approach to management

The clearly structured and defined processes help the organization understand the interrelationship and functioning among these processes. In addition, this enables the organization to effectively steer the process flow and provides a solid platform to conduct factual decision making.

- Principle 6: continual improvement

Similar to other QMSs and the concept addressed in TQM, the ISO 9001 standard addresses explicitly the need to keep on continual improvement on all the operational processes, product and service quality. This serves the aim to achieve ever-increasing improvement in customer satisfaction, the ultimate goal

of QMS. It is for this reason that organization has to review, evaluate, analyze and look for improvement opportunities continuously through the regular internal quality audit and management review.

- Principle 7: factual approach to decision making

The ISO 9001 standard claims that the management needs to collect reliable data relevant to QMS for further analysis and makes use of this information for decision making. All these data and information should be made readily available for management purpose and the records are properly kept for a pre-defined time period.

- Principle 8: mutually beneficial supplier relationships

The new version of ISO 9001 standard puts focus on establishing a long-term co-operation relationship with suppliers. This is based upon the fact that if the organization has to produce and supply consistent quality products and service, it should have reliable suppliers to support it. Mutual trust and beneficial supplier status can help achieve this. It is therefore the standard requests the organization to effect a proper supplier management procedure and build up a stable and reliable customer-supplier relationship.

The rapid popularity of QMS standards like ISO 9001 reflects the increasing concern of customers and subsequently the industry as a whole for continuous improvement in product and service quality. The certification to ISO 9001 of a

company can demonstrate to its customers that the company is able to provide consistent quality products and service with the stringent operational control within the company, and that the customers may rest assured that the quality standard of the company is maintained and enhanced in a continual manner.

In view of the above-mentioned development and philosophy of QMS and ISO 9000 family series, generally speaking there are common features with Six Sigma programs as captioned by previous literatures. According to Klefsjo et al. (2001), the general characteristics among them are:

- It is a top-down, rather than bottom-up approach;

- It is a highly disciplined approach that typically includes four stages: measure, analyze, improve and control;

- It is a data-oriented approach, making sound and heavy use of various statistical decision tools.

Six Sigma is a systematic, data-driven approach using the DMAIC process and utilizing design for Six Sigma method (DFSS) (GE, 2004). The fundamental principle of Six Sigma is to "take an organization to an improved level of sigma capability through the rigorous application of statistical tools and techniques" (Antony et al., 2003).

People always mention there is nothing new for Six Sigma approach. Reed

(2000) contended that no new matter at all about Six Sigma and that it "has been around for many years, just called something else". It is generally agreed that the only "new" feature of Six Sigma is that it highly addresses the explicit relationship of the tactical with the strategic. That is, what is new in Six Sigma is that efficient, often statistical, techniques are used in a systematic way to reduce variation and improve processes and there is a focus on results – including customer-related ones that lead to enhanced marketplace performance and hence improved bottom-line financial results (Klefsjo et al., 2001).

Anbari (2002) pointed out that Six Sigma is more comprehensive than prior quality initiatives such as TQM and Continuous Quality Improvement (CQI). The Six Sigma method includes measured and reported financial results, uses additional, more advanced data analysis tools, focuses on customer concerns, and uses project management tools and methodology. He summarized the Six Sigma management method as follows:

Six Sigma = TQM (or CQI) + Stronger Customer Focus + Additional Data Analysis Tools + Financial Results + Project Management

Jiju (2007) commented that there are four aspects of the Six Sigma strategy that are not accentuated in other quality management and improvement methodologies of the past.

- Firstly, Six Sigma places a clear focus on achieving bottom-line results in monetary terms. No Six Sigma project is approved unless the project's

return-on-investment is clearly identified and understood by the team. The bottom-line impact of a project depends heavily on the type of project (Black Belt, Green Belt or White Belt);

- Secondly, Six Sigma has been very successful in integrating the human (teamwork, culture change, motivation, customer focus, etc.) and process (process control, process monitoring, process analysis, process improvement, etc.) aspects of improvement;

- Thirdly, the key characteristic of Six Sigma is that it integrates both statistical and non-statistical tools of quality improvement in a sequential manner within a powerful problem-solving framework (Define-Measure-Analyze-Improve-Control);

- Fourthly, the characteristic of Six Sigma is that it creates a powerful team infrastructure (Project champions, Master Black Belts, Black Belts, Green Belts and Yellow Belts) for implementation of projects.

Some people comment that Six Sigma is part of TQM. Six Sigma provides a structured means of pushing product and process improvement, but we do not see it as an alternative to TQM (Klefsjo et al., 2001). In this context TQM is regarded as a management system consisting of values, methodologies and tools that aims to improve customer satisfaction with a reduced amount of resources. With this view it is explicit to conclude that Six Sigma is a methodology within TQM. Furthermore, it may be regarded properly that the rationale behind Six

Sigma's successful story is that it can be well structured as well as offering systematic and scientific use of a number of efficient quality tools.

According to Tilo et al. (2004), both QMS (namely ISO 9001 standard) and Six Sigma approach can be effectively integrated to achieve full benefits for an organization. It is addressed for the following areas as the critical rationale for such integration:

- Process analysis

Since the Year 2000 version of the ISO 9000 standard series, it begins to address the process approach in controlling the operations within an organization. The inputs, processes and outputs of the operations are to be well defined. Information and data relating to these processes are properly collected and analyzed to establish improvement measures. In this context, the process management principle of Six Sigma is well matched. Six Sigma demands for the SIPOC model and that also emphasizes for the required process management approach. The process mapping in Six Sigma projects offer the same analytic framework for deciding the appropriate improvement potentials in any operational practices.

- Identification of improvement areas

Six Sigma offers an objective-oriented approach for the identification of projects, which promise a high financial success (Tilo et al., 2004). Each Six Sigma

project targets at minimizing process derivation and increasing cost effectiveness. This philosophy basically works in the same direction with current ISO 9000 standards that an organization should standardize its operational flow and continuously find ways to improve its quality and operational efficiency. The use of product, process, service and system audit techniques in ISO 9000 QMS aims at maintaining quality consciousness within the company's environment on the one hand, and helps offer potential grounds for implementing improvement measures on the other. It is therefore the Six Sigma approach and ISO 9000 standards offer very close management concept as to enhance the company's quality performance.

- Conformance between project and process objectives

In ISO 9000 QMS arena, the top management of the organization has to establish the quality policy, objectives and targets. These objective statements have to be clearly written and announced in the company. The whole company's functional areas and work projects should follow and concur to these objectives. Employees are well informed and trained to stick to these requirements. Whereas in Six Sigma company the project and process objectives are agreed and should be made in concurrence during the "Define" stage of the Six Sigma project. A clear project charter is to be identified and the related objectives and process mapping will be determined. After identifying the involved processes using process maps, the process objectives described in QMS can be compared with the planned Six Sigma project objectives. It is therefore ISO 9000 QMS will go in the same direction with Six Sigma approach and the Six Sigma projects will align

with the company's policy, objectives and targets as defined in QMS.

- Choice of project participants

There is generally an ISO 9000 project team to kick off and help develop the QMS. Even after the establishment and certification of the ISO 9001 standard, the company has to maintain and enhance the quality level continuously. This practice is similar to that of Six Sigma project that well trained participants are to be recruited to take part in the Six Sigma projects. Every Six Sigma team member will assume a specific role to play in the program. A balanced selection of appropriate team members to the Six Sigma projects will be critical to the success of the programs. According to Tilo et al. (2004), the participants required for a Six Sigma projects have to be chosen by examining the related processes, and that the required knowledge, which individual participants need to fulfil the demands of the project, can be estimated by regarding the definitions in the system as well as specific project tasks. This is the same selection criteria of an ISO 9000 project that the members have to be chosen appropriately based on their experience, capability, attitude in work area, training background, and so on. It is important for both Six Sigma and ISO 9000 projects to select the proper employees to participate in the quality improvement campaign.

- Planning of project resources

It is always argued that the availability of adequate resources for both ISO 9000 and Six Sigma is the CSFs for their effective implementation. These resources

include human manpower, provision of training, allowance of time and space for staff participation in projects, other capital investment and support to the improvement facilities, and so on. Top management of companies implementing ISO 9000 QMS and Six Sigma strategy should prepare to plan in advance for the provision of project resources fulfilling the project implementation requirements and their continued availability.

- Standardization of project evaluation measures

A consistent proceeding for the definition of project objectives and their controlling should be established for the steering of the projects (Tilo et al., 2004). The same concept applies to both ISO 9000 and Six Sigma projects. A well-defined evaluation criteria and performance appraisal methods should be provided in the project charter during "Define" phase of the Six Sigma projects. Similarly, a clearly defined evaluation and audit procedure together with the assessment criteria should be made available during the establishment stage of an ISO 9000 QMS. This facilitates an objective evaluation of the project performance and further analysis on the improvement opportunities in these quality improvement projects.

- Documentation of results

Both of the ISO 9000 and Six Sigma projects need to be well recorded and documented on their implementation results in order to provide ground for future study and improvement projects. For ISO 9000 standards, they address a

systematic approach to record all the implementation outcomes, as an evidence of the system's running and assessment ground. The records have to be kept properly and readily available for inspection. In Six Sigma company, the project records should be maintained in all stages of implementation to support data analysis and for reviewing the project performance. At the end of the projects, the project teams have to present the whole project proceeding and explain their outcomes based on the retained records and information.

A summary of the key features between QMS and Six Sigma is given in Table 2-4 below.

Table 2-4: Key Features between QMS and Six Sigma

	QMS	Six Sigma
Objective	Customer satisfaction through high quality products	Monetary benefit through customer satisfaction
Strategy	Arranging business processes according to requirements of standards	High quality level/low failure rates in all business processes
Management	Listing of management responsibilities	Commitment a clear objectives for projects, creating an organizational structure which pursues the objectives

Organization	Process owner; management representative (responsible for QMS)	Process owner (green belts); project officer (black belts)
Regarded resources	Human resources, infrastructure and work environment	Required resources for projects (basically human resources)
Training	Required, but not specified	In all areas of an organization, different levels of qualification dependent on the function in processes
Project management	PDCA (model for continuous improvement, voluntary)	DMAIC/DMADV (continuous improvement approach)
Process approach	Model of a process-based QMS	SIPOC (approach for describing single processes)
Methods	No specification	Specified toolbox
Documentation	Listing of requirements	No specification

(Source: Tilo et al., 2004)

According to Tilo et al. (2004), QMS permits an entire and coherent overview of the interaction of processes within an organization. He commented that in the scope of Six Sigma projects, single process step have to be systematically analyzed and improved. Several advantages are pointed by Tilo et al. (2004) that may arise through integration of both approaches:

- an effective proceeding to identify the most relevant improvement areas;
- the assurance of conform project and process objectives and thus the sustainability of Six Sigma projects;
- choice of the most capable project participants and minimization of the qualification effort;
- the fulfilment of all organizational requirements for running projects using standard procedures and measures; and
- increased availability of project experiences through well-structured documentation facilities.

The benefits of implementing an effective QMS may be tremendous and long lasting. It is believed that the ISO 9000 standard will assist companies of all sizes and nature to achieve consistent operation and enhanced quality performance.

With the integration of Six Sigma approach, the company will move a further step towards TQM. As a result, customer satisfaction, employee involvement and continuous quality improvement will be further enhanced.

2.9 Six Sigma Application and Implementation in Various Industries

It is well observed that successful implementation and growing organizational interest in Six Sigma approach have been exploding rapidly over the past decades. The Six Sigma initiative is developing at quick pace as a major driving force for many technology-driven, project-driven organizations. It is a business strategy that focuses on improving customer requirements understanding, business systems, productivity, and financial performance (Kwak and Anbari, 2006). Dating back to the mid-1980s, applications of the Six Sigma methods allowed many organizations to sustain their competitive advantage by integrating their knowledge of the process with statistics, engineering, and project management (Anbari, 2002).

Since Six Sigma is originated from manufacturing industry, many service-oriented companies still conform to the notion that Six Sigma is confined just to manufacturing companies. The best way to convince a service-oriented company to initiate, develop and implement Six Sigma strategy is through the three rudimentary principles of statistical thinking advocated by Hoerl and Snee (2002). These are:

a. All work occurs in a system of interconnected processes;

b. All processes exhibit variability; and

c. All processes create data that explains variability and it is our responsibility to understand the sources of variability and devise effective strategies to reduce or eliminate variability.

In fact, according to Jiju (2006), service-oriented companies adopting Six Sigma will have the following benefits:

- Effective management decisions due to heavy reliance on data and facts instead of gut-feelings and hunches. Hence costs associated with fire-fighting and misdirected problem solving efforts with no structured or disciplined methodology could be significantly reduced;

- Increased understanding of customer needs and expectations, especially the critical-to-quality service performance characteristics which will have the greatest impact on customer satisfaction and loyalty;

- Efficient and reliable internal operations, leading to greater market share and satisfied shareholders;

- Improved knowledge across the organization on various tools and techniques for problem solving, leading to greater job satisfaction for employees;

- Reduced number of non-value added operations through systematic elimination, leading to faster delivery of service;

- Reduced variability in service performance, leading to more predictable and consistent level of service;

- Transformation of organizational culture from being reactive to proactive thinking or mindset;

- Improved cross-functional teamwork across the entire organization.

As captioned by Kwak and Anbari (2006), the Six Sigma methodology has been applied and implemented successfully in various industries as mentioned below:

a. Manufacturing Sector

Motorola was the first organization to use the term Six Sigma in the 1980s as part of its quality performance measurement and improvement program. Six Sigma has since been successfully applied in other manufacturing organizations such as GE, Boeing, DuPont, Toshiba, Seagate, Kodak, Honeywell, Texas Instruments,

Sony, etc. The reported benefits and savings are composed and presented from investigating various literatures in Six Sigma (Weiner, 2004; de Feo and Bar-El, 2002; Antony and Banuelas, 2002; Buss and Ivey, 2001; McClusky, 2000). Table 2-5 summarizes the organizations, projects, benefits, improvements, and savings by implementing the Six Sigma process.

Table 2-5: Reported Benefits and Savings from Six Sigma in Manufacturing Sector

Company/ Project	Metric/ Measures	Benefits/ Savings
Motorola (1992)	In-process defect levels	150 times reduction
Raytheon/ Aircraft integration systems	Depot maintenance inspection time	Reduced 88% as measured in days
GE/Railcar leasing business	Turnaround time at repair shops	62% reduction
Allied Signal (Honeywell)/ laminates plant in South Carolina	Capacity, cycle time, inventory, on-time delivery	Up 50%, down 50%, down 50%, increased to near 100%
Allied Signal (Honeywell)/ Bendix IQ brake pads	Concept-to-shipment cycle time	Reduced from 18 months to 8 months
Hughes aircraft's missiles systems group/ wave soldering operations	Quality/ productivity	Improved 1,000%/ improved 500%
General Electric	Financial	$2 billion in 1999
Motorola (1999)	Financial	$15 billion over 11 years

Dow chemical/ rail delivery project	Financial	Savings of $2.45 million in capital expenditures
DuPont/ Yerkes plant in New York (2000)	Financial	Savings of more than $25 million
Telefonica de espana (2001)	Financial	Savings and increases in revenue 30 million euro in the first 10 months
Texas instruments	Financial	$600 million
Johnson and Johnson	Financial	$500 million
Honeywell	Financial	$1.2 billion
Ford	Financial	$2.52 billion
Samsung	Financial	$1.5 billion

(Sources: Kwak and Anbari, 2006; Weiner, 2004; de Feo and Bar-El, 2002; Antony and Banuelas, 2002; Buss and Ivey, 2001; McClusky, 2000)

b. Financial Sector

Following the successful implementation of Six Sigma strategy in manufacturing industry, servicing industry like financial institutions finds it may be benefited through adopting this tactic. This is especially the case that finance and credit department are demanded to reduce cash collection cycle time and variation in collection performance to remain competitive. According to Kwak and Anbari (2006), typical Six Sigma projects in financial institutions include improving accuracy of allocation of cash to reduce bank charges, automatic payments, improving accuracy of reporting, reducing documentary credits defects, reducing

check collection defects, and reducing variation in collector performance.

Bank of America (BOA) is regarded as one of the pioneers in adopting and implementing Six Sigma approach to streamline operations, attract and retain customers, and create competitiveness over credit unions (Kwak and Anbari, 2006). It was reported to have over hundreds of Six Sigma projects covering functional area like cross-selling, deposits, and problem resolution. BOA reported a 10.4% increase in customer satisfaction and 24% decrease in customer problems after implementing Six Sigma (Roberts, 2004). Other financial institutions including, GE Capital Corp., JP Morgan Chase, and SunTrust Banks are using Six Sigma to focus on and improve customer requirements and satisfaction (Roberts, 2004).

c. Healthcare Sector

In addition to financial sector, healthcare sector is said to be very well matched with Six Sigma principles because of the stringent quality requirements for this sector that tolerates zero defect or no mistake for healthcare treatment.

According to Lazarus and Butler (2001), some of the successfully implemented Six Sigma projects include improving timely and accurate claims reimbursement. Ettinger (2001) said that Six Sigma approach helps streamline the process of healthcare delivery, while Revere and Black (2003) mentioned it reduces the inventory of surgical equipment and related costs.

The radiology film library at the University of Texas MD Anderson Cancer Centre also adopted Six Sigma and improved service activities greatly (Kwak and Anbari, 2006; Benedetto, 2003). As put forward by Elsberry (2000), for the same institution's outpatient CT exam lab, patient preparation times were reduced from 45 minutes to less than 5 minutes in many cases and there was a 45% increase in examinations with no additional machines or shifts.

d. Engineering and Construction Sector

In 2002, Bechtel Corporation, one of the largest engineering and construction companies in the world, reported savings of US$200 million with an investment of US$30 million in its six Sigma program to identify and prevent rework and defects in everything from design to construction to on-time delivery of employee payroll (Kwak and Anbari, 2006; Eckhouse, 2003).

There is another case, as captioned by Moreton (2003), that Six Sigma was implemented to streamline the process of neutralizing chemical agents, and in a national telecommunications project to help optimize the management of cost and schedules.

e. Research and Development Sector

The main quality criteria in research and development (R&D) arena are to reduce cost, enhance speed in responding to market, and streamlining R&D processes. To measure the effectiveness of Six Sigma, organizations need to focus on

data-driven reviews, improved project success rate, and integration of R&D into regular work processes (Kwak and Anbari, 2006).

Johnson and Swisher (2003) noted that a survey revealed as of 2003, only 37% of the respondents had formally implemented Six Sigma principles in their R&D organization. Rajagopalan et al. (2004) reported that the development and manufacturing of the new prototype at W.R. Grace (Refining Industry) was cut to 8-9 months from 11-12 months by implementing the Design for Six Sigma process.

The overall benefits gained from Six Sigma in R&D sector are said to be fewer resources, predictable usage profile, possible earlier launch, etc.

Six Sigma methodology is applied for changing the culture and work practice in a company through breakthrough improvements by focusing on out-of-the-box thinking in order to achieve aggressive and prominent goals. The application of Six Sigma concept is universal and its strategy is generic. The widespread applications of Six Sigma were possible due to the fact that organizations were able to articulate the benefits of Six Sigma presented in financial returns by linking process improvement with cost savings (Kwak and Anbari, 2006).

As captioned in above section, companies from all industries and scale are able to adopt Six Sigma in their quality improvement journey and if it is operated properly, the tremendous rewards to the companies are anticipated.

2.10 Summary

In this chapter, the literature relating to quality management and Six Sigma, in particular, the CSFs of effective Six Sigma implementation were reviewed. The evolution of quality and adoption of quality management approach in apparel industry were studied. The principles and development of QMS like ISO 9000 family standards were explored for understanding the existing current trend of quality management practice. The application of Six Sigma and its diffusion, especially for the situation in China, were identified. The effectiveness and pitfalls of Six Sigma approach were then studied to provide a foundation for defining its implementation outcomes. The review findings are employed to establish the criteria of the desired results of effective Six Sigma implementation.

In the latter sections of this chapter, the relationship between QMS and Six Sigma was reviewed. A number of aspects for these 2 closely related quality improvement concepts were concluded and listed for comparison. Based on previous research for Six Sigma application in different industries, the characteristics of its implementation status were identified among these industries. Based on all these information obtained from the literature review, a solid base for developing a research model for achieving the research objectives can then be constructed.

In the next chapter, the development of the research model, the identification of implementation elements and CSFs for Six Sigma, and the desired implementation outcomes as well as the propositions among them will be

discussed and explained.

Chapter Three – Research Model Design

In Chapter Two, it has reviewed the literature related to Six Sigma history, its origin, adoption status and recent development and diffusion. Six Sigma is concluded to be an effective management approach in enhancing products and service quality level through the use of statistical methodology and quality tools. In the meantime, Six Sigma effectiveness, its pitfalls and relationship with QMS are explored. Although Six Sigma is always appraised to be a fast and effective management approach to achieve cost-saving and create financial benefits, its potential pitfalls and inadequacies were studied in last chapter. In the last section of Chapter Two, an overall application status of Six Sigma in various industries is reviewed. It is obvious that the implementation of Six Sigma approach gains tremendous acceptance in wide variety of industries, and that, this trend is going to grow in coming decade. In this view, it is worth studying how Six Sigma can be implemented effectively in apparel industry in China, a fast-growing manufacturing field facing rapid changing business environment in this developing country.

In this chapter, there are six sections covering the research model development and detailed explanation of each of the sub-models. The first section (Section 3.1) outlines a generic research model for Six Sigma implementation approach which is proposed based on the literature review outcome in Chapter Two as well as information gathering and theories summarized from the industry. The correlation of the CSFs for effective implementation of Six Sigma is constructed with the respective desirable implementation outcomes. In the second to fifth

section (Section 3.2 to Section 3.5), the four sub-models within the research mainframe are described. The hypotheses of each of these sub-models are explained for establishing a foundation in understanding and studying the correlation of the CSFs of Six Sigma adoption with that of the implementation outcomes for apparel industry in China. In the last section (Section 3.6), a brief review of the models and propositions developed was summarized.

3.1 Model Overview

There are a number of researches conducted previously for Six Sigma implementation. In addition, many studies have been carried out to investigate the CSFs of Six Sigma approach. However, there lacks of research for exploring such major factors affecting the implementation of Six Sigma in apparel industry in developing countries like China. Moreover, there is no study conducted before for linking these CSFs to the favorable implementation outcomes of Six Sigma strategy. These desirable implementation results of Six Sigma projects are summarized based on previous literature and are further established in this thesis as outlined in the following section.

There are various implementations outcomes of Six Sigma. From the quality management (Flynn et al., 1994) perspectives, it is identified the following four major desired outcomes that are shared across various studies. The four major outcomes are summarized as follows:

- Cost and Efficiency

An effective quality management in any operation processes usually comes with major improvements in cost-effectiveness and efficient use of resources. Factories that implement Six Sigma projects can help their companies provide better products and services “in a faster manner and with a lower cost than competitors” (Coronado and Antony, 2002; Eckes, 2000; Harry and Schroeder, 2005). Six Sigma is a method to improve process capability and enhance process throughput (Nave, 2002). Furthermore, organizations often present the benefits of implementing Six Sigma in financial returns by linking process improvement with cost saving (Kwak and Anbari, 2006).

- Continuous Improvement

In addition to improvements in cost and effective use of resources, an effective quality management can also help enhance the quality level. As stated in previous chapter, Six Sigma is a quality management method that aims at reducing defect rates. Organization can rely on Six Sigma project specialists at different levels in the continuous improvement process (Zu et al., 2008). Through the DMAIC stages of implementation, the Six Sigma approach helps reduce cost by minimizing variability in the processes, which leads to decreased defects. The DMAIC approach is an ongoing process that eliminates bottlenecks in the work process. Six Sigma is also hailed as a method to reduce waste, increase customer satisfaction, and improve financial results (Revere et al., 2004). By using statistical methods, organizations are able to understand fluctuations in a process, which will allow them to pinpoint the cause of the problem and analysis

the trend of the defects (Näslund, 2008). This would help organization continuously reduce defect rates in different levels of production, which finally lead to continuous improvement in the workflow process.

- Customer and Employee Satisfaction

The aim of quality improvement is to increase customer satisfaction, and thus leads to higher profitability. From the service-profit chain perspective (Heskett et al., 1997), customer loyalty is the key driven force to make profit (Reichheld and Sasser Jr, 1989). A satisfied employee would help improve customer loyalty by providing quality services and products (Heskett and Schlesinger, 1994). Six Sigma improves the effectiveness and efficiency of all operations in order to meet or exceed customer's needs and expectations (Antony and Banuelas, 2001). Employees are involved through quality training and additional responsibility for quality improvements. These empowerment measures help satisfy employee and become more loyal and emotionally attached. It is believed that these exceeded needs and expectations of employee shall create higher level of customer satisfaction, which lead to customer loyalty. The impact of an operation is moderated by the satisfaction level of employees. Internal Six Sigma projects (projects for processes that serving internal customers) facilitate employees from different departments to deliver quality services to external customers, which would lead to employee satisfaction and eventually customer satisfaction (Heskett and Schlesinger, 1994).

- Product and Service Quality

In today's apparel industry, production also comes with service, such as product design, order management, and inventory management, etc. Six Sigma emphasizes on the defect-free process. It is for this reason that serving internal customer (that is, employee) will enable an organization to provide higher level of product and service quality. In addition, the quality control of final product and service delivery will follow the Six Sigma criteria, thus ensuring the product and service quality to be the desirable outcome from the projects.

As mentioned in Chapter Two, there are previous studies of Six Sigma focus on the success factors of implementing Six Sigma methodology. As outlined by Lee et al. (2011), he compared the most common CSFs based upon previous studies and as a result, the findings are illustrated in Table 2-2.

There are total 18 CSFs proposed by various scholars. Coronado and Antony (2002) identified 12 CSFs by investigating Six Sigma projects in organizations. Caulcutt (2001) found 7 CSFs by investigating the success cases of implementing Six Sigma in a few big companies, which are Motorola, GE, Black and Decker, Allied Signal (now Honeywell), ABB and Bombardier. Tilo et al. (2004) demonstrated another 7 CSFs (Table 2-2) to successfully run Six Sigma projects. Lee et al. (2011) compared all the CSFs mentioned in above literature and proposed that "Linking Six Sigma to customer" and "Project prioritization and selection" are also essential ingredients of effective Six Sigma implementation, as these two factors were mentioned in all previous studies.

This study restructured the CSFs from previous discussions, as some of the factors are conceptually linked and highly relevant. It is proposed that some of the factors should be grouped together into a single construct, while some factors should be rephrased to better reflect the general situation. For example, linking Six Sigma to business strategy and linking Six Sigma to human resources are highly related, because a company should hire new staffs who have Six Sigma experience to execute the business strategy that is linked to Six Sigma. Similar conceptual reconstructions have been conducted for all CSFs, and it will facilitate the investigation on what factors are more critical in apparel industry. This study categorized and rephrased the above 18 CSFs into three major elements (Table 3-1), which are (1) Management's Intention and Commitment, (2) Top Management Ability, and (3) Organizational Ability. After conducting factor analysis and reliability test, it is confirmed these categorizations and the total CSFs in the model is 11. The details of the factor analysis will be discussed in next chapter.

Table 3-1: Three Major Elements and Eleven CSFs of Effective Six Sigma Implementation

Implementation Elements	Critical Success Factors
1. Management's Intention and Commitment	Resources Allocation
	Management Participation & Involvement
2. Top Management Ability	Linking Six Sigma to Business Strategies
	Project Selection, Prioritization and Tracking
	Project Team Management
	Management by Objectives and Facts

3. Organizational Ability	Linking Six Sigma to Customers
	Project Management Skills
	Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review
	Communication and Organizational Culture
	Employee Attitude and Engagement

In Six Sigma literature, most studies focus on comparing Six Sigma methodology to TQM (e.g., Andersson et al., 2006; Näslund, 2008) or the effectiveness of Six Sigma approaches. Brun (2011) reviewed 96 books and over 100 scholarly works published in international journals, and he argues that the CSFs of Six Sigma implementation vary across countries. He pointed out that the Italian companies are usually SMEs, which have "the characteristic of family owned business. It is therefore they are different from "the North-American public company model" (Brun, 2011). There are also differences of company model in China when compared to that in U.S. Many companies in China are prioritized and have "the characteristic of family owned business", whereas some of them are still state-owned. It is therefore the Six Sigma implementation may be different in China with that in U.S. As previous studies mainly focused on developed markets (mainly in the U.S. market), there is lack of study investigating emerging markets such as China for the success factors of Six Sigma implementation. As a result of this, it is therefore a hope to establish the research model as outlined below for providing an insight and investigation base for identifying the key factors for successful Six Sigma implementation that will lead to achieve the favorable implementation outcomes of Six Sigma program.

The research model and related main hypotheses are outlined in Figure 3-1 below.

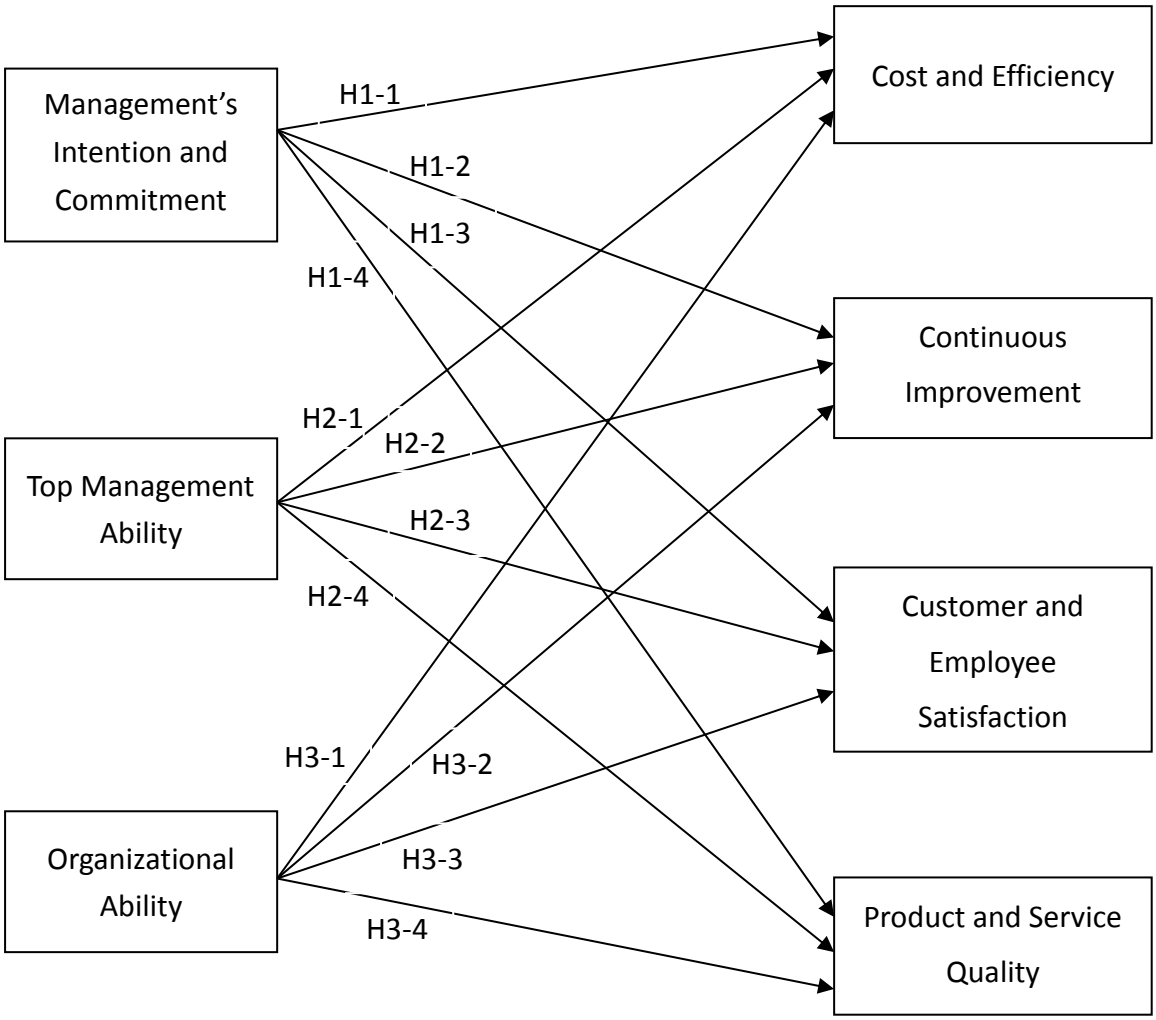


Figure 3-1: Research Model for Effective Six Sigma Implementation and Implementation Outcomes

Figure 3-1 shows the research framework and main hypotheses. There are three major elements for effective Six Sigma implementation (that is, Management's Intention and Commitment, Top Management Ability and Organizational Ability)

and four Six Sigma implementation outcomes (that is, Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality). For each of the major elements, there are different key factors identified to support the realization of the elements. The relationship and categorization of these elements and CSFs are provided in Table 3-1 above. The major elements and their respective hypotheses are defined below and illustrated as individual model for the sake of explanation and data analysis. There are various hypotheses constructed under each of these models in addition to those hypotheses being established under the main research model as outlined in Figure 3-1 above. They will be further explained and discussed in Section 3.2 to 3.5 below. In Chapter Five, it is going to test and confirm their relationships based on our survey data.

3.2 Model I – Management's Intention and Commitment

A number of scholars and quality consulting professional have reviewed the CSFs of implementing quality improvement projects and Six Sigma adoption. Yusof and Aspinwall (1999) pointed out that in their research undertaken for SMEs regarding TQM implementation, understanding of CSFs is vital to success of these organizations. It is concluded to be a failure implementation result if lacking these factors. As for Six Sigma projects, Chen (2006) studied the relationship between business approach and Six Sigma implementation. He further pointed out the top factor in successful Six Sigma adoption is DAMIC integration.

A commonly accepted concept for effective quality enhancement projects is that top management's commitment and involvement is critical. According to Brady and Allen (2006), they reviewed success factors of Six Sigma and identified 13 distinct items in this area, whereas top management's commitment is listed the first factor among the others. They also found that nearly 50% of the articles in their survey included top management's commitment as a success factor for Six Sigma implementation.

Companies may need to allocate resources, such as training resources, facilities upgrading and technology investment, to get a better implementation outcome of Six Sigma. For example, being a Black Belt Six Sigma specialist requires minimum of one-year's training. In GE, the length is around 16-20 weeks. The organization will allocate adequate resources for the training and evaluating the training outcome (demonstrate how candidates have met the requirements) in order to get an accredited Black Belt candidate (Ingle and Roe, 2001).

Top management may also allocate hardware resources that support the Six Sigma implementation. For example, senior management can acquire new equipment to remove bottlenecks and variations. Facilities upgrading or technology investment can increase production efficiency and improve product quality on firm productivity (Thatcher and Oliver, 2001). According to Thatcher and Oliver (2001), investments in technologies that reduce the variable cost of designing, developing, and manufacturing a product encourage the firm to improve product quality and to charge a higher price, which lead to higher profits and customer satisfaction.

Moreover, top management's continuous support and enthusiasm is one of the most important factors to implement Six Sigma (Henderson and Evans, 2000). The CEOs in Motorola, GE, and Honeywell, support, participate and are actively involved in Six Sigma initiatives, which lead to the success of their Six Sigma implementation (Coronado and Antony, 2002). Eckes (2000) found that top management must actively participate in Six Sigma projects in order to attain and ensure the successful implementation of Six Sigma. In conclusion, management's intention and commitment including provision of appropriate resources and management involvement are very critical to the successful implement of Six Sigma, which lead to better implementation outcomes (Halliday, 2001). Therefore, it is proposed the following main hypotheses under this model.

H1-1: Management's Intention and Commitment has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H1-2: Management's Intention and Commitment has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H1-3: Management's Intention and Commitment has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H1-4: Management's Intention and Commitment has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

In order to provide further insights and to find out clearly how the CSFs under this element affect the implementation outcomes of Six Sigma projects, it is realized the need to construct additional hypotheses for testing and confirming the relationship between the factors with that of the outcomes. Hypotheses of the two CSFs (Resources Allocation and Management Participation and Involvement) for this element are illustrated in Figure 3-2 below:

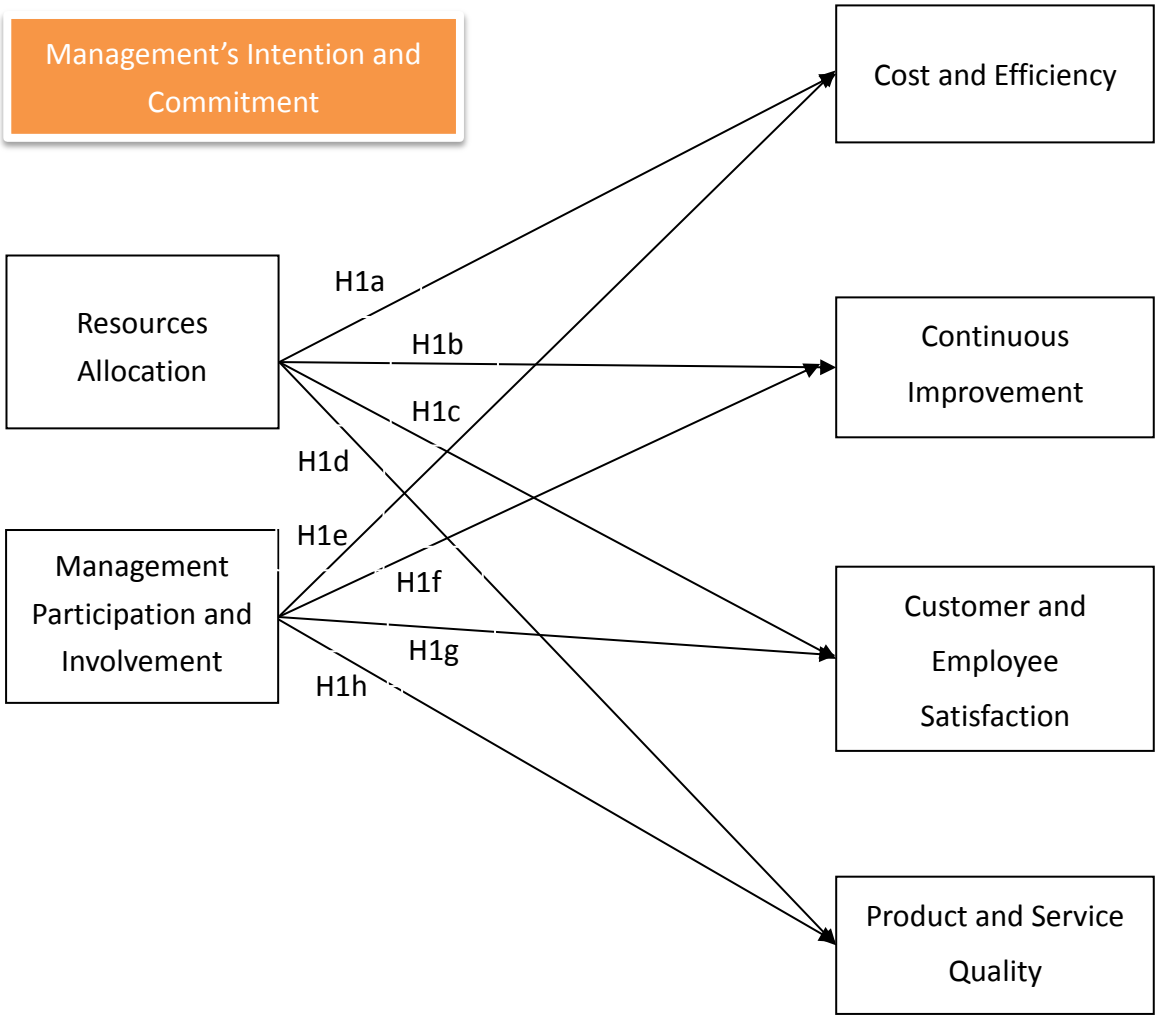


Figure 3-2: Model I – Management's Intention and Commitment

(1) Resources Allocation (H1a to H1d)

H1a: Resources Allocation has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H1b: Resources Allocation has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H1c: Resources Allocation has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H1d: Resources Allocation has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

(2) Management Participation and Involvement (H1e to H1h)

H1e: Management Participation and Involvement has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H1f: Management Participation and Involvement has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H1g: Management Participation and Involvement has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H1h: Management Participation and Involvement has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

3.3 Model II – Top Management Ability

Top management may have committed to implement Six Sigma in their operations, but their ability to link Six Sigma to their corporate business strategy will affect the effectiveness of his Six Sigma project. Harry and Schroeder (2005) found that 61% of the top performing firms link their rewards for top management ability to their business strategies. Therefore, the top management ability to link Six Sigma to business strategy is important. Coronado and Antony (2002) has demonstrated that Six Sigma is a more structured and profit-oriented method than other previous quality management philosophies (e.g. TQM). The impact of Six Sigma is connected to the bottom-line of the business, and thus how the top management using the Six Sigma in their business strategy may lead to successful implementation of Six Sigma, which helps improve an organization's profitability.

According to Brady and Allen (2006), a number of top management skills constitutes the critical factors to effective Six Sigma adoption, including forming the right team, bottom line focus, project selection, customer focus, and so on. Six Sigma methodology is a top-down approach that is led by enthusiastically and unwavering top management (Ma et al., 2008). They addressed that it is necessary for top management to have the necessary management skill for leading the Six Sigma projects, to provide resources and to promote culture change. They are responsible for ensuring the successful implementation of Six Sigma in

their own areas of influence. To this consideration top management should be able to align Six Sigma strategy with organizational business strategy.

According to Ingle and Roe (2001), Six Sigma is a project-driven methodology, which selects the projects that are closely tied to the business goals or objectives of the companies and provide maximum financial benefits to them. A correct project priority during Six Sigma implementation will help improve company competitive advantages, profitability, product life cycle, etc. (Coronado and Antony, 2002). In addition, Linderman et al. (2003) have found that Six Sigma projects with specific challenging goals have a greater magnitude of improvement than those without goals. Therefore, the implementation outcomes of Six Sigma shall be improved if top management defines clearly its objectives and manages it by facts. In order to understand how top management ability will on the whole affect the outcomes of Six Sigma implementation, it is proposed for the following hypotheses.

H2-1: Top Management Ability has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H2-2: Top Management Ability has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H2-3: Top Management Ability has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H2-4: Top Management Ability has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

There are four CSFs being identified under this element (Top Management Ability) that may contribute to and influence the effectiveness of Six Sigma approach. They are “Linking Six Sigma to Business Strategies”, “Project Selection, Prioritization and Tracking”, “Project Team Management” and “Management by Objective and Fact”. This research consolidates these four factors to this element based on literature study and the current normal practice and concerns of Six Sigma strategy.

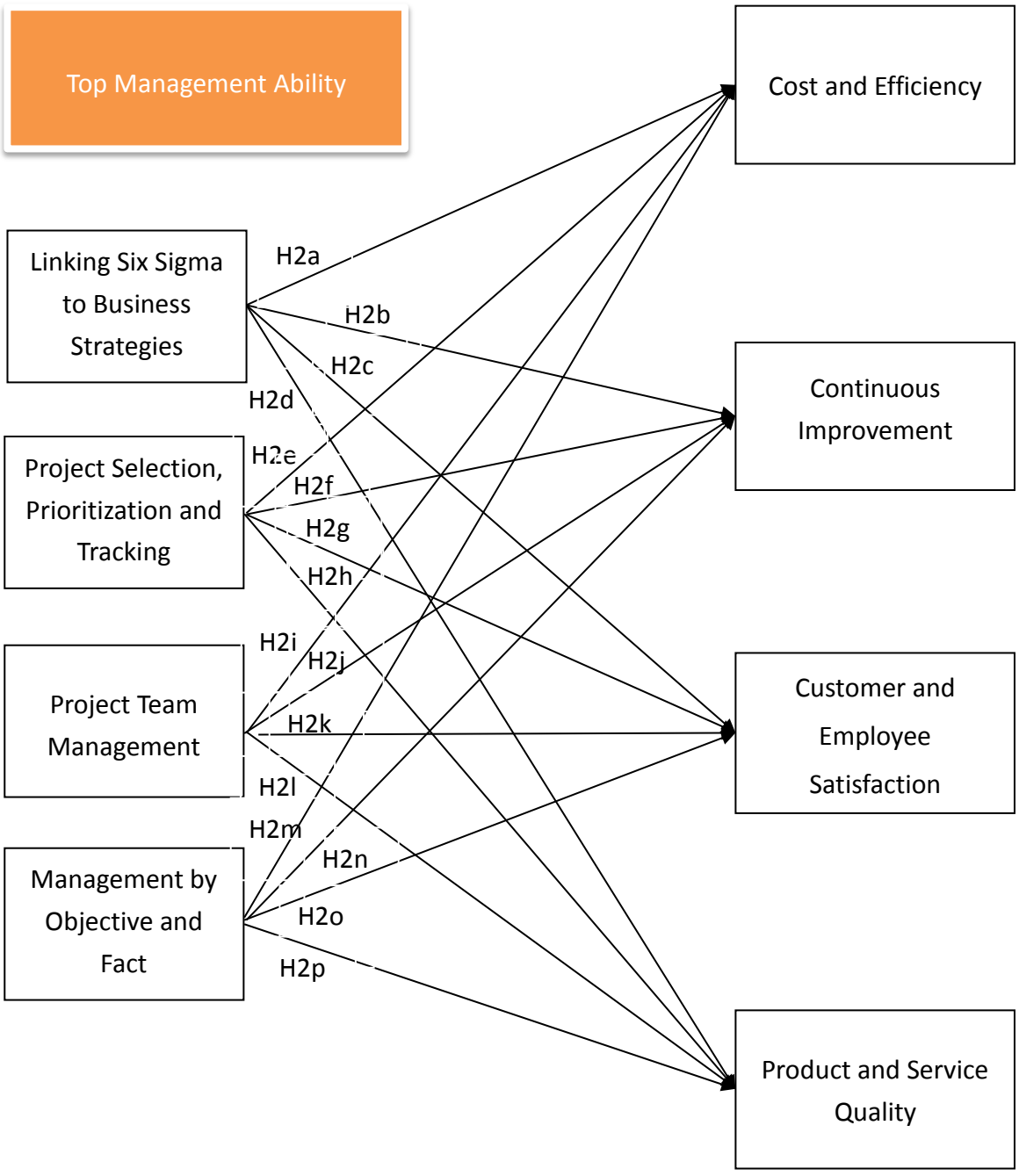


Figure 3-3: Model II – Top Management Ability

As a result, the following hypotheses are developed for these factors as stated below:

(1) Linking Six Sigma to Business Strategies (H2a to H2d)

H2a: Linking Six Sigma to Business Strategies has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H2b: Linking Six Sigma to Business Strategies has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H2c: Linking Six Sigma to Business Strategies has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H2d: Linking Six Sigma to Business Strategies has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

(2) Project Selection, Prioritization and Tracking (H2e to H2h)

H2e: Project Selection, Prioritization and Tracking have a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H2f: Project Selection, Prioritization and Tracking have a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H2g: Project Selection, Prioritization and Tracking have a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H2h: Project Selection, Prioritization and Tracking have a positive influence on Six Sigma implementation from Product and Service Quality aspect.

(3) Project Team Management (H2i to H2l)

H2i: Project Team Management has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H2j: Project Team Management has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H2k: Project Team Management has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H2l: Project Team Management has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

(4) Management by Objective and Fact (H2m to H2p)

H2m: Management by Objective and Fact has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H2n: Management by Objective and Fact has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H2o: Management by Objective and Fact has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H2p: Management by Objective and Fact has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

3.4 Model III – Organizational Ability

Six Sigma projects are carried out by project teams. In turn, the ability of project teams and overall organizational ability form the critical element for the success and effectiveness of Six Sigma adoption. As highlighted by Ma et al. (2008), the ability to focus on market and customer is foundation for organization's survival. It is likewise for Six Sigma projects, that for organization's success the key factor is to understand what customer requirements are, to evaluate customer satisfaction and to collect customer information. Ma et al. (2008) concluded that organizational ability including focus on market and customer, as well as effective evaluation and motivation measures are the CSFs of implementing Six Sigma approach for manufacturing industry in China.

Organizational ability of Six Sigma implementation consists of (1) linking Six Sigma to customers, (2) project management skills, (3) understanding of Six Sigma methodology, tools, techniques and progress reviews, (4) communication

and organizational cultural, and (5) employee attitude and engagement. Customers, as the end-users of the supply chain, products are produced to satisfy their needs and expectations (Harry and Schroeder, 2005). All Six Sigma projects start and end with a customer. Therefore, Coronado and Antony (2002) states that it is necessary to set clear project goals based on customers' expectations. Therefore, customers play an important role on the implementation of Six Sigma. Six Sigma projects can help identify the customer needs and understand the linkage to various business activities (Neuman and Cavanagh, 2000).

According to Eckes (2002), poor project management skills can be lethal to the failure of implementation of Six Sigma. Coronado and Antony (2002) stated that trainings for project management skills are included in the black-belt training program, which is crucial for the implementation of Six Sigma. In that case, project management skills are vital to Six Sigma implementation. In order to make proper use of the Six Sigma strategy, top management and employees need to flourish the understanding on the methodology, tools and techniques, such as design of experiments, statistical process control, regression analysis, analysis of variance and other advanced statistical tools and techniques (Antony and Banuelas, 2002). Progress review is also critical to Six Sigma implementation. In GE's cases of successful implementation of Six Sigma, top management participates in weekly and monthly Six Sigma reviews. They monitored the project process with Master Black Belt team monthly (Henderson and Evans, 2000). Moreover, Six Sigma adoption needs to be adjusted into different organizational culture and strived to enhance communications. According to Erwin and Douglas (2000), in

some organizations, employees are fear to make mistakes and often hide defects due to the fear-based organization culture. Six Sigma, on the other hand, helps build up "an open and safe environment where defects are seen as improvement opportunities" (Erwin and Douglas, 2000). Therefore, it is proposed for the following hypotheses for confirming how this element contributes to the effective Six Sigma implementation.

H3-1: Organizational Ability has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H3-2: Organizational Ability has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H3-3: Organizational Ability has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H3-4: Organizational Ability has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

There are five factors being considered as critical success aspects to achieve the effective implementation of Six Sigma under this element "Organizational Ability". To understand how significant for these factors in correlating to Six Sigma outcomes, the study establishes hypotheses to test and confirm their relationship. These hypotheses are detailed in Figure 3-4 below.

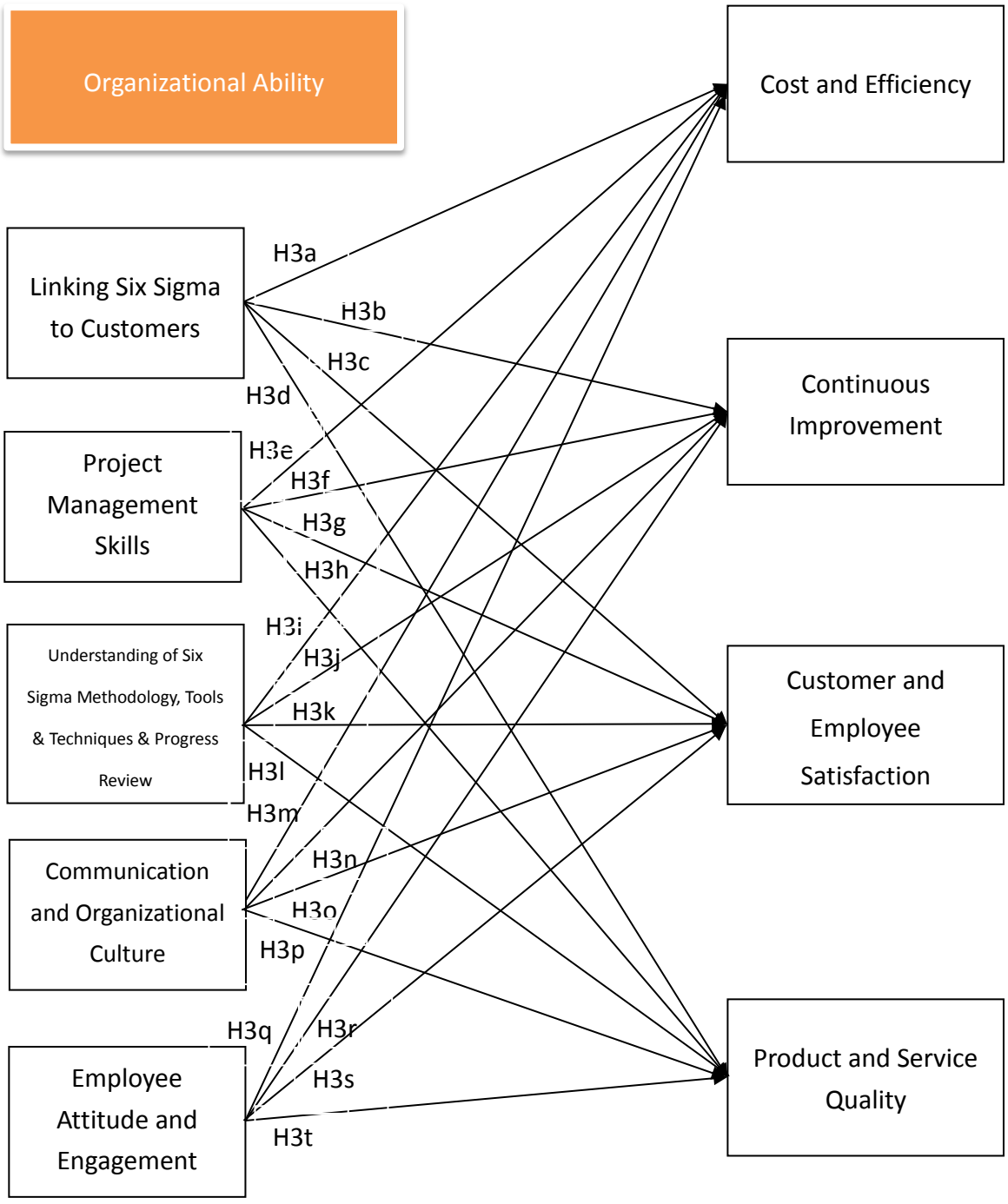


Figure 3-4: Model III – Organizational Ability

(1) Linking Six Sigma to Customers (H3a to H3d)

H3a: Linking Six Sigma to Customers has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H3b: Linking Six Sigma to Customers has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H3c: Linking Six Sigma to Customers has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H3d: Linking Six Sigma to Customers has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

(2) Project Management Skills (H3e to H3h)

H3e: Project Management Skills has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H3f: Project Management Skills has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H3g: Project Management Skills has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H3h: Project Management Skills has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

(3) Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review (H3i to H3l)

H3i: Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H3j: Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H3k: Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H3l: Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

(4) Communication and Organizational Culture (H3m to H3p)

H3m: Communication and Organizational Culture has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H3n: Communication and Organizational Culture has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H3o: Communication and Organizational Culture has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

H3p: Communication and Organizational Culture has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

(5) Employee Attitude and Engagement (H3q to H3t)

H3q: Employee Attitude and Engagement has a positive influence on Six Sigma implementation from Cost and Efficiency aspect;

H3r: Employee Attitude and Engagement has a positive influence on Six Sigma implementation from Continuous Improvement aspect;

H3s: Employee Attitude and Engagement has a positive influence on Six Sigma implementation from Customer and Employee Satisfaction aspect;

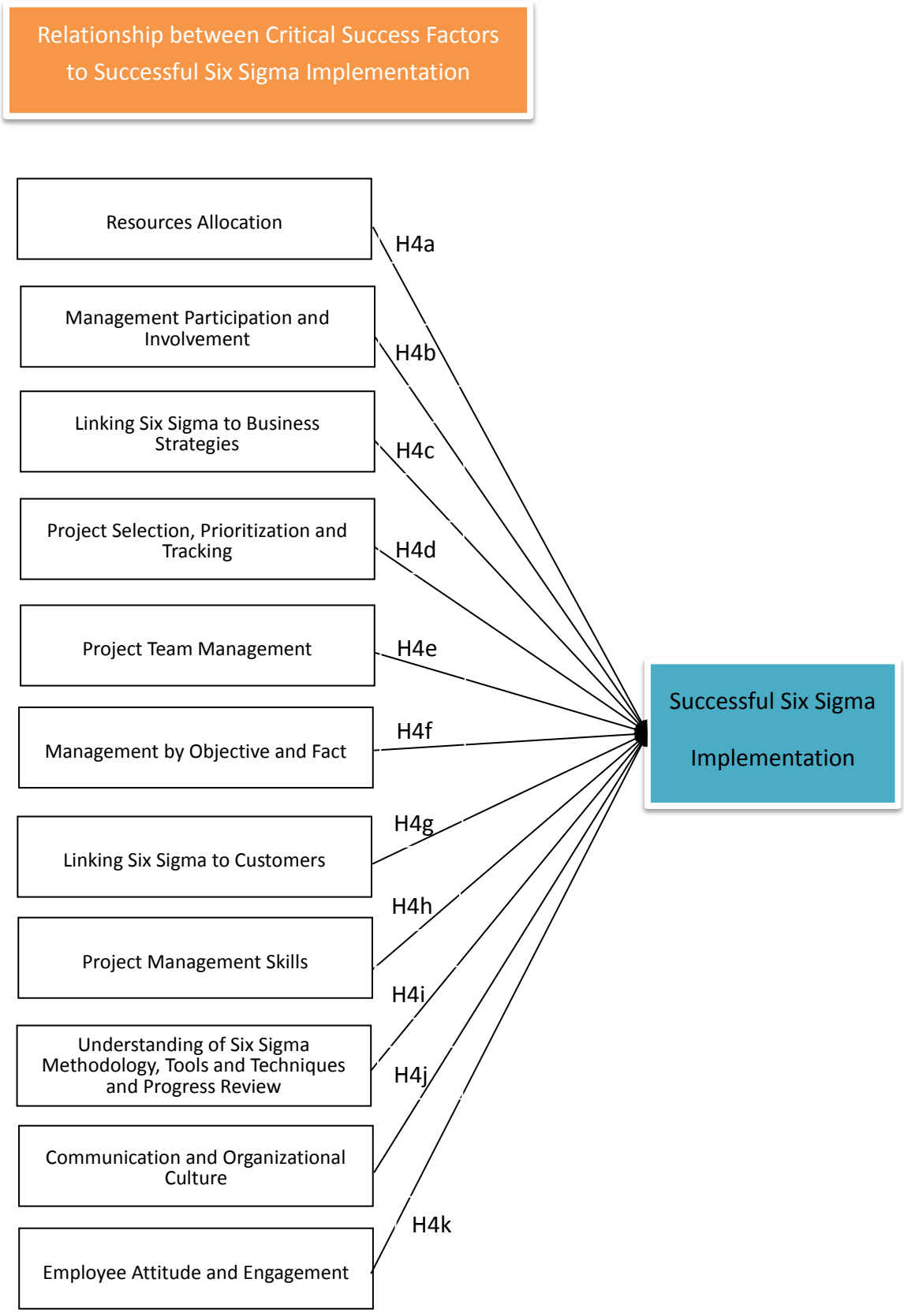
H3t: Employee Attitude and Engagement has a positive influence on Six Sigma implementation from Product and Service Quality aspect.

3.5 Model IV – CSFs and Implementation Outcomes

The above three models are constructed to present the relationship among the various Six Sigma implementation elements and success factors to that of the desirable outcomes. A number of hypotheses are developed for testing and also for analysis which will be discussed in detail in subsequent chapters. In fact, it is needed to understand how the identified CSFs of Six Sigma implementation will directly lead to the successful implementation of Six Sigma approach. In this Model IV, a research model is set up for this purpose. The 11 identified CSFs will be linked to the successful results of Six Sigma implementation. The investigation and understanding of how these factors impose influence to the level of success of Six Sigma projects are important for organizations to optimize their focus of Six Sigma adoption, resources investment, project management and measures of improving the project efficiency. As pointed out by Yusof and Aspinwall (1999) that CSFs are vital to organizations' success for quality management, and without these factors organizations will be failure.

In order to find out how these factors relate to the success of the Six Sigma implementation, the following model is developed and related hypotheses are outlined as follows:

Figure 3-5: Model IV – CSFs and Implementation Outcomes



Hypothesis H4:

H4a: Resources Allocation has a positive influence on success of six sigma implementation;

H4b: Management Participation and Involvement has a positive influence on success of six sigma implementation;

H4c: Linking Six Sigma to Business Strategies has a positive influence on success of six sigma implementation;

H4d: Project Selection, Prioritization and Tracking have a positive influence on success of six sigma implementation;

H4e: Project Team Management has a positive influence on success of six sigma implementation;

H4f: Management by Objective and Fact has a positive influence on success of six sigma implementation;

H4g: Linking Six Sigma to Customers has a positive influence on success of six sigma implementation;

H4h: Project Management Skills has a positive influence on success of six sigma

implementation;

H4i: Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review has a positive influence on success of six sigma implementation;

H4j: Communication and Organizational Culture has a positive influence on success of six sigma implementation;

H4k: Employee Attitude and Engagement has a positive influence on success of six sigma implementation.

3.6 Summary

This chapter provides an overview of the main research model and its development. Following the review of literature in the previous chapter, the desired implementation outcomes of Six Sigma were defined. Moreover, the 11 identified CSFs based on past research were concluded and they were further grouped into different Six Sigma implementation elements based on previous studies. Sub-models based on the 3 implementation elements were developed and related hypotheses were set up for investigating their relationship in subsequent chapter. In addition, for the purpose of understanding how the CSFs may contribute to the successful implementation of Six Sigma, another sub-model was constructed for studying the correlation among them. In total, there are 67 hypotheses being drawn in this chapter under different models in order to confirm their contribution to the effective Six Sigma implementation and therefore,

provide an insight for the objective of developing an effective implementation model for Six Sigma application in apparel industry in China.

In the next chapter, Chapter Four, explanation of the research methodology, survey questionnaire development, focus group and mass survey, and the data analysis tools are presented.

Chapter Four – Research Methodology

Chapter Three had defined the research model for fulfilling the utmost need to create an implementation model for Six Sigma for apparel industry in China. The key implementation elements, CSFs for its effective implementation and the desirable implementation outcomes of Six Sigma were elaborated. The research model was established and the correlations among the elements, factors and outcomes of Six Sigma approach were explained. The four sub-models contained under the research model were illustrated. To confirm the relationship among these sub-models and the implementation outcomes of Six Sigma methodology, 67 hypotheses were set. These propositions and the subsequent research tools, including the survey study, confirmatory factor analysis and regression analysis model, help establish a foundation in understanding and studying the prescribed interrelationship of the various elements and CSFs of Six Sigma strategy with that of the implementation outcomes for apparel industry in China.

At the end of this research study, it is able to provide more insights into the research topic and offer a confirmation result of the established propositions.

4.1 Research Method Outline

In order to test a series of propositions set up in last chapter based on extensive literature review of Six Sigma implementation and latest status for apparel manufacturing industry in China, both qualitative (focus group discussion) and

quantitative (a questionnaire survey targeting at apparel and apparel-related enterprises in China) research methods were employed.

Firstly, focus group interviews were conducted with a number of quality management and Six Sigma consultants/ experts for collecting their comments and suggestions regarding the proposed research model and survey questionnaire design. This exercise helps provide initial feedback on the research model approach and the draft survey questionnaire.

Upon gathering the comments and recommendations from the focus group study, the research model and survey questionnaire were fine-tuned to suit for the research study approach. The research direction and validity are confirmed to ensure the study outcomes fulfilling the research objectives and targets and that they helps future study in Six Sigma related topics and the implementation of Six Sigma in apparel industry in China.

In order to collect the industry data for studying and confirming the propositions established under the research model and the related correlation among the sub-models and implementation outcomes, an industry survey was conducted in early 2014. There are 10 enterprises belonging to apparel and apparel-related manufacturing industry participated in the survey. All the participating companies in the survey have prior experience in Six Sigma implementation and/ or are prepared for Six Sigma adoption with relevant selected staff having attended the Six Sigma training.

A total of 160 completed questionnaires were collected from the surveyed companies that are valid for conducting data analysis and further investigation study.

The research process of this study is illustrated in Figure 4-1.

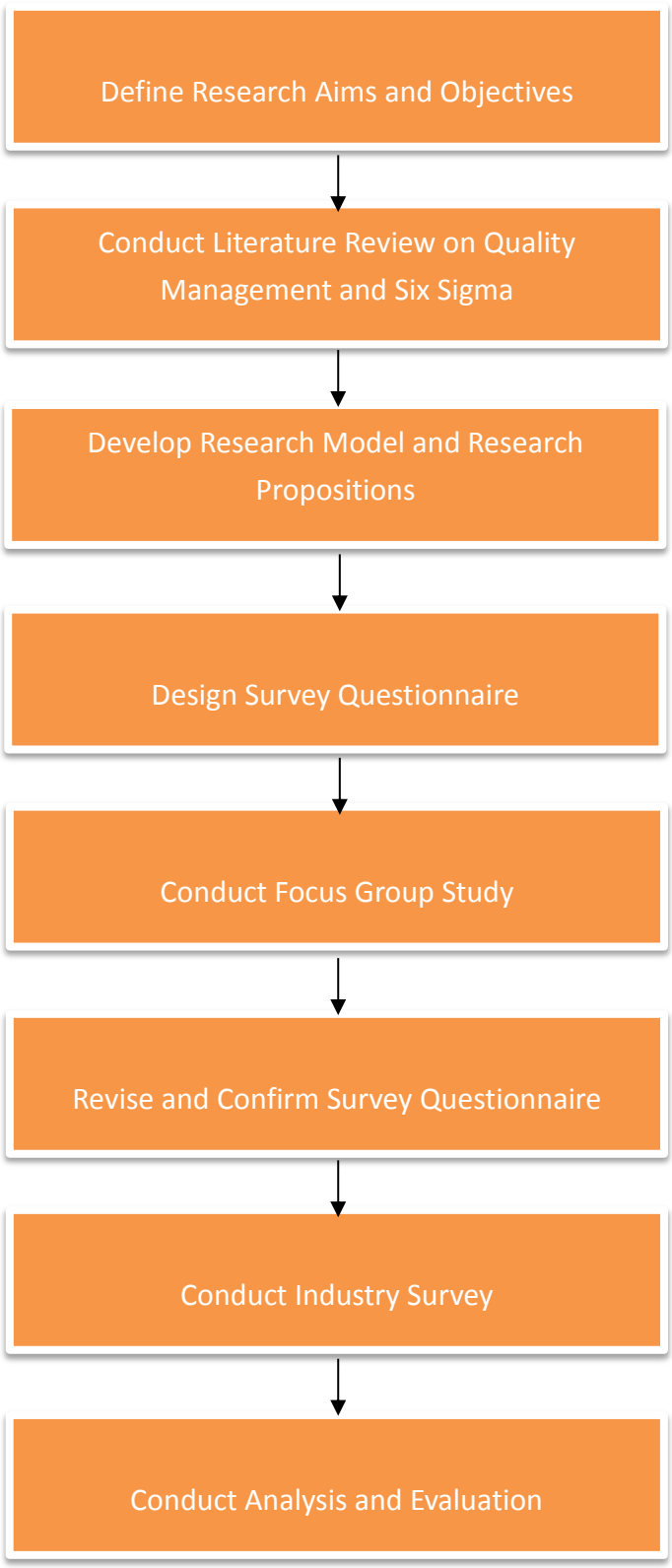


Figure 4-1: Research Flowchart of this Study

4.2 Focus Group Discussion

Following the development of research model and related sub-models, relevant research propositions are established. There are totally 67 hypotheses set up for investigating and confirming relationship among the 3 implementation elements and 11 CSFs of the Six Sigma implementation for apparel industry in China. As an industrial survey methodology is adopted for collecting the information and performing the evaluation, a survey questionnaire is therefore designed. For the sake of confirming the appropriateness of the survey direction and questionnaire approach, a focus group study over the survey questionnaire was conducted in 2013. The reason for using the focus group discussion in this study is that, it is one of the most popular methods employed to arouse and gather ideas and comments relating to survey approach and questionnaire development (Kwan, 2006; Churchill, 1996). In fact, the brainstorming, open-minded discussion and interactions during the focus group event are helpful in stipulating further insights and opinions that are valuable inputs to fine-tune the intended survey study and questionnaire design.

The focus group discussion consisted of 3 quality management professionals and/ or Six Sigma experts. They are experienced in providing quality management consultancy and training service, assisting companies from different industries (including manufacturing, finance, servicing, and so on) to adopt Six Sigma approach, as well as having long-term engagement in apparel industry in both Hong Kong and Mainland China. Two of the experts hold PhD degree and the

other one was graduated in textiles and clothing faculty in Hong Kong Polytechnic University in 1980's. All of them have over 15 years' working experience in their respective fields. They are all known by the researcher before conducting this research. Prior to confirming the selection of these experts, telephone calls and face-to-face briefings to them were conducted to ensure they are appropriate in participating in this exercise and that a balance of experience and focus can be achieved. The expert profiles of these participants are listed in Table 4-1 below.

Table 4-1: Profile of Participants in Focus Group

	Michael	**Maggie**	**Dr. Chan**
Sex	M	F	M
Age	53	43	48
Education Level	Master Degree	Doctor Degree	Doctor Degree
Occupation	Quality Consultant	In-house Master Black Belt	Management Consultant
Industry	Manufacturing and servicing	Finance	Manufacturing
Years of Work Experience	Over 30 years	Over 20 years	Over 25 years
Professional Qualification	Lead quality, environmental and occupational health and safety management system auditor/ Six Sigma Black Belt	Master Black Belt	Master Black Belt

The said discussion was conducted in Hong Kong. The participants were distributed with the preliminary information, survey background and draft questionnaire for study beforehand. This helps ensure that an initial understanding of the discussion can be gained. Participants were advised to take a thorough review of the information and they were invited to raise any questions during their preview of the provided materials.

In the course of the discussion, the researcher took the lead to brief the participants again the objectives of the exercise and the proceeding of the discussion. Permission was also asked from the participants to record the discussion for accurate transcription and as study reference. To ensure the best effective discussion in open manner by the group, it was addressed the confidentiality of discussion contents and outcomes. The discussion took approximately 2 hours. The research model was reviewed. Feedback on the survey approach and questionnaire was collected. In order to assure the reliability of the information, content review and analysis, that was conducted by re-evaluating the themes of content, were undertaken. The key contents of the discussion and the participants' main focus expressed were transcribed. All of this information is useful in enhancing the questionnaire and confirming the survey objectives.

Upon completion of the discussion, the researcher expressed thanks and appreciation to the participants for their kind involvement and effort for the exercise.

4.3 Main Research Study

4.3.1 Questionnaire Design

A survey questionnaire was developed for performing an industry survey to collect data regarding the understanding of the CSFs for implementation of Six Sigma in apparel industry in China. Additionally the questionnaire includes survey questions for assessing the relationship between CSFs and the Six Sigma implementation outcomes for China's apparel enterprises. The questions therein are made reference to previous research studies and theses relating to CSFs for the successful implementation of Six Sigma projects and key ingredients for a successful Six Sigma adoption. Moreover, additional questions are developed based upon the inputs from experienced consultants and Six Sigma practitioners.

There are five sections in the questionnaire consisting of 112 questions. Sections one to three contain 72 questions and they are measuring the critical factors of successful Six Sigma implementation. The fourth section covers the 4 Six Sigma outcomes, and there are 21 questions for the 4 factors. The fifth section collects the respondent profiles (19 questions for this part). As a result, there are 112 questions in total for the whole survey questionnaire. A summary of the questionnaire sections and the question number are provided in Table 4-2 below. For the details of the questions, please refer to the appendix.

Table 4-2: Summary of Questionnaire Sections

Section No.	Evaluation Element	Critical Success Factor	No. of Questions
1	Management's Intention and Commitment	Resources Allocation	5
		Management Participation and Involvement	7
2	Top Management Ability	Project Selection, Prioritization and Tracking	9
		Project Team Management	7
		Management by Objective and Fact	6
		Linking Six Sigma to Business Strategies	5
3	Organizational Ability	Communication and Organizational Culture	8
		Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review	8
		Linking Six Sigma to Customers	7
		Employee Attitude and Engagement	4
		Project Management Skills	6
4	Implementation Outcome of Six Sigma	Cost and Efficiency	6
		Continuous Improvement	5
		Customer and Employee Satisfaction	5
		Product and Service Quality	5
5	Respondent Profiles		19
Total			**112**

4.3.2 Sampling Strategy and Data Collection

The data for this study were drawn from an industrial survey that was designed to assess and understand the CSFs and the outcomes of Six Sigma implementation in China. As shown in Table 4-3 below, the sampled companies consist of apparel

and apparel-related enterprises. These companies are selected mainly from the directory of local trade associations or referral from Six Sigma consulting agents. 176 questionnaires were distributed to the 10 selected enterprises, which are located in the regions of Guangdong and Fujian Province in China. All of the 10 surveyed companies are either currently implementing Six Sigma projects or had experience in Six Sigma implementation. All of them have experience in some kinds of quality programs other than Six Sigma, including Lean, ISO 9001 and 5S. The majority of companies have Six Sigma implementation experience over 1 year. Their major (or some) clients are involved in apparel business.

Among the distributed questionnaires, 160 completed questionnaires were received. The overall response rate is 91%. The questionnaires were completed by staff in these companies, who are either directly participated in Six Sigma projects or have been trained for Six Sigma. A briefing session was conducted to each of the sampled companies to facilitate the data collection process. Every participant had three hours to complete the questionnaires, which were then collected on the same day. All levels of managerial staff participated.

Table 4-3: Demographics of Sampled Companies

Industry	Product	Location	Ownership	Company Size	Years of Six Sigma Experience	Completed Questionnaire
Apparel Manufacturing	Woven Jacket	Fujian Province	Mainland Chinese investment	Medium (101-500 employees)	3 Years	41
Apparel Manufacturing	Woven Jean	Guangdong Province	Mainland Chinese	Medium (101-500	2 Years	27

			investment	employees)		
Apparel-related Manufacturing	Fabric Trim	Guangdong Province	Foreign investment	Medium (101-500 employees)	4 Years	5
Apparel-related Manufacturing	Mold Cup	Guangdong Province	Foreign investment	Medium (101-500 employees)	3 Years	3
Apparel-related Manufacturing	Metal Parts	Guangdong Province	Foreign investment	Medium (101-500 employees)	3 Years	5
Apparel-related Manufacturing	Narrow Elastic Fabric	Guangdong Province	Foreign investment	Large (>500 employees)	5 Years	8
Apparel-related Manufacturing	Zipper	Guangdong Province	Mainland Chinese investment	Small (</=100 employees)	1 Year	15
Apparel-related Manufacturing	Button/ Buckle/ Toggle	Fujian Province	Foreign investment	Medium (101-500 employees)	2 Years	18
Apparel-related Manufacturing	Garment Knitted Fabric	Guangdong Province	Mainland Chinese investment	Medium (101-500 employees)	2 Years	18
Apparel-related Manufacturing	Garment Knitted Fabric	Guangdong Province	Mainland Chinese investment	Medium (101-500 employees)	1 Year	20

4.3.3 Data Analysis Tools

In this study, the author first used factor analysis to confirm the categorization on the survey questions. After that it is conducted for a reliability test on the 11 CSFs on 3 major elements of Six Sigma implementation (that is, Management's Intention and Commitment, Top Management Ability and Organizational Ability). Subsequently, the following regression models are designed to examine how the 3

implementation elements together with the CSFs (that is, Resources Allocation; Management Participation and Involvement; Linking Six Sigma to Business Strategies; Project Selection, Prioritization and Tracking; Project Team Management; Management by Objective and Fact; Linking Six Sigma to Customers; Project Management Skills; Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review; Communication and Organizational Culture; Employee Attitude and Engagement) affect the 4 Six Sigma implementation outcomes (that is, Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality).

For 3 Main Elements Hypothesis:

IO_1 = β0 + β1 Management's Intention and Commitment + β2 Top Management Ability + β3 Organizational Ability + β* Company and Respondent Information

For CSFs and Detail Content:

IO_1 = β0 + β1 Resources Allocation + β2 Management Participation and Involvement + β3 Linking Six Sigma to Business Strategies + β4 Project Selection, Prioritization and Tracking+ β5 Project Team Management + β6 Management by Objective and Fact + β7 Linking Six Sigma to Customers + β8 Project Management Skills + β9 Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review + β10 Communication and Organizational Culture + β11 Employee Attitude and Engagement + β* Company and

Respondent Information

For Successful Six Sigma Implementation:

$IO_2 = \beta 0 + \beta 1$ Cost and Efficiency + $\beta 2$ Continuous Improvement + $\beta 3$ Customer and Employee Satisfaction + $\beta 4$ Product and Service Quality + $\beta *$ Company and Respondent Information

IO_1 is the dependent variable that represents the implementation outcome of Six Sigma. IO_2 is the dependent variable that represents the success of Six Sigma implementation. "Company and Respondent Information" is the information of each survey respondent and their respective company.

4.4 Summary

In this chapter, the research methods, focus group discussion arrangement, and main research procedures and data analysis techniques employed for this study are discussed and justified. It is mentioned that both qualitative and quantitative methods were adopted as the research strategy to gather the mass data.

A focus group discussion and mass industry survey in apparel and apparel-related industry were conducted. The survey questionnaire was developed based on previous research and literature that is further reviewed and confirmed by quality management and Six Sigma experts.

Several major statistical techniques were performed including factor analysis, reliability testing, and regression model analysis, to test and confirm the research model and hypotheses.

In the subsequent chapter (Chapter Five), a detailed report of the information and data sampled and collected in the focus group and questionnaire survey is provided and explained.

Chapter Five – Results

The research methodology and analysis procedure are described in Chapter Four. Following the research process mentioned, the results of the investigation and analysis are given in this chapter. Chapter Five aims to provide a detailed report for the said research outcomes. The first section (Section 5.1) discusses about the feedback and comments of the focus group discussion. The second section (Section 5.2) details the factor analysis and reliability test undertaken to confirm the factor categorization and acceptance of the model approach. From the third to seventh section (Section 5.3 to Section 5.7), it is explained in details the survey outcomes, the data analysis findings and the investigation implications of the main research hypothesis and the 4 sub-models of this research topic. Tables and figures are presented in these sections to facilitate the result presentation and interpretation.

Lastly, there is a summary of this chapter and a brief review of the research outcomes in the eighth section (Section 5.8).

5.1 Focus Group Discussion

5.1.1 Discussion Findings

The discussion was carried out in a classroom in Hong Kong Polytechnic University. The participants were able to express ideas and comments for the survey methodology and questionnaire in an open, focus and relaxing

environment. No potential disturbance or interruption would happen during the course of discussion.

There are 10 discussion questions listed on the discussion form for study and review by the participants. A five-point Likert scale ranging from "1 – Disagreed" to "5 – Very Agreed" was adopted. The discussion questions are set based on the purpose of collecting the general ideas and comments from the participants regarding the questionnaire design and survey approach. The participants were asked to indicate their agreement level to each of these questions. If there was any query relating to the discussion questions, the participants might ask for information and clarification from the researcher immediately during the session.

The questions for review and discussion are summarized in Table 5-1 below.

Table 5-1: Summary of Questions for Review and Discussion by the Focus Group

1.	Are the evaluation statements for the first element "Management's Intention & Commitment" and its related critical success factors appropriate?
2.	Are the evaluation statements for the second element "Top Management Ability" and its related critical success factors appropriate?
3.	Are the evaluation statements for the third element "Organizational Ability" and its related critical success factors appropriate?

4.	Are the evaluation statements for Question 1. A.-U. appropriate?
5.	Are the evaluation statements for Question 2. A.-N. appropriate?
6.	Are the evaluation statements for Question 3. A.-L. appropriate?
7.	Are the questions covered by Respondent Profile appropriate?
8.	On the whole, are the evaluation statements in this Questionnaire feasible?
9.	On the whole, is this questionnaire suitable for apparel industry?
10.	On the whole, is this Questionnaire suitable for China enterprises?

After responding to the discussion questions, an idea and information exchange session was conducted. The researcher led the discussion group to study and discuss each of their answered questions and to raise further comments and feedback to the discussion topic.

A summary of the feedback to the discussion questions are provided in Table 5-2 below.

Table 5-2: Summary of Feedback to Discussion Questions

Questions	Evaluation*				
	1	2	3	4	5
1. Are the evaluation statements for the first element "Management's Intention & Commitment" and its related critical success factors appropriate?	-	-	2	1	-
2. Are the evaluation statements for the second element "Top Management Ability" and its related critical success factors appropriate?	-	-	1	2	-
3. Are the evaluation statements for the third element "Organizational Ability" and its related critical success	-	-	1	2	-

	factors appropriate?					
4.	Are the evaluation statements for Question 1. A.-U. appropriate?	-	-	1	2	-
5.	Are the evaluation statements for Question 2. A.-N. appropriate?	-	-	2	1	-
6.	Are the evaluation statements for Question 3. A.-L. appropriate?	-	-	1	2	-
7.	Are the questions covered by Respondent Profile appropriate?	-	-	-	3	-
8.	On the whole, are the evaluation statements in this Questionnaire feasible?	-	-	-	3	-
9.	On the whole, is this questionnaire suitable for apparel industry?	-	-	1	1	1
10.	On the whole, is this Questionnaire suitable for China enterprises?	-	-	-	2	1

From the feedback to the questions in the focus group discussion, it is confirmed that the participants agreed to the appropriateness of the contents of the 3 elements (that is, Management's Intention & Commitment, Top Management Ability and Organizational Ability) in the survey questionnaire. It was accepted to adopt those survey questions to collect information for the 3 implementation elements and 11 CSFs for effective Six Sigma implementation for understanding and testing their relationship with the four desirable Six Sigma implementation outcomes (that is, Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality).

In addition, the feedback from the participants further confirmed the subsequent 3 questions in the questionnaire that how are the elements and factors for effective Six Sigma implementation can contribute to related implementation outcomes. The discussion feedback showed they generally agreed that the questions are

appropriate to help find out the response and idea of how do the respondents will express properly to the conditions set out in related questions. They thought that the questions are acceptable in interpreting the targeted circumstances and as such appropriate response will be able to be provided and collected.

For the section "Respondent Profile", all the 3 participants expressed "Quite Agreed" to the adequacy of the questions in obtaining the respondents' background information. This respondents' information gathered is helpful in the subsequent analysis session for further investigating and understanding of the rationale of the findings in this research.

For discussion question 8, all the participants agreed that on the whole, the survey questionnaire is well designed to collect the desired information and it is appropriate to proceed the said survey in achieving the purpose. The evaluation statements are clear and appropriate to be interpreted and understood by the respondents.

Furthermore, it is generally accepted by the participants that this questionnaire is suitable for apparel industry. The questionnaire was developed after reviewing literature including a number of articles and papers relating to apparel industry. The questions were prepared targeting for collecting relevant information from apparel enterprises on the whole. It is therefore believed that the questionnaire is useful in conducting the survey for this research which aims at apparel and apparel-related industry.

The last question of the focus group discussion, discussion question 10, collected the feedback from the participants that whether the questionnaire is suitable for China enterprise. The overall response is that the questionnaire is well developed to suit for enterprises in China. It's agreed that the questions are suitable for conducting the survey targeting at China business circumstance.

In addition to the direct response from the participants to the above 10 discussion questions, selected comments and recommendations from them are stated as follows.

1. "On the whole, the questionnaire is suitable for apparel industry in China. It's desirable to further put more apparel's concerns in the questions." (Michael)

2. "It's good to consider more for SME aspects for apparel factories in China in the questionnaire as they're the major business circle in current China's industry." (Michael)

3. "There are basic requirements for implementing Six Sigma in China. These should be considered and may form another dimension of the questionnaire. I want to share with you my points of view as below:" (Michael)

    a. Top management is aware of and accepts the use of Six Sigma approach for her enterprise's improvement projects and company's culture change;

b. Top management commitment – The big boss needs not to get involved in the Six Sigma project, but at least s/he can appoint her/ his deputy to fully support the implementation of Six Sigma projects;

c. The current status of QMS the enterprise is implementing – based on ISO9001:2000, purely their internal system control or no system at all;

d. The capacity and capability of the middle level management of the enterprise;

e. The resources of the enterprise can be allocated to implement Six Sigma projects in terms of monetary and manpower;

f. The enterprise should sustain this new company culture and continuously look for new improvement projects according to the DMAIC cycle.

4. "It may need to have well prepared reports – financial reports, customer survey result, employee satisfaction result and so forth – before answering the questionnaire. For some SMEs of apparel and textiles industry in China, they may not be well equipped with this capability. It is ideal to inform and remind the participating companies and respondents for proper preparation of these materials before the survey." (Michael)

5. “For the content of the questionnaire, it’s well defined and statements are clear.” (Maggie)

6. “The survey form is quite comprehensive and takes some time to fill in.” (Maggie)

7. “The survey setting sounds like for HK companies but for China, you may want to add questions and explore more ideas for China enterprises.” (Maggie)

8. “May consider more face-to-face interaction with the respondents for completing this questionnaire. Have a brief explanation session before starting the survey. This will help you explore more interesting findings during and after the survey. If you need lots of data for statistical analysis, then it is better to send out survey. But if you need more qualitative information for thesis paper, it is worth to have in depth face to face interview to see the Six Sigma driver for China enterprises.” (Maggie)

9. “You may ask not only executive leader but also senior management. It happens very commonly in SMEs that the executive may not really understand the situation in the production floor.” (Dr. Chan)

10. “I suggest you to include some questions to ask for continuous improvement concept in your model.” (Dr. Chan)

11. “You may ask more specific in the survey, e.g. how many time corporate leader join the quality related meeting?” (Dr. Chan)

12. “You may ask whether they have used proper Six Sigma project management skills in the process?” (Dr. Chan)

13. Implementation outcomes should be clearly asked and whether they are related to each of the implementation elements and critical success factors.” (Dr. Chan)

Consistent with the findings of Ma et al. (2008), Six Sigma strategy works in a top-down approach that is led by enthusiastic and esteemed top management. The above response pointed out that the survey should target at different level of an organization, especially at the executive and senior management level. Particularly for some management information and data that are needed for replying to the survey, it is obvious that face-to-face interview with the executive level members may be more appropriate to collect the feedback and response from the candidates.

From the discussion, participants believed that the survey approach and questionnaire developed are suitable for this research. Although they expressed a few comments and improvement proposals to the survey, it is generally agreed that the questionnaire and related survey procedure are feasible. There is not any response in the discussion questions that the participants show “1 – Disagreed” or

"2 – Slightly Disagreed". Even though there are a few comments that may urge for minor amendments to the questionnaire draft, the response is very positive to adopt the survey method and questionnaire for the research.

As a result of the focus group discussion practice, the questionnaire draft was updated to reflect the comments and recommendations gathered in the exercise. The following section will explain the revision of the questionnaire and how it is adopted in the survey for the research.

5.1.2 Revision of Survey Questionnaire

Based on the outcomes of focus group discussion, more insight into the major elements and CSFs toward effective Six Sigma implementation for apparel industry in China was achieved. There are sufficient comments and recommendations collected for fine-tuning the questionnaire in the survey. After analyzing the information gathered from the discussion, the questionnaire was updated in various aspects. These revisions include:

- The inclusion of more China-related elements in the questionnaire to fit for implementation practice and culture for organization operating in China. For example, these are appended to survey statements in sections of "Resources Allocation", "Communication & Organizational Culture", and so on;

- According to the common problems facing China enterprises while

implementing Six Sigma especially for SMEs as mentioned in Chapter Two, such as the issue of “Financial Limitation” and “Lack of Strategic Vision/ Long-term Goals Formulation”, relevant sections in the questionnaire were updated to allow a clearer description of survey statements to facilitate accurate collection of related information;

- As mentioned by all discussion participants, top management’s commitment and involvement in the survey is critical to gather accurate and hands-on information, the questionnaire statements are greatly incurred content relating to top management and company executive level;

- To enable the collection of more specific information in the survey, both management and operational level staff were arranged to take part in the survey. A face-to-face briefing and introduction to the survey objectives, survey approach and questionnaire content were provided before filling in the survey statements. There are also survey questions in the last sections as well as in the Respondent Profile that ask for detailed feedback for the implementation information and organizational performance of Six Sigma projects;

- Similar to ISO 9001 QMS, the Six Sigma approach emphasizes in process approach. To understand how successful an organization in implementing Six Sigma strategy is, the assessment over process management and related technique adopted is important. It is therefore

the questionnaire places significant content and emphasis in top management ability and organizational capability to manage Six Sigma projects. Zu et al. (2011) also highlighted that it is advisable to companies in China to set up explicit implementation plans and improvement strategies as well as rules and policies to regulate employees' behaviors toward the organization's quality improvement mission;

- To ensure a clear understanding of how the Six Sigma elements and CSFs will contribute to the desirable implementation outcomes of Six Sigma, Question 3 statements were further stated to collect idea for how the respondents feel about these would be rated in their satisfaction level during the process. These can provide further insight of how the elements and factors are related to the effective implementation of Six Sigma.

As a result of these amendments and updating to the questionnaire, the revised version was released in 2014 and the survey was conducted afterward.

A survey questionnaire sample is provided in the appendix of this thesis report.

5.2 Factor Analysis and Reliability Test

The results of factor analysis (factors loading) and reliability test (Cronbach's alpha) are given in Table 5-3 below.

Table 5-3: Results of the CSFs Analysis for All Three Implementation Elements for Effective Six Sigma Implementation

Element I: Management's Intention and Commitment

	Factor 1	Factor 2	
	Resources Allocation	Management Participation and Involvement	Cronbach's alpha
Resources Allocation 1	0.736		0.701
Resources Allocation 2	0.763		
Resources Allocation 3	0.642		
Resources Allocation 4	0.557		
Resources Allocation 5	0.651		
Management Participation and Involvement 1		0.778	0.839
Management Participation and Involvement 2		0.784	
Management Participation and Involvement 3		0.785	
Management Participation and Involvement 4		0.626	
Management Participation and Involvement 5		0.715	
Management Participation and Involvement 6		0.737	
Management Participation and Involvement 7		0.538	
Eigenvalue	3.732	2.242	
Cum. var explained (%)	31.103	49.789	

Element II: Top Management Ability

	Factor 1	Factor 2	Factor 3	Factor 4	
	Project Selection, Prioritization and Tracking	Project Team Management	Management by Objective and Fact	Linking Six Sigma to Business Strategies	Cronbach's alpha
Project Selection, Prioritization and Tracking 1	0.438				0.824
Project Selection, Prioritization and Tracking 2	0.700				
Project Selection, Prioritization and Tracking 3	0.679				

Project Selection, Prioritization and Tracking 4	0.462				
Project Selection, Prioritization and Tracking 5	0.594				
Project Selection, Prioritization and Tracking 6	0.632				
Project Selection, Prioritization and Tracking 7	0.651				
Project Selection, Prioritization and Tracking 8	0.671				
Project Selection, Prioritization and Tracking 9	0.474				
Project Team Management 1		0.452			0.652
Project Team Management 2		0.492			
Project Team Management 3		0.588			
Project Team Management 4		0.708			
Project Team Management 5		0.440			
Project Team Management 6		0.755			
Project Team Management 7		0.732			
Management by Objective and Fact 1			0.505		0.718
Management by Objective and Fact 2			0.696		
Management by Objective and Fact 3			0.804		
Management by Objective and Fact 4			0.556		
Management by Objective and Fact 5			0.550		
Management by Objective and Fact 6			0.515		
Linking Six Sigma to Business Strategies 1				0.483	0.751
Linking Six Sigma to Business Strategies 2				0.709	
Linking Six Sigma to Business Strategies 3				0.830	
Linking Six Sigma to Business Strategies 4				0.643	
Linking Six Sigma to Business Strategies 5				0.640	
Eigenvalue	6.009	4.007	2.063	1.578	
Cum. var explained (%)	22.254	37.093	44.732	50.575	

Element III: Organizational Ability

	Factor 1 Communication and Organizational Culture	Factor 2 Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review	Factor 3 Linking Six Sigma to Customers	Factor 4 Employee Attitude and Engagement	Factor 5 Project Management Skills	Cronbach's alpha
Communication and Organizational Culture 1	0.704					0.794
Communication and Organizational Culture 2	0.596					
Communication and Organizational Culture 3	0.451					
Communication and Organizational Culture 4	0.499					
Communication and Organizational Culture 5	0.443					
Communication and Organizational Culture 6	0.610					
Communication and Organizational Culture 7	0.690					
Communication and Organizational Culture 8	0.648					
Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review 1		0.545				0.813
Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review 2		0.568				
Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review 3		0.550				
Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review 4		0.656				
Understanding of Six Sigma Methodology, Tools and Techniques and Progress		0.660				

Review 5						
Understanding of Six Sigma Methodology,						
Tools and Techniques and Progress		0.680				
Review 6						
Understanding of Six Sigma Methodology,						
Tools and Techniques and Progress		0.638				
Review 7						
Understanding of Six Sigma Methodology,						
Tools and Techniques and Progress		0.481				
Review 8						
Linking Six Sigma to Customers 1			0.701			0.829
Linking Six Sigma to Customers 2			0.850			
Linking Six Sigma to Customers 3			0.746			
Linking Six Sigma to Customers 4			0.641			
Linking Six Sigma to Customers 5			0.540			
Linking Six Sigma to Customers 6			0.574			
Linking Six Sigma to Customers 7			0.607			
Employee Attitude and Engagement 1				0.651		0.626
Employee Attitude and Engagement 2				0.521		
Employee Attitude and Engagement 3				0.626		
Employee Attitude and Engagement 4				0.593		
Project Management Skills 1					0.430	0.710
Project Management Skills 2					0.584	
Project Management Skills 3					0.633	
Project Management Skills 4					0.417	
Project Management Skills 5					0.522	
Project Management Skills 6					0.591	
Eigenvalue	6.868	3.422	3.009	1.813	1.643	
Cum. Var explained (%)	20.812	31.181	40.300	45.795	50.774	

*Only the significance loadings (>0.4) are shown in the tables (Numally, 1978).

Table 5-3, Element I, II and III show the results of the principal component analysis for all three major elements for effective Six Sigma implementation. As being seen in the tables, the factor loadings confirm our categorizations on CSFs.

In addition, all Cronbach's alpha values (0.626 ~ 0.839) are higher than the threshold level of 0.6 recommended for exploratory research by Numally (1978). These indicate that the reliability for the CSFs is established.

5.3 Main Research Study

In this section, the study presents the results of main hypotheses. The relationship between the three main implementation elements (that is, Management's Intention and Commitment, Top Management Ability, and Organizational Ability) and Six Sigma implementation outcomes (that is, Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality) is investigated. This will provide proof and guideline for enterprise's management for which main elements they should focus to get the specific results.

The results are given in Table 5-4 below.

Table 5-4: Parameter Estimates (t-statistics) from Regression Results for the Four Implementation Outcomes of Six Sigma

	Cost and Efficiency		Continuous Improvement		Customer and Employee Satisfaction		Product and Service Quality	
Intercept	0.444	-0.356	0.083	-0.086	-0.065	(-0.065)*	1.687	(1.474)*
Management's Intention and Commitment	0.257	(1.574)*	0.331	(2.688)***	0.298	(2.319)**	0.025	-0.167
Top Management Ability	-0.076	(-0.356)	-0.329	(-2.051)	-0.19	(-1.137)	-0.11	(-0.566)
Organizational Ability	0.741	(3.485)***	0.829	(5.166)***	0.96	(5.736)***	0.76	(3.898)***
Nature of business (Manufacturing)	-	-	-0.261	(-1.686)	0.072	-0.444	-	-
Nature of business(Servicing)	0.097	-0.472	-	-	-	-	-0.092	(-0.491)
Position	0.155	(1.504)*	0.027	-0.349	-0.047	(-0.584)	0.069	-0.736
Role in Six Sigma implementation	-0.091	(-1.194)	-0.028	(-0.482)	0.016	-0.262	-0.083	(-1.188)
Internal or external Six Sigma role	-0.033	(-0.084)*	0.431	(1.455)*	-0.897	(-2.906)	-0.049	(-0.136)
Permanent or part-time Six Sigma role	-0.393	(-2.184)	0.083	-0.61	0.01	-0.074	-0.33	(-2.002)
Company size	0.223	(3.098)***	-0.073	(-1.350)	-0.07	(-1.243)	0.316	(4.788)***
Years of Six Sigma implementation (Individuals)	0.069	-1.275	0.062	(1.518)*	0.066	(1.549)*	-0.068	(-1.373)
Years of Six Sigma implementation (Company)	-0.01	(-0.148)	0.187	(3.641)***	0.145	(2.706)***	0.068	-1.084
Education level	-0.097	(-0.946)	-0.003	(-0.038)**	-0.108	(-1.349)	0.016	-0.17
Education background (Engineering)	0.079	-0.809	-0.002	(-0.027)**	-0.025	(-0.330)	-0.01	(-0.110)*
Education background (Others)	0.102	-0.564	0.086	-0.626	-0.23	(-1.605)	0.088	-0.528
Average time of Six Sigma project	-0.108	(-0.687)	-0.08	(-0.674)	-0.111	(-0.897)	-0.198	(-1.368)
Six sigma training population	-0.174	(-2.212)	0.035	-0.598	-0.029	(-0.476)	-0.091	(-1.271)
Six sigma implementation population	0.094	-1.1	0.084	(1.301)*	0.09	(1.340)*	0.026	-0.336
Six sigma master black belts population	-0.008	(-0.027)**	0.199	-0.855	0.659	(2.711)***	0.35	-1.236
Six sigma black belts population	0.144	-0.504	-0.073	(-0.340)	-0.114	(-0.508)	-0.107	(-0.411)
Six sigma green belts population	0.065	-1.203	-0.024	(-0.591)	0.047	-1.102	0.073	(1.478)*
No. of finished Six Sigma projects (annually)	0.063	-0.415	0.045	-0.396	0.133	-1.117	-0.063	(-0.460)
Average saving	0.049	-0.678	-0.089	(-1.624)	0.009	-0.149	-0.126	(-1.905)
n	161		161		161		161	
Model F Value	4.986***		6.024***		10.386***		4.584***	
R^2	46.30%		51.30%		64.50%		44.30%	
Adjusted R^2	37.00%		42.80%		58.30%		34.60%	
R^2 for Control Factors	30.30%		25.00%		39.90%		32.60%	
Incremental R^2	16.10%		26.20%		24.60%		11.70%	
Adjusted R^2 for Control Factors	20.10%		14.00%		31.00%		22.70%	
Incremental adjusted R^2	17.00%		28.80%		27.20%		11.90%	

All tests are one-tailed: *p ≤ 0.10; **p ≤ 0.05; ***p ≤ 0.01

Table 5-4 presents the results of the regression model. H1-1 to H1-4 predict that Management's Intention and Commitment has a positive influence on the outcomes of Six Sigma implementation. The coefficients of Management's Intention and Commitment are positive and significant for Cost and Efficiency, Continuous improvement, and Customer and Employee Satisfaction. The result

shows it is especially highly significant for Continuous Improvement. This result supports H1-1, H1-2, and H1-3, which indicates Management's Intention and Commitment has a positive influence on Six Sigma implementation from Cost and Efficiency, Continuous Improvement, and Customer and Employee Satisfaction aspects. However, the H1-4 is not supported because the coefficients of Management's Intention and Commitment are not significant for Product and Service Quality.

H2-1 to H2-4 predict that Top Management Ability has a positive influence on the outcomes of Six Sigma implementation. Table 5-4 shows that the estimated coefficients for Top Management Ability are all negative and not significant for all models. Therefore, this result cannot support H2-1, H2-2, H2-3, and H2-4.

H3-1 to H3-4 predict that Organizational Ability has a positive influence on the outcomes of Six Sigma implementation. Table 5-4 shows that the coefficients of Organizational Ability are positive and highly significant for all models. This result supports H3-1 to H3-4, which means Organizational Ability has a significant positive influence on Six Sigma implementation from Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality aspects.

Overall, the four regression models are highly significant with F value of 4.986, 6.024, 10.386, and 4.584 respectively for Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality. The R^2 (adjusted R^2) are 46.3% (37.0%), 51.3% (42.8%), 64.5%

(58.3%) and 44.3% (34.6%) respectively, which are acceptable and comparable to similar studies. Moreover, the range of variance inflation factor (VIF) is 1.133-5.172 that is below the traditional rule of thumb threshold value of 10 and a more stringent threshold value of 6 (Cohen, Cohen et al., 2003). This indicates that the regression coefficients have no multi-collinearity issue.

As being shown in Table 5-4, the Organizational Ability is the most important element to address in adopting Six Sigma methodology. The CSFs related to this element affect all the outcomes for Six Sigma implementation. This finding is similar to the previous studies in this field. Some studies that compared the status of quality management practices in China was close to the developing countries such as India and Mexico, and was even comparable to the developed countries such as the USA and Norway, but Chinese companies had different beliefs and focus in their implementation (Zu et al., 2011). Organizational culture and ability have been widely considered as critical for effective quality management implementation (Prajogo and Mcdermott, 2005). Implementation factors like project management skills, ability to apply Six Sigma methodology, tools and techniques, communication, and employee attitude and engagement, are especially the significant subjects affecting the effectiveness of a Six Sigma project. Antony and Banuelas (2002) and Coronado and Antony (2002) highlighted the core factors for successful introduction and implementation of Six Sigma approach in manufacturing and service organizations in their studies and that organizational ability namely linking Six Sigma to customers, project management skills, understanding of Six Sigma methodology, tools and techniques and progress review, cultural change, linking Six Sigma to human

resources, and so on, is an indispensable part for Six Sigma's success.

The second important element is Management's Intention and Commitment. It will affect the Cost and Efficiency, Continuous Improvement, and Customer and Employee Satisfaction, especially significant for Continuous Improvement. The finding is supported by the previous research in past few years. Six Sigma requires top management's dedication and contribution to resources and effort (Kwak and Anbari, 2006). For Six Sigma, a good example is GE's former CEO, Jack Welch. He was praised for his tremendous involvement in launching and supporting the Six Sigma adoption in GE (Henderson and Evans, 2000). It is well believed that sufficient top management's intention and commitment to quality improvement programs like Six Sigma will have a strong positive influence on the overall effectiveness of the projects, and that will enhance cost and efficiency internally which as a result, improves the customer and employee satisfaction. Implementation of Six Sigma projects means commitment of resources, time, money, and effort from the entire organization (Kwak and Anbari, 2006). They claimed the organizations' CEOs are often involved extensively in the successful implementation of Six Sigma approach.

In order to have a more in-depth idea of how three main elements will affect the Six Sigma implementation, related test will be performed for each of the CSFs under those three main elements. This will give a clearer idea to top management of the enterprises that for what factors they should focus to get the desired results. Below listed are the results for each factor with detailed data.

This study will examine the overall performance first in the following table (Table 5-5). After then it will focus on each main element and perform test separately for them.

Table 5-5: Parameter Estimates (t-statistics) from Regression Results for the Four Implementation Outcomes of Six Sigma (Detailed Data)

	Cost and Efficiency			Continuous Improvement			Customer and Employee Satisfaction			Product and Service Quality		
	B	t	Sig.	B	t	Sig.	B	t	Sig.	B	t	Sig.
Intercept	0.197	(0.153)	0.439	0.472	(0.482)	0.315	0.051	(0.05)	0.480	1.609	(1.417)*	0.080
Resources Allocation	0.180	(1.595)*	0.057	0.021	(0.246)	0.403	-0.052	(-0.581)	0.438	0.049	(0.491)	0.312
Management Participation and Involvement	0.041	(0.325)	0.373	0.297	(3.116)***	0.001	0.256	(2.563)***	0.006	-0.003	(-0.025)**	0.020
Linking Six Sigma to Business Strategies	-0.121	(-1.048)	0.703	-0.055	(-0.626)	0.468	0.004	(0.041)	0.484	-0.079	(-0.775)	0.560
Project Selection, Prioritization and Tracking	0.084	(0.585)	0.280	-0.227	(-2.087)	0.961	-0.178	(-1.567)	0.880	0.211	(1.662)**	0.050
Project Team Management	0.235	(1.241)	0.108	0.066	(0.469)	0.320	0.061	(0.412)	0.340	0.109	(0.656)	0.257
Management by Objective and Fact	-0.097	(-0.677)	0.500	-0.147	(-1.356)	0.822	-0.065	(-0.577)	0.435	-0.377	(-2.982)	0.997
Linking Six Sigma to Customers	0.333	(2.46)***	0.008	0.085	(0.834)	0.203	0.337	(3.166)***	0.001	0.067	(0.562)	0.288
Project Management Skills	-0.125	(-0.813)	0.582	0.410	(3.563)***	0.000	0.194	(1.609)*	0.055	-0.225	(-1.663)	0.901
Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review	0.046	(0.332)	0.370	0.092	(0.885)	0.189	0.037	(0.338)	0.368	0.321	(2.627)***	0.005
Communication and Organizational Cultural	0.192	(1.213)	0.114	0.241	(2.025)**	0.023	0.458	(3.682)***	0.000	0.548	(3.931)***	0.000
Employee Attitude and Engagement	0.132	(0.948)	0.173	0.043	(0.416)	0.339	-0.033	(-0.305)	0.239	-0.036	(-0.289)	0.227
Nature of business (Manufacturing)				-0.231	(-1.489)	0.861	0.065	(0.402)	0.344			
Nature of business(Servicing)	0.011	(0.052)	0.479							-0.035	(-0.191)	0.151
Position	0.184	(1.774)**	0.039	0.022	(0.288)	0.387	-0.076	(-0.936)	0.649	0.080	(0.879)	0.191
Role in Six Sigma implementation	-0.082	(-1.079)	0.717	-0.024	(-0.42)	0.325	0.026	(0.438)	0.331	-0.092	(-1.37)	0.827
Internal or external Six Sigma role	0.080	(0.162)	0.436	0.138	(0.372)	0.355	-0.840	(-2.164)	0.968	0.061	(0.141)	0.444
Permanent or part-time Six Sigma role	-0.336	(-1.691)	0.907	-0.037	(-0.246)	0.194	-0.019	(-0.122)*	0.097	-0.101	(-0.578)	0.436
Company size	0.127	(1.313)*	0.096	0.057	(0.786)	0.217	0.037	(0.481)	0.316	0.239	(2.797)***	0.003
Years of Six Sigma implementation (Individuals)	0.060	(1.115)	0.134	0.068	(1.694)**	0.046	0.060	(1.431)*	0.077	-0.060	(-1.268)	0.793
Years of Six Sigma implementation (Company)	0.055	(0.731)	0.233	0.117	(2.084)**	0.020	0.114	(1.934)**	0.028	0.151	(2.283)**	0.012
Education level	-0.019	(-0.182)	0.144	-0.029	(-0.36)	0.281	-0.155	(-1.868)	0.936	0.037	(0.4)	0.345
Education background (Engineering)	0.069	(0.705)	0.241	0.021	(0.283)	0.389	0.013	(0.17)	0.432	0.031	(0.362)	0.359
Education background (Others)	0.205	(1.087)	0.140	0.055	(0.391)	0.348	-0.245	(-1.655)	0.899	0.137	(0.828)	0.205
Average time of Six Sigma project	-0.081	(-0.507)	0.387	-0.158	(-1.318)	0.810	-0.113	(-0.896)	0.628	-0.212	(-1.504)	0.865
Six sigma training population	-0.156	(-1.871)	0.936	-0.026	(-0.413)	0.320	-0.050	(-0.763)	0.553	-0.050	(-0.687)	0.507
Six sigma implementation population	0.113	(1.288)*	0.100	0.113	(1.72)**	0.044	0.107	(1.558)*	0.061	0.036	(0.471)	0.319
Six sigma master black belts population	0.124	(0.391)	0.348	-0.008	(-0.032)**	0.026	0.574	(2.316)**	0.011	0.404	(1.452)*	0.075
Six sigma black belts population	0.085	(0.297)	0.384	0.068	(0.314)	0.377	-0.074	(-0.328)	0.256	-0.209	(-0.827)	0.590
Six sigma green belts population	0.058	(1.032)	0.152	0.004	(0.104)	0.459	0.042	(0.968)	0.168	0.063	(1.286)	0.101
No. of finished Six Sigma projects (annually)	-0.013	(-0.084)*	0.067	0.019	(0.161)	0.436	0.068	(0.558)	0.289	-0.071	(-0.522)	0.397
Average saving	0.037	(0.468)	0.320	-0.033	(-0.555)	0.420	0.050	(0.801)	0.212	-0.120	(-1.737)	0.915
n		161			161			161			161	
F		4.172	0.000		5.082	0.000		8.333	0.000		4.504	0.000
R Square		51.3%			56.4%			67.9%			53.2%	
Adjusted R Square		39.0%			45.3%			59.8%			41.4%	
R^2 for Control Factors		30.30%			25.00%			39.90%			32.60%	
Incremental R^2		20.96%			31.37%			28.03%			20.57%	
Adjusted R^2 for Control Factors		20.10%			14.00%			31.00%			22.70%	
Incremental adjusted R^2		18.88%			31.28%			28.78%			18.66%	

Table 5-5 presents the results of the regression model for each element. On the whole, the four regression models are highly significant with F value of 4.172, 5.082, 8.333, and 4.504 respectively for Cost and Efficiency, Continuous

Improvement, Customer and Employee Satisfaction, and Product and Service Quality. The R^2 (adjusted R^2) are 51.3% (39.0%), 56.4% (45.3%), 67.9% (59.8%) and 53.2% (41.4%) respectively, which are quite acceptable. Moreover, the range of variance inflation factor (VIF) is 1.236-5.577 that is below the traditional rule of thumb threshold value of 10 and a more stringent threshold value of 6 (Cohen, Cohen et al., 2003). This indicates that the regression coefficients have no multi-collinearity issues.

The overall analysis results for CSFs are similar to the main element results, which show that the Organizational Ability is the most important element for Six Sigma implementation. The second important implementation element is the Management's Intention and Commitment. This research is going to identify the detailed success factors in the four studies below.

5.4 Model I - Management's Intention and Commitment

In this section, it goes to examine the relationship between the CSFs fall within scope of Management's Intention and Commitment and the four Six Sigma implementation outcomes (that is, Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality). Here are the results for H1a-H1h as shown in Table 5-6 below.

Table 5-6: Parameter Estimates (t-statistics) from Regression Results for the Four Implementation Outcomes of Six Sigma - CSFs for Management's Intention and Commitment

	Cost and Efficiency			Continuous Improvement			Employee and Customer Satisfaction			Product and Service Quality		
	B	t	Sig.	B	t	Sig.	B	t	Sig.	B	t	Sig.
Resources Allocation	0.180	(1.595)*	0.057	0.021	(0.246)	0.403	-0.052	(-0.581)	0.438	0.049	(0.491)	0.312
Management Participation and Involvement	0.041	(0.325)	0.373	0.297	(3.116)***	0.001	0.256	(2.563)***	0.006	-0.003	(-0.025)**	0.020

H1a-H1d predict that Resources Allocation has a positive influence on the outcomes of Six Sigma implementation. The coefficients of Resources Allocation is positive and significant for Cost and Efficiency (p-value: 0.057), which supports H1a. The coefficients of Resources Allocation is positive but not significant for Continuous improvement (p-value: 0.403), Customer and Employee Satisfaction (p-value: 0.438), and Product and Service Quality (p-value: 0.312), which does not support H1b, H1c, and H1d.

H1e-H1h predict that the Management Participation and Involvement has a positive influence on the outcomes of Six Sigma implementation. The coefficients of the Management Participation and Involvement is positive but not significant for Cost and Efficiency (p-value: 0.057), which does not support H1e. The coefficients of the Management Participation and Involvement is positive and significant for Continuous improvement (p-value: 0.001), Customer and Employee Satisfaction (p-value: 0.006), and Product and Service Quality (p-value: 0.020), which supports H1f, H1g, and H1h.

This result shows that Resources Allocation only contributes to Cost and Efficiency. There is a significant relationship between them because implementing quality improvement programs normally request adequate resource support. For Six Sigma to work well, implementation must be with the impetus of the top management (Thevnin, 2004). He emphasized that top management should be dedicatedly involved from the onset of the program. It must also be part of the vision of the organization with resources and human capital dedicated

for its ensured success. Six Sigma approach employs statistical technique to enhance improvement. People knowledge and capability are key elements to its success. To achieve its objectives, both Six Sigma project teams and employees need to be sufficiently trained to equip them with the necessary techniques and awareness respectively for a successful implementation. With the strong support from top management to invest in resources allocation, Six Sigma implementation will then gain its greatest effect and desired outcomes. Part of Six Sigma's other benefits was that it enabled the organization to maintain the focus on operational efficiency and magnify explicitly the impact when operation and process improve subsequently (Thevnin, 2004). Overall, the research results by Swink and Jacobs (2012) indicated that the benefits of Six Sigma adoption tend to more than compensate for associated costs and requirement investments.

Another factor under the first element Management's Intention and Commitment - Management Participation and Involvement, is found to have influence over Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality. Six Sigma requires top management's dedication and contribution to resources and effort (Kwak and Anbari, 2006). Johnson and Swisher (2003) addressed for successful Six Sigma application, it is critical to have sustained and visible management commitment and involvement. Management's active participation and extensive involvement in Six Sigma projects will highly enhance employees' attention and focus to product and service improvement. The overall organizational culture will be changed to quality focus, and continuous improvement will be of paramount importance to everyone's mind in the company-wide environment. As a result, both customers

and employees will be better satisfied with the improved operation and performance. As mentioned by Thevnin (2004), the significant competitive advantage that can be obtained from implementing Six Sigma is by way of the three basic resources: customer, process, and employee.

5.5 Model II – Top Management Ability

In this section, it will examine the relationship between the second element Top Management Ability and the four Six Sigma implementation outcomes (that is, Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality). The results for testing H2a-H2p are given in Table 5-7 below.

Table 5-7: Parameter Estimates (t-statistics) from Regression Results for the Four Implementation Outcomes of Six Sigma - CSFs for Top Management Ability

	Cost and Efficiency			Continuous Improvement			Employee and Customer Satisfaction			Product and Service Quality		
	B	t	Sig.	B	t	Sig.	B	t	Sig.	B	t	Sig.
Linking Six Sigma to Business Strategies	-0.121	(-1.048)	0.703	-0.055	(-0.626)	0.468	0.004	(0.041)	0.484	-0.079	(-0.775)	0.560
Project Selection, Prioritization and Tracking	0.084	(0.585)	0.280	-0.227	(-2.087)	0.961	-0.178	(-1.567)	0.880	0.211	(1.662)**	0.050
Project Team Management	0.235	(1.241)	0.108	0.066	(0.469)	0.320	0.061	(0.412)	0.340	0.109	(0.656)	0.257
Management by Objective and Fact	-0.097	(-0.677)	0.500	-0.147	(-1.356)	0.822	-0.065	(-0.577)	0.435	-0.377	(-2.982)	0.997

H2a-H2d predict that Linking Six Sigma to Business Strategies has a positive influence on the outcomes of Six Sigma implementation. The coefficients of the Linking Six Sigma to Business Strategies is positive but not significant for Cost and Efficiency (p-value: 0.703), Continuous Improvement (p-value: 0.468), Customer and Employee Satisfaction (p-value: 0.484), and Product and Service Quality (p-value: 0.560). Overall, it does not support H2a, H2b, H2c, and H2d.

H2e-H2h predict that Project Selection, Prioritization and Tracking has a positive

influence on the outcomes of Six Sigma implementation. The coefficients of the Project Selection, Prioritization and Tracking is positive but not significant for Cost and Efficiency (p-value:0.280), Continuous Improvement (p-value: 0.961), and Customer and Employee Satisfaction (p-value: 0.880). This factor does not support H2e, H2f, and H2g. The coefficients of the Project Selection, Prioritization and Tracking is positive and significant for Product and Service Quality (p-value: 0.050), which means it supports H2h.

H2i-H2l predict that Project Team Management has a positive influence on the outcomes of Six Sigma implementation. The coefficients of the Project Team Management is positive but not significant for Cost and Efficiency (p-value: 0.108), Continuous Improvement (p-value: 0.320), Customer and Employee Satisfaction (p-value: 0.340), and Product and Service Quality (p-value: 0.257). This Six Sigma factor does not support H2i, H2j, H2k, and H2l.

H2m-H2p predict that Management by Objective and Fact has a positive influence on the outcomes of Six Sigma implementation. The coefficients of the Management by Objective and Fact is positive but not significant for Cost and Efficiency (p-value: 0.500), Continuous Improvement (p-value: 0.822), Customer and Employee Satisfaction (p-value: 0.435), and Product and Service Quality (p-value:0.997). Hypothesis H2m, H2n, H2o, and H2p are not supported by this factor.

The result shows that there is only a positive relationship associated with Project Selection, Prioritization and Tracking to Product and Service Quality. The Six

Sigma method is a project-driven management approach to improve the organization's products, services, and processes by continually reducing defects in the organization (Kwak and Anbari, 2006). Johnson and Swisher (2003) mentioned that for successful Six Sigma implementation it is critical to pick and select strategically important projects. In Six Sigma implementation process, it is often conducted on project-based approach. It is therefore the Six Sigma projects have to be carefully considered, reviewed, planned, and selected to maximize the benefits of its application. In a research project by Antony and Banuelas (2002), Project Selection, Prioritization and Tracking is ranked number 5 of the importance as key ingredients for effective implementation of Six Sigma program. It is highly addressed to have proper criteria for the selection and prioritization of projects. Kwak and Anbari (2006) stated that the project has to be feasible, organizationally and financially beneficial, and customer oriented. This factor will have a direct effect upon the operation and process improvement and therefore, the product and service quality will be subsequently enhanced on a continual manner.

5.6 Model III – Organizational Ability

In this section, the relationship between the CSFs of Organizational Ability and the four Six Sigma implementation outcomes (that is, Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality) is examined. The analysis results for H3a-H3t are shown in Table 5-8 below.

Table 5-8: Parameter Estimates (t-statistics) from Regression Results for the Four Implementation Outcomes of Six Sigma - CSFs for Organizatonal Ability

	Cost and Efficiency			Continuous Improvement			Employee and Customer Satisfaction			Product and Service Quality		
	B	t	Sig.	B	t	Sig.	B	t	Sig.	B	t	Sig.
Linking Six Sigma to Customers	0.333	(2.46)***	0.008	0.085	(0.834)	0.203	0.337	(3.166)***	0.001	0.067	(0.562)	0.288
Project Management Skills	-0.125	(-0.813)	0.582	0.410	(3.563)***	0.000	0.194	(1.609)*	0.055	-0.225	(-1.663)	0.901
Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review	0.046	(0.332)	0.370	0.092	(0.885)	0.189	0.037	(0.338)	0.368	0.321	(2.627)***	0.005
Communication and Organizational Culture	0.192	(1.213)	0.114	0.241	(2.025)**	0.023	0.458	(3.682)***	0.000	0.548	(3.931)***	0.000
Employee Attitude and Engagement	0.132	(0.948)	0.173	0.043	(0.416)	0.339	-0.033	(-0.305)	0.239	-0.036	(-0.289)	0.227

H3a-H3d predict that Linking Six Sigma to Customers has a positive influence on the outcomes of Six Sigma implementation. The coefficients of Linking Six Sigma to Customers is positive and highly significant for Cost and Efficiency (p-value: 0.008) and Customer and Employee Satisfaction (p-value: 0.001), which supports H3a and H3c. The coefficients of Linking Six Sigma to Customers is positive but not significant for Continuous Improvement (p-value: 0.203) and Product and Service Quality (p-value: 0.288), which means it does not support H3b and H3d.

H3e-H3h predict that Project Management Skills has a positive influence on the outcomes of Six Sigma implementation. The coefficients of Project Management Skills is positive and significant for Continuous Improvement (p-value: 0.000), and Customer and Employee Satisfaction (p-value: 0.055), which supports H3f and H3g. The coefficients of Project Management Skills is positive but not significant for Cost and Efficiency (p-value: 0.582), and Product and Service Quality (p-value: 0.901). Therefore, this factor does not support H3e and H3h.

H3i-H3l predict that Understanding of Six Sigma Methodology, Tools and

Techniques and Progress Review has a positive influence on the outcomes of Six Sigma implementation. The coefficients of Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review is positive but not significant for Cost and Efficiency (p-value:0.370), Continuous Improvement (p-value: 0.189), and Customer and Employee Satisfaction (p-value: 0.368), which does not support H3i, H3j, and H3k. The coefficients of Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review is positive and significant for Product and Service Quality (p-value: 0.005), which means it supports H3l.

H3m-H3p predict that Communication and Organizational Culture has a positive influence on the outcomes of Six Sigma implementation. The coefficients of Communication and Organizational Culture is positive but not significant for Cost and Efficiency (p-value: 0.114), which does not support H3m. The coefficients of Communication and Organizational Culture is positive and significant for Continuous Improvement (p-value: 0.023), Customer and Employee Satisfaction (p-value: 0.000), and Product and Service Quality (p-value: 0.000). This factor is confirmed to support H3n, H3o, and H3p.

H3q-H3t predict that Employee Attitude and Engagement has a positive influence on the outcomes of Six Sigma implementation. The coefficients of Employee Attitude and Engagement is positive but not significant for Cost and Efficiency (p-value: 0.173), Continuous Improvement (p-value: 0.339), Customer and Employee Satisfaction (p-value: 0.239), and Product and Service Quality (p-value: 0.227). As a result, this factor does not support H3q, H3r, H3s, and H3t.

The result shows that Communication and Organizational Culture is the most critical factor to successfully implement Six Sigma under this element. It can affect those Six Sigma outcomes like Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality. The result is similar to previous research that an organizational culture is influential to the consequence of quality improvement projects. A successful introduction and implementation of Six Sigma requires adjustments to the culture of the organization and a change in the attitudes of its employees (Antony and Banuelas, 2002). A quality-driven culture of an enterprise will motivate employees to adopt continuous improvement mind-set and accept responsibility for the product and service quality of their own work.

Another important factor of Organizational Ability is the Project Management Skills. It can positively affect the Six Sigma outcomes in Continuous Improvement and Customer and Employee Satisfaction. As Six Sigma approach is a project-driven methodology, it is important for the project team members to have sound project management skills to meet the various deadlines or milestones during the course of the project (Antony and Banuelas, 2001). It is also criticized that most of the projects on Six Sigma implementation fail due to poor project management skills, setting and keeping ground rules, determining the meeting's roles and responsibilities (Antony and Banuelas, 2002; Eckes, 2000). Six Sigma team with good project management capability will assist the achievement of the project objectives and enhance customer satisfaction, which in turn leads to better employee satisfaction. The project has to be reviewed

periodically to evaluate the status of its progress as well as the performance of Six Sigma tools and techniques being implemented (Kwak and Anbari, 2006). This critical success factor will ensure the project details to be well documented to track project constraints, mainly cost, schedule, and scope. As stated by Kwak and Anbari (2006), there should be a lesson-learned mechanism to capture the key issues of pervious projects so that continuous improvement can be achieved.

5.7 Model IV – Six Sigma Implementation Outcomes

In addition to testing the relationships between the implementation elements and CSFs (that is, Model I - Management's Intention and Commitment, Model II - Top Management Ability, and Model III - Organizational Ability) and the Six Sigma implementation outcomes (that is, Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality), the study further tested the relationship between the above success factors to that of the success of Six Sigma implementation (for outcomes of success or not success) in order to identify which factors contribute most to the final result.

Firstly, the three main implementation elements were tested to give an overall result on the relationship. Afterward, each of the CSFs was tested to give a further in-depth consideration. This practice helps identify which CSFs contribute more on the relationship and which are less. This will give suggestions and guidelines to the managerial team of enterprises that which factors they have to focus more when they desire to have a better overall application result.

Additionally, the relationship between Six Sigma implementation outcomes (that is, Cost and Efficiency, Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality) and the success of Six Sigma implementation (for outcomes of success or not success) are studied to see which outcomes contribute most to the overall success. This will give further insights to company's managerial team an idea that which outcomes they should focus most to achieve final success of six sigma implementation. This is important as the organizations that have adopted Six Sigma claim that the projects' contribution to an organization mainly focuses on increasing the wealth of the shareholders by improving bottom-line results and achieving high quality products and services (Antony, 2007). According to Antony (2004), Six Sigma will be around as long as the projects yield measureable or quantifiable bottom-line results in monetary or financial terms. These are the long-standing belief of the blooming Six Sigma application over years.

Below is the results for the relationships between the three main elements (that is, Management's Intention and Commitment, Top Management Ability, and Organizational Ability) and success of Six Sigma implementation (for outcomes of success or not success). The findings are illustrated in Table 5-9 below.

Table 5-9: Main Implementation Elements and Success of Six Sigma Implementation

	Success of Six Sigma Implementation			
	B	t	2-tail Sig.	1-tail Sig.
Intercept	4.626	8.773	0.000	0.000
Management's Intention and Commitment	0.012	0.169	0.866	0.433
Top Management Ability	0.106	1.185	0.238	0.119
Organizational Ability	0.005	0.058	0.954	0.477
Nature of business (Manufacturing)	-	-	-	-
Nature of business(Servicing)	-0.080	-0.926	0.356	0.644
Position	-0.063	-1.453	0.149	0.851
Role in Six Sigma implementation	-0.007	-0.210	0.834	0.166
Internal or external Six Sigma role	-0.116	-0.700	0.485	0.515
Permanent or part-time Six Sigma role	-0.269	-3.541	0.001	0.999
Company size	-0.124	-4.063	0.000	1.000
Years of Six Sigma implementation (Individuals)	-0.045	-1.958	0.052	0.948
Years of Six Sigma implementation (Company)	-0.023	-0.786	0.433	0.567
Education level	-0.098	-2.262	0.025	0.975
Education background (Engineering)	-0.080	-1.939	0.055	0.945
Education background (Others)	-0.016	-0.210	0.834	0.166
Average time of Six Sigma project	-0.103	-1.554	0.123	0.877
Six sigma training population	-0.102	-3.067	0.003	0.997
Six sigma implementation population	0.037	1.035	0.303	0.151
Six sigma master black belts population	0.040	0.309	0.758	0.379
Six sigma black belts population	0.036	0.295	0.769	0.384
Six sigma green belts population	0.129	5.630	0.000	0.000
No. of finished Six Sigma projects (annually)	-0.069	-1.079	0.282	0.718
Average saving	0.121	3.969	0.000	0.000
n	161			
Model F Value	19.976	0		
R^2	77.58%			
Adjusted R^2	73.70%			
$R^2_{\text{for Control Factors}}$	30.30%			
Incremental R^2	47.28%			
Adjusted $R^2_{\text{for Control Factors}}$	20.10%			
Incremental adjusted R^2	53.60%			
All tests are one-tailed: *p ≤ 0.10; **p ≤ 0.05; ***p ≤ 0.01				

As shown in Table 5-9, the coefficients of all three elements (that is,

Management's Intention and Commitment, Top Management Ability, and Organizational Ability) is positive but not significant for the success of Six Sigma implementation, which represents that there is no significant relationships associated with the three main elements and the overall success of Six Sigma implementation. This may be due to the offsetting effect among the CSFs belonging to each of the implementation elements. Therefore, further test is performed to give a more clear interpretation for the Hypotheses H4a to H4k.

Table 5-10 below shows the test outcomes of the relationship of the 11 CSFs with the success of Six Sigma implementation.

Table 5-10: CSFs and Success of Six Sigma Implementation

	Success of Six Sigma Implementation		
	B	t	Sig.
Intercept	4.470	8.167	0.000
Resources Allocation	0.006	0.121	0.452
Management Participation and Involvement	-0.008	-0.157	0.125
Linking Six Sigma to Business Strategies	0.124	2.526	0.006
Project Selection, Prioritization and Tracking	0.021	0.338	0.368
Project Team Management	0.006	0.071	0.472
Management by Objective and Fact	-0.056	-0.925	0.643
Linking Six Sigma to Customers	-0.066	-1.142	0.744
Project Management Skills	0.047	0.726	0.235
Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review	-0.045	-0.767	0.555
Communication and Organizational Cultural	0.083	1.235	0.110
Employee Attitude and Engagement	0.016	0.261	0.397
Nature of business (Manufacturing)	-	-	-
Nature of business(Servicing)	-0.064	-0.730	0.533
Position	-0.054	-1.236	0.781
Role in Six Sigma implementation	-0.002	-0.059	0.047
Internal or external Six Sigma role	-0.076	-0.360	0.281
Permanent or part-time Six Sigma role	-0.227	-2.680	0.992
Company size	-0.114	-2.771	0.994
Years of Six Sigma implementation (Individuals)	-0.040	-1.764	0.920
Years of Six Sigma implementation (Company)	-0.029	-0.899	0.629
Education level	-0.096	-2.134	0.965
Education background (Engineering)	-0.061	-1.463	0.854
Education background (Others)	-0.018	-0.230	0.182
Average time of Six Sigma project	-0.117	-1.722	0.912
Six sigma training population	-0.107	-3.006	0.997
Six sigma implementation population	0.057	1.529	0.064
Six sigma master black belts population	-0.008	-0.056	0.045
Six sigma black belts population	0.029	0.241	0.405
Six sigma green belts population	0.123	5.202	0.000
No. of finished Six Sigma projects (annually)	-0.056	-0.847	0.602
Average saving	0.123	3.711	0.000
n		161	
F		15.259	0.000
R Square		79.4%	
Adjusted R Square		74.2%	
R^2 for Control Factors		30.30%	
Incremental R^2		49.07%	
Adjusted R^2 for Control Factors		20.10%	
Incremental adjusted R^2		54.07%	
All tests are one-tailed: *p ≤ 0.10; **p ≤ 0.05; ***p ≤ 0.01			

H4a and H4b predict that the CSFs for element Management's Intention and Commitment (that is, Resources Allocation and Management Participation and Involvement) have positive influence on the success of Six Sigma implementation. The coefficients of Resources Allocation and Management Participation and Involvement are both positive but not significant for success of Six Sigma implementation (p-value: 0.452 and 0.125 respectively), which do not support H4a and H4b.

H4c to H4f predict that the CSFs for element Top Management Ability (that is, Linking Six Sigma to Business Strategies; Project Selection, Prioritization and Tracking; Project Team Management; Management by Objective and Fact) have positive influence on the success of Six Sigma implementation. The coefficients of Linking Six Sigma to Business Strategies is positive and highly significant (p-value: 0.006), which supports H4c. The B value (0.124) of it is the highest one among all the coefficients. The coefficients of Project Selection, Prioritization and Tracking; Project Team Management; Management by Objective and Fact are positive but not significant. This means they do not support H4d to H4f.

H4g to H4k predict that the CSFs for element Organizational Ability (that is, Linking Six Sigma to Customers; Project Management Skills; Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review; Communication and Organizational Culture; and Employee Attitude and Engagement) have positive relationship with the success of Six Sigma

implementation. The coefficients of all these factors are not significant (p-value: 0.744, 0.235, 0.555, 0.110, and 0.397 respectively), that means they do not support the hypotheses H4g to H4k.

According to Table 5-10, the factor "Linking Six Sigma to Business Strategies" is highly correlated with the success of Six Sigma implementation, which shows the success of Six Sigma implementation at the organizations' strategic level is very important. If the strategies of an enterprise being more focus on Six Sigma, it will be more likely to get a significantly desirable result of overall Six Sigma performance.

From Table 5-9 and Table 5-10, the number of Green Belt in a company has a significant positive relationship with the success of Six Sigma implementations. This means if the organization has more number of Green Belt, it is more likely to achieve a better result for Six Sigma implementation. In Six Sigma methodology, Green Belt members are always the practical work force for carrying out the planned tasks and procedures. As mentioned in previous literature, it is important to have sufficient number of well trained work force to enhance the overall performance of Six Sigma implementation. Therefore, in preparing for Six Sigma adoption, it is critical to get ready for enough Green Belt members for kicking off and executing the projects.

In addition, a test about the relationship between Six Sigma outcome and overall success of Six Sigma implementation was conducted. This gives the organization's management a further insight on whether the Six Sigma outcomes

really represent the successful implementation on the whole.

Table 5-11: Six Sigma Outcomes and Success of Six Sigma Implementation

	Success of Six Sigma Implementation		
	B	t	Sig.
Intercept	4.355	10.333	.000
Cost and Efficiency	.051	1.225	.111
Continuous Improvement	-.039	-.825	.589
Employee and Customer Satisfaction	.121	2.446	.008
Product and Service Quality	.012	.252	.401
Nature of business (Manufacturing)	-	-	-
Nature of business(Servicing)	-.084	-.996	.679
Position	-.068	-1.623	.893
Role in Six Sigma implementation	-.004	-.131	.104
Internal or external Six Sigma role	.056	.347	.365
Permanent or part-time Six Sigma role	-.235	-3.133	.998
Company size	-.130	-3.835	1.000
Years of Six Sigma implementation (Individuals)	-.057	-2.540	.988
Years of Six Sigma implementation (Company)	-.030	-1.052	.705
Education level	-.088	-2.131	.965
Education background (Engineering)	-.086	-2.214	.971
Education background (Others)	-.024	-.325	.255
Average time of Six Sigma project	-.071	-1.117	.734
Six sigma training population	-.082	-2.538	.988
Six sigma implementation population	.027	.830	.204
Six sigma master black belts population	-.020	-.158	.125
Six sigma black belts population	.033	.292	.386
Six sigma green belts population	.114	5.248	.000
No. of finished Six Sigma projects (annually)	-.078	-1.290	.801
Average saving	.122	4.093	.000
n		161	
F		21.595	0.000
R Square		79.9%	
Adjusted R Square		76.2%	
R^2 for Control Factors		30.30%	
Incremental R^2		49.59%	
Adjusted R^2 for Control Factors		20.10%	
Incremental adjusted R^2		56.09%	
All tests are one-tailed: *p ≤ 0.10; **p ≤ 0.05; ***p ≤ 0.01			

As shown in Table 5-11, the coefficient of Customer and Employee Satisfaction is positive and highly significant, which means there is a positive relationship associated with Customer and Employee Satisfaction and the success of Six Sigma implementation. It cannot be found for significant relationship between the other three Six Sigma implementation outcomes and the success of Six Sigma. This implies that if the company intends to have an overall desirable Six Sigma outcome, it should focus more on Customer and Employee Satisfaction. From the profit chain point of view, the reason is that employee's satisfaction will affect the product and service quality, which in turn leads to a better customer satisfaction. As mentioned by Buch and Tolentino (2006), it is clear that the employee satisfaction will contribute to better Six Sigma performance, and that the training and reward systems are integral components of a successful Six Sigma program, and the two must be linked so that learning and new responsibilities that follow are perceived by employees as rewards of the program. If, on the other hand, employees are not entertained with the program, the Six Sigma application may be perceived as exploitation and its sustainability would be threatened (Shani and Docherty, 2003).

5.8 Summary

In this chapter, the relationship of the 3 implementation elements and 11 CSFs of Six Sigma implementation to the 4 identified implementation outcomes were examined. Following the procedures and guideline set out for this research in Chapter Four, a focus group study, an industrial survey, related factor analysis and

reliability test on the elements and factors, as well as the regression models were conducted and studied. The results are presented for all these tests. Under the context of apparel industry in China, a high-clock speed supply chain model, the findings provide valuable implications to the Six Sigma approach and quality management literature.

The results reveal that some elements and CSFs are not as expected to be critical as previous research to the implementation outcomes in apparel industry in China. The implementation element of Management's Intention and Commitment is significant for achieving outcomes of Cost and Efficiency, Continuous Improvement and Customer and Employee Satisfaction. The element is particularly relevant to Continuous Improvement. It is identified Resources Allocation and Management Participation and Involvement to be two CSFs under this main element. From the study, it is found that Resources Allocation is significant for Cost and Efficiency with a p-value 0.057. For factor of Management Participation and Involvement, it is confirmed in the test that the factor is significant for Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality. Overall, Management's Intention and Commitment is important to achieve the purpose of Six Sigma adoption and the organizational management should provide sufficient resources and be actively involved in the Six Sigma projects to allow them to be a successful one.

In this study, the implementation element of Top Management Ability is found not to be significant for achieving the desired outcomes of Six Sigma implementation. It is identified Linking Six Sigma to Business Strategies, Project Selection,

Prioritization and Tracking, Project Team Management, and Management by Objective and Fact to be four CSFs under this main element. From the study, it is found that for factors Linking Sigma to Business Strategies, Project Team Management, and Management by Objective and Fact are all not significant to the desired implementation outcomes of Six Sigma. The result shows that only Project Selection, Prioritization and Tracking has a positive relationship associated with the implementation outcome of Product and Service Quality. Many organization experienced considerable difficulty in identifying and prioritizing Six Sigma projects in alignment with overall process improvement objectives (Chakravorty, 2009). It is important to be clear about the critical consideration of proper project selection. One reason many Six Sigma improvement programs fail is because improvement projects are not correctly identified and prioritized (Zimmerman and Weiss, 2005). Similar to previous research, this study's finding reflects that for apparel industry in China, it is important to select the proper project and top management should ensure sufficient tracking on the project progress in order to obtain a successful outcome in Six Sigma adoption in China. However, on the whole, Top Management Ability and its associated CSFs are found to have less impact on the implementation outcomes for Six Sigma adoption in China. It indicates that the main role for company management of apparel enterprises in China is to provide adequate resources and ensure proper selection of projects for implementation of Six Sigma approach rather than practically managing the project team or leading the Six Sigma projects on basis of management by objective and fact.

The implementation element of Organizational Ability is analyzed and tested to

include CSFs of Linking Six Sigma to Customers, Project Management Skills, Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review, Communication and Organizational Culture, and Employee Attitude and Engagement. The element is found to have a positive impact on the outcomes of Six Sigma implementation. The results show that project team's ability is highly significant for achieving the four desired Six Sigma outcomes. Based upon the analysis figures, it is concluded that Organization's Ability is the most important consideration over the three implementation elements for effective implementation of Six Sigma in apparel industry in China. The factor Linking Six Sigma to Customers is highly related to attain Cost and Efficiency and Customer and Employee Satisfaction, while another factor Project Management Skills is critical for Continuous Improvement and Customer and Employee Satisfaction. For factor Understanding of Six Sigma Methodology, Tools and Techniques and Progress Review, it mainly affects the Product and Service Quality. Similar to previous research, it is concluded that the factor Communication and Organizational Culture is crucial to quality improvement projects, and in the study the factor is found to be significant for Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality. As mentioned by Zu et al. (2011), when initiating quality management programs at companies in China, managers need to address the issue of organizational culture. They further addressed that it is beneficial that the managers assess the existing cultural environment in their organization, identify the gap between the existing culture and the desired quality culture, and then make plans to adapt employees' beliefs and values and to develop a culture for quality improvement. However, the last factor under this element, Employee

Attitude and Engagement is not significant for all the four desired implementation outcomes of Six Sigma application.

In the execution of factor analysis and reliability test, it is confirmed the categorization on the CSFs and six sigma implementation results. In the regression models, it is further concluded the relevant implementation elements and their significance to Six Sigma implementation outcomes.

On the whole, the results of analyzing the relationship between implementation elements and implementation outcomes are similar to that between the CSFs and implementation outcomes. Companies should consider Organizational Ability to be the most important aspect for achieving desired Six Sigma implementation outcomes, while Management's Intention and Commitment will be the second one.

Chapter Six – Discussion and Conclusions

In the previous chapter, Chapter Five, it has reported the results of the focus group discussion and industry survey. All the information and data collected were presented and analyzed thereafter. This chapter aims to consolidate the findings and provide a conclusion with consideration of the relevant implications of this study. In addition, it is hoped through the study to evolve an implementation model for Six Sigma to be developed for illustration of the investigation outcomes. There are six sections in this chapter. The first section (Section 6.1) recaps the Six Sigma concepts, consolidates the findings, and illustrate the developed Six Sigma Implementation Model for apparel organization in China. The second section (Section 6.2) suggests the theoretical and practical implications of this research. The third section (Section 6.3) presents the limitations perceived for this study, and then, there are recommendations for future research given in the fourth section (Section 6.4). In the fifth section (Section 6.5), a brief conclusion of this study is drawn. Lastly, there is a list of publications by the author shown in Section 6.6.

6.1 Effective Six Sigma Implementation Model

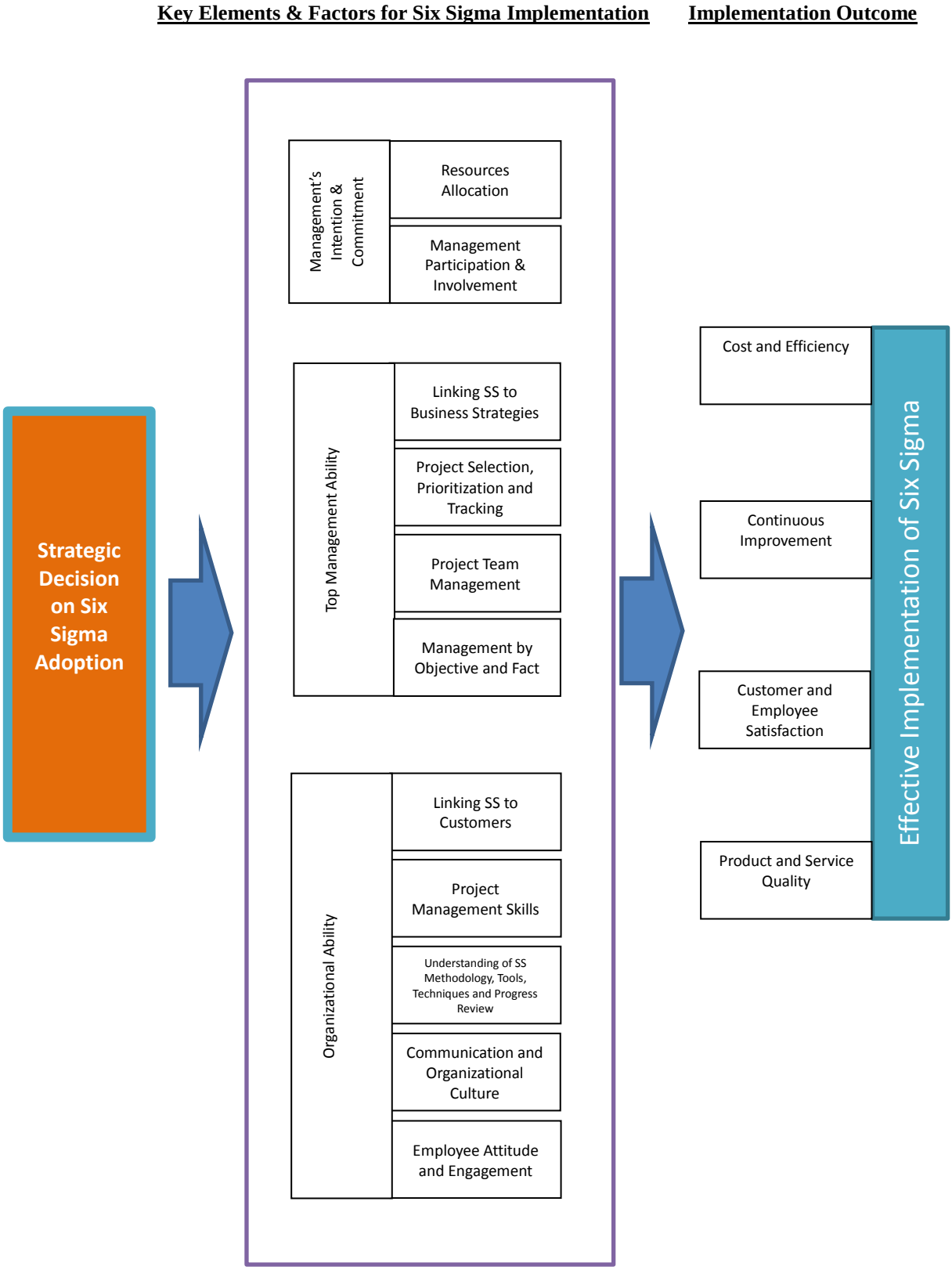
Six Sigma can be considered both a business strategy and a science that has the aim of reducing manufacturing and service costs, and creating significant improvements in customer satisfaction and bottom-line savings through combining statistical and business process methodologies into an integrated model of process, product and service improvement (Thomas and Barton, 2006). As

mentioned in previous literature and studies, the successful use of Six Sigma approach can bring about a number of benefits and positive rewards to the organization in short period. It advocates customer focus and customer satisfaction as the top priority. This approach helps build up an internal culture of the company that continuous improvement on processes, products and service is the common aim and long-term strategy within the company-wide environment. Like other programs emerging under the TQM umbrella, Six Sigma is said to require a transformational change in an organization's culture, structure, and processes (Buch and Tolentino, 2006). Its effect is always company-wide and able to penetrate into different hierarchy of an organization.

The application of Six Sigma strategy is diversified and cross-boundaries. Despite its origination in United States that being initiated by an electronic company, its recent development has extended to Asian countries and is currently adopted by both manufacturing and servicing industry. Many organizations gain from their successful application of Six Sigma methodology. However, some are not equally rewarded from its implementation. Some argued that the lack of an implementation model of Six Sigma approach leads to the various results of its application. The situation is especially severed when the approach is applied in labor-intensive manufacturing industry like apparel organizations. More serious still is the complicated environment for operating quality improvement practice in China. The difficulties facing China companies implementing Six Sigma are discussed in Chapter Two. It is commonly believed that one reason for the failure of Six Sigma implementation is because a clear illustration of the relationship of major implementation elements, their CSFs and the desired

implementation outcomes is not available. There is no explicit study and exploration for an implementation model for Six Sigma, particularly for apparel industry in China. Therefore, it is of paramount important to develop this model approach for Six Sigma adoption. Based on the literature study, research establishment and survey investigation, and the result analysis, this research intends to provide an implementation model outlining the necessary elements and CSFs for Six Sigma adoption by apparel and apparel-related industry in China. The overall result of this study indicates and depicts a developed model as shown in Figure 6-1 below.

Figure 6-1: Effective Six Sigma Implementation Model



The Six Sigma Implementation Model (SSIM) as depicted above provides an illustration for the inputs (Strategic Decision on Six Sigma Adoption), transformation process (Key Elements and CSFs), and outputs (Effective Six Sigma Implementation) of the Six Sigma approach to be adopted in apparel industry in China.

On the left-hand side of the Model, the organization's top management should make the decision whether the company should adopt Six Sigma approach for achieving the strategic objectives in quality improvement. Andel (2007) once mentioned that Six Sigma programs should be implemented with a clear objective of improving competitive positioning and of increasing the company's value as perceived by the customer. It therefore implies that all activities related to Six Sigma implementation should be approached from that consideration. In this SSIM, it is important to address that Six Sigma adoption is a strategic management decision which leads to the various elements and factors to be carefully emphasized and invested in order to achieve the desired effective Six Sigma implementation outcomes.

In the process of Six Sigma adoption and application in an apparel company in China, it is concluded to take into consideration of the three implantation elements and 11 success factors on a company-wide arena. Each of these factors should be made aware of by all the company members. People involvement, no matter on which level within an organization, should be addressed to allow the Six Sigma implementation a successful one. There is growing concern that Six Sigma or

other process improvement programs fail because they do not consider the human side of implementation (Chakravorty, 2009). Zimmerman and Weiss (2005), in their previous research, had pointed out that organization need to pay attention to the human side of Six Sigma implementation and this is an important area for future research as well. This research and the developed SSIM are intended to provide helpful guideline and indication for practicing managers eager to effectively implement Six Sigma approach to achieve sustained results in their respective business environment.

6.2 Research Implications

The purpose of this research was to investigate the relationship among Six Sigma implementation elements, CSFs and the desired implementation outcomes. From this investigation, it is hoped to establish a SSIM that best fits for the apparel industry in China. The results of this study clearly reflect the importance of Management's Intention and Commitment and the Organizational Ability in supporting the success of Six Sigma adoption. Under the context of apparel supply chain in China, a said-to-be high-clock speed industry, the findings provide valuable implications to the Six Sigma and quality management literature.

6.2.1 Theoretical Contributions

The study reveals that some factors are not as expected to be critical to the implementation outcome in the apparel industry. Particularly, the Top Management Ability in Six Sigma does not provide significant prediction on the

outcome. It shows that top management only needs strong intention and commitment on Six Sigma adoption, but they are not necessary to have the practical knowledge of it. In addition, it is argued that the findings in China are applicable to other production based in emerging markets, such as Vietnam and Bangladesh. It is because the apparel production in these countries is also labor-intensive in nature, and the involvement in apparel industry is similar to the garment manufacturers in China.

In addition, the findings show that the critical factors of successful Six Sigma implementation are contingent to the operational context. Similar studies found that the contextual factors would affect the efficacy of a QMS (e.g., Lo et al., 2013; Swink and Jacobs, 2012). This study fits in this stream of literature, and it enriches the understanding on how to implement a quality management effectively. For instance, the research findings show that company size is a significant predictor on the cost and efficiency, and product and service quality outcome. This suggests that larger organizations can obtain more benefits from these two outcomes than small one if they decide to implement Six Sigma. In addition, the critical factors proposed and tested in developed countries might not have the same effect to the adopters in developing countries, or to high-clock speed industries. The study's findings, therefore, suggest that future studies on the efficacy of a QMS should consider factors including the status of the economy and company nature. Furthermore, linking the management intention with the awareness of developing the organizational ability is a viable approach to obtain more desirable outcomes from Six Sigma implementation.

This study also contrasts to the previously mentioned studies (that is, Swink and Jacobs, 2012) on QMS adoption, which mainly use secondary data in their methodology. The survey approach allows us to provide a deeper understanding of the key constructs, such as the top management team's ability to understand thoroughly the Six Sigma, and the organizational ability.

6.2.2 Managerial Implications

After analyzing the data and summarizing the key success factors, it is concluded the most effective approach to implement Six Sigma in apparel industry in China is to ensure that the management provides clear intention and resources to develop the ability of the entire organization for the implementation.

The findings suggest that the implementation element Organizational Ability is the primary factor for successful implementation of Six Sigma. This factor affects all four major outcomes of Six Sigma. Management's Intention and Commitment is the second important factor and that it significantly affects the adopting companies' ability to improve their quality management continuously, and the customer and employee satisfaction.

Viewing these impacts in a holistic view, it can be concluded that for an organization having strong management's intention and commitment in Six Sigma strategy, it can possibly create an organizational culture to drive continuous improvement. It therefore helps increase stakeholders' satisfaction. However, this company cannot achieve outstanding benefits from the cost and efficiency,

and the product and service quality. Employee should have better understanding of Six Sigma methodology, tools, techniques, and project management skill, so that they are more capable to link Six Sigma to customers' needs. This will in turn lead to improved operational outcomes in products and processes. For this reason, the top management team for apparel industry in China or in other emerging markets, should ensure that the internal communication and organizational culture are well developed, so that their employees have positive attitude towards Six Sigma. This allows the organization to be easier to engage in process improvement missions.

On the whole, this study provides a solid ground for China textile and apparel enterprises to prepare for their Six Sigma implementation journey. It is suggested, based on the findings of this research, that organization in China should establish explicit managerial strategies and devote full commitment from top management to launch Six Sigma approach in the future, with an aim in achieving the best desirable outcomes throughout its implementation. Furthermore, the overall organizational ability of the enterprises in China should be enhanced to facilitate an efficient and effective adoption of Six Sigma approach, particularly for the increasing awareness of quality improvement philosophy.

6.3 Research Limitations

This study encounters limitations, therefore, the results must be interpreted with caution. First, there is possibility that there are positive respondent biases on the outcomes of Six Sigma. This is due to the fact that only self-reporting data

collection method was used. With this method, there is only limited actual observation of reported behavior was conducted. The respondents may wish to project a positive image on Six Sigma because their duties are related to it. The respondents will try to avoid being perceived as incapable to manage a Six Sigma project effectively. However, the self-reporting method can still measure the respondents' attitudes and beliefs (Merkin, 2006). Given that the questionnaire was anonymous, the self-reported survey responses should accurately reflect respondents' actual thoughts and behavior (Kwan, 2006).

Second, the industry survey and data collection are mainly conducted in the apparel manufacturers in China, and one may argue that the results may not be universally applicable to all other manufacturing and service industry sectors. Additionally, the findings in this study may not generalize to the entire business environment in China. It may conclude that Management's Intention and Commitment, and Organizational Ability of Six Sigma are the two critical factors to incur in a successful Six Sigma implementation for enterprises in apparel or apparel-related industry.

Third, the CSFs being investigated are based on the current literature. There may be some other factors that also create influence to the results of Six Sigma application which are not counted in. These potential factors may in the long run create threats and opportunities to the effective implementation of Six Sigma projects.

Fourth, the study's sample of Six Sigma companies in the industry survey only

included firms that are known to have applied Six Sigma approach or intended to operate that. However, it is possible that these companies are not representative of all organizations in the industry that have adopted Six Sigma.

6.4 Suggestions for Future Research

Although there are several limitations in this research, as an initial study focusing in Six Sigma implementation elements, CSFs and implementation outcomes for apparel industry in China, it does provide valuable opportunities for future research. There are a number of suggestions that can be made both for building on top of this study and for extending the Six Sigma implementation model to other business sectors in China.

Firstly, for the sake of improving the context of this research on a more generalized basis, it is recommended that an industry survey covering wider geographic distribution in Mainland China and more diverse apparel and apparel-related enterprises can be conducted. In addition, a larger number of samples to be selected is also suggested. Although cost and other resource inputs thus conducted are increased, the survey outcomes will have higher confidence on its finding reliability and credibility.

Firm characteristics such as company size, industry type, or process type are often considered as important contextual factors that may affect how quality management practices are applied in organizations (Zu et al., 2011). In considering the implementation elements and CSFs for effective implementation

of Six Sigma, it is highly recommended to take organizational nature, characteristics, and culture into account for the analysis and construction of the implementation model. Especially for undertaking quality initiative in China, to better understand the implementation status of quality management there, it is important to consider how a company's underlying characteristics affect its adoption and application of the practices (Zu et al., 2011; Zhao et al., 2007).

Moreover, it is recommended that future research can analyze the desired Six Sigma outcomes by employing observational data collection methods, namely experiments. By this approach actual observation of the implementation outcomes and its benefits together with its pitfalls through the use of observation and third party experiments is expected to provide wider and more objective insights.

Related to this research theme, one important area of future study can be referred is to investigate the relationship between an organization's motivation for adopting Six Sigma and its subsequent implementation performance. This may be an interesting topics for how strong the motivation of an organization have in adopting Six Sigma approach, may lead to a desirable and satisfactory implementation of Six Sigma program.

On top of this study, it is advised to encourage future research to conduct similar investigation in other high-clock speed industry sectors, such as electronics industry, in order to confirm the current findings. Similar studies for the medium or slow-clock speed industries can also be looked into to provide a fair

comparison with the findings from high-clock speed industry.

6.5 Conclusions

The objectives of this study are to investigate the implementation elements and major success factors leading to a satisfactory Six Sigma implementation, as well as establishing an implementation model for adopting Six Sigma effectively for apparel industry in China. Based on the literature review, it is established 3 major implementation elements and 11 CSFs relevant to effective Six Sigma implementation for apparel industry in China. As a result, there are 67 hypotheses set up to analyze and confirm the relationship among the various sub-models and the implementation outcomes of Six Sigma approach. Subsequently, factor analysis and reliability tests were performed to confirm the categorizations and identified factors for Six Sigma implementation. Based on the focus group discussion and mass survey in apparel industry in China, the survey results concluded the relevance of the 3 elements and 11 factors and that, 2 of the elements are well supported for their influence to the success of Six Sigma adoption.

The research result shows that Organizational Ability and Management's Intention and Commitment have significant impact among the elements in the Six Sigma implementation process. They cause direct influence to the level of successful Six Sigma adoption. The results did not find significant relevance for Top Management Ability to the Six Sigma implementation outcomes. Furthermore, the current study found that under the element of Organizational Ability, the

critical success factor - Communication and Organizational Culture, is particularly important as it significantly enhances the desired Six Sigma outcomes in Continuous Improvement, Customer and Employee Satisfaction, and Product and Service Quality on the whole. The second important element is Management's Intention and Commitment. From the findings, it concluded that this element will significantly affect the Cost and Efficiency, Continuous Improvement, and Customer and Employee Satisfaction. It found that on the whole, top management's commitment to Six Sigma application, is particularly critical for incurring the positive outcome of continuous improvement. As reported in many previous studies and literature, Six Sigma requires top management's dedication and contribution to resources and effort (Kwak and Anbari, 2006). It is therefore beneficial that the organization's top management should be well prepared to provide sufficient support and involvement to this quality improvement initiative in order to gain the greatest return from it.

Finally, a SSIM is developed to illustrate how a Six Sigma methodology can be applied satisfactorily and successfully. Therefore, it can be concluded that the current study has arrived at an enhanced understanding of how Six Sigma approach can be adopted properly and how can it be implemented effectively in apparel industry in China.

6.6 List of Publications

Conference Paper:

1. Lee, T.Y., Wong, W.K., Yeung K.W., 2008. Developing a Six Sigma Management System Model for China SMEs. 86th Textile Institute World Conference.

Journal Article:

1. Lee, T.Y., Wong, W.K., Yeung, K.W., 2011. Developing a Readiness Self-Assessment Model (RSM) for Six Sigma for China Enterprises. International Journal of Quality and Reliability Management 28 (2), 169-194.

2. Lee, T.Y., Zhou, Y., Wong, W.K., Lo, K.Y., 2015. Critical Factors for Effective Implementation of Six Sigma for Fast Fashion Manufacturers in China. International Journal of Production Economics (under review).

APPENDICES

Appendix I

Question Sheet for Focus Group Discussion

Question Sheet for Focus Group Discussion (R1)

Participant Particulars:

Name :	
Designation :	
Organization :	
Contact :	☐ Telephone :
	☐ Email :
	☐ Address :
Experience and Qualifications in Connection with Six Sigma:	

This question sheet is designed to collect comments and recommendations from Six Sigma experts relating to the research survey and a questionnaire for effective Six Sigma implementation model. Please kindly review the following questions which are made against the survey questionnaire and it is my great pleasure to have your valuable feedback and comments for enhancing the survey questionnaire.

Questions	Evaluation*					Comments/ Recommendations
	1	2	3	4	5	
1. Are the evaluation statements for the first element "Management's Intention & Commitment" and its related critical success factors appropriate?						
2. Are the evaluation statements for the second element "Top Management Ability" and its related critical success factors appropriate?						
3. Are the evaluation statements for the third						

element “Organizational Ability” and its related critical success factors appropriate?						
4. Are the evaluation statements for Question 1. A.-U. appropriate?						
5. Are the evaluation statements for Question 2. A.-N. appropriate?						
6. Are the evaluation statements for Question 3. A.-L. appropriate?						
7. Are the questions covered by Respondent Profile appropriate?						
8. On the whole, are the evaluation statements in this Questionnaire feasible?						
9. On the whole, is this questionnaire suitable for apparel industry?						
10. On the whole, is this Questionnaire suitable for China enterprises?						

* 1 – Disagreed; 2 – Slightly Disagreed; 3 – Agreed; 4 – Quite Agreed; 5 – Very Agreed

Other Comments / Recommendations:

****** THANK YOU ******

Appendix II

Survey Questionnaire (Initial Version)

A Roadmap Model for Effective Implementation of Six Sigma

有 效 执 行 六 西 格 玛 的 策 略 模 型

Survey Questionnaire

调 查 问 卷

I am a research student of the Institute of Textiles and Clothing of the Hong Kong Polytechnic University. Currently, I am conducting a research relating to a roadmap model of readiness for six sigma approach and the key factors through to its effective implementation. As your company has conducted / been conducting six sigma project(s) and you are one of the members in your company involved in the said project(s), I shall be grateful if you can, based on your experience with six sigma, provide your feedback to the following questions.

本人是香港理工大学 — 纺织及制衣学系的研究生。目前，我正在进行一项有关六西格玛计划实施可行性评估的策略模型和有效实施六西格玛的关键因素的研究。由于您司已经执行/ 正在执行六西格玛项目，并且您是 贵司在上述项目所涉及的成员之一，我将致以万分感谢您能根据您对六西格玛的执行经验，对以下问题提供您的反馈信息。

Your participation will be truly appreciated as your responses will be invaluable in providing information for the aforesaid research study. Please be assured that all information collected from this survey will be used solely for academic purpose and will be kept strictly confidential. Thank you!

我真诚的感谢您的参与，您的反馈将为上述研究提供宝贵的研究资料。请您放心，这项调查所收集到的所有信息将只用于学术用途，并会被严格保密。谢谢！

Instruction: Based on your experience in six sigma implementation, please put a "✓" mark in the space provided to indicate the degree of concurrence to each of the circumstance stated in the "Survey Statement" in contributing to the "Evaluation Element (Eva. Elmt.)" that affects the readiness for six sigma approach and subsequent outcome of effective six sigma implementation.

指引： 基于您对六西格玛的推行经验，请您根据表格中的调查项目(这些调查项目对六西格玛的准备和有效执行都有影响)，填写您对各项的同意程度于表中的评分栏。

1 – Very Unimportant/ Unrelated **3 – Neutral** **5 – Very Important/ Related**
1 – 非常不重要/ 非常不相关 **3 – 中立** **5 – 非常重要/ 非常相关**

Eva. Elmt. 评估类别	Survey Statement 调查项目	Evaluation 评分				
		1	2	3	4	5
Management's Intention & Commitment 管理层的意愿与承诺	***Resources Allocation 资源分配***					
	1. Company should provide sufficient monetary & non-monetary resources for six sigma projects. 公司应为六西格玛项目提供足够的资源：包括资金和非资金资源。					
	2. Company should treat six sigma implementation as top priority. 公司应优先考虑六西格玛的执行。					
	3. Company, especially for that in China, should be prepared to employ sufficient qualified staff of appropriate educational & intellectual capacity background for six sigma implementation. 公司，特别是在中国的公司，针对六西格玛，应该聘请有能力胜任六西格玛执行项目的合格员工 :这些员工需要拥有合适的教育背景和善于思维的能力。					
	4. Company should arrange sufficient training for six sigma implementation. 针对六西格玛的实施，公司应安排足够的培训。					
	5. Company should employ, if appropriate, a full time in-house consultant to lead six sigma project. 如适当，公司应当聘用一个全职的内部顾问，用以指导六西格玛项目。					
	6. Company should further employ, if needed, external consultant to provide guidance on six sigma implementation. 如有需要，公司应进一步聘用外部顾问，提供专业的六西格玛的实施及指导。					
	7. Company should set up an appropriate reward system to appraise six sigma implementation. 公司应设立适当的奖励制度，以推进六西格玛的实施。					
	8. Company should allow staff to allocate part of their working hours to take part in six sigma implementation.					

		公司应允许员工利用正常的部分工作时间去参与六西格玛的执行。					
	9.	Company should have a fair, clear & proper rewarding system to retain qualified six sigma staff to ensure an effective six sigma implementation. 公司应该有一个公平、公正、适当的奖励制度，以留住合资格的员工，确保六西格玛的有效实施。					
	Management Participation & Involvement　管理层的参与及投入						
	1.	Company should encourage management's participation & involvement in six sigma implementation. 公司应鼓励管理人员参与及投入于六西格玛项目的实施。					
	2.	Company should set up a six sigma steering committee comprising management of company to facilitate six sigma implementation. 公司应成立一个包括公司管理层的督导委员会，促进公司的六西格玛的实施。					
	3.	Management of company should lead & participate in six sigma implementation. 公司管理层应领导及参与六西格玛的实施。					
	4.	Management of company should allocate sufficient time to participate & involve in six sigma implementation. 公司管理层应分配足够的时间参加与投入六西格玛的实施。					
	5.	Management of company should ensure the implementation of six sigma is on the right track. 公司管理层应确保六西格玛在正确的轨道上实施。					
	6.	Management of company should constantly review six sigma implementation progress with six sigma teams. 公司管理层应经常与六西格玛团队评审六西格玛的执行进度。					
	7.	Management of company should provide, if needed, inputs & recommendations during six sigma implementation. 在六西格玛实施过程中，公司管理层应提供必要的信息输入和建议。					
Top Management Ability 高层管理能力	***Linking Six Sigma to Business Strategies　把六西格玛关联到企业经营战略***						
	1.	Top management should be aware of the ever-changing business environment & link it with six sigma implementation. 高层管理人员应掌握不断变化的商业环境，并把它关联到六西格玛的执行。					
	2.	Top management should be able to develop feasible strategic planning based on current external environment, existing culture & performance of the company which is linked with six sigma implementation. 高层管理人员应能基于把六西格玛的执行关联到外界环境的趋势、现有的文化和公司业绩，从而开发可行的战略计划。					
	3.	Top management should be aware of the importance of linking six sigma to business strategies & long-term goals of the company.					

	高层管理人员应清楚了解把六西格玛关联到公司的经营策略与公司的远期目标的重要性。					
	4. Top management should be able to involve related departments and staff for discussion when setting up the business strategies. 高层管理人员应当能与相关部门和工作人员参与讨论，制定公司的经营策略。					
	5. Top management should link the six sigma projects to the established business strategies. 高层管理人员应把六西格玛关联到已制定的经营策略。					
	6. Top management should review the progress regularly during six sigma implementation & compare its subsequent results to that of the business strategies. 高层管理人员应定期检讨六西格玛的实施进度，并以其实施的结果与经营策略作对比。					
	7. Top management should prepare to modify its six sigma approach, if needed, during implementation in fulfilling the business strategies. 高层管理人员应在六西格玛实施过程中有必要時，适时修改六西格玛的过程方法，以滿足公司的经营策略。					
	Project Selection, Prioritization & Tracking　项目选择，确定优先次序与跟踪					
	1. Top management should be aware of the importance of project prioritization & selection to the success of six sigma implementation. 高层管理人员应明确了解项目的优先次序和选择的重要性，以便能成功的推行六西格玛。					
	2. Top management should emphasize the importance of customer-oriented & meeting customer requirements to project selection & prioritization. 高层管理人员应強調以顾客为关注焦点和达到客户要求的重要性，作為项目选择和确定实施的优先次序的重要因素。					
	3. Top management should relate feasibility, financial & organizational benefits to project selection & prioritization. 高层管理人员应把项目的可行性、所用的资金、组织的效益关联到项目选择和确定实施的优先次序。					
	4. Top management should relate likelihood of success within a reasonable timeframe to project selection & prioritization。 高层管理人员应把项目在合理的期限内，能成功实施的可能性关联到项目选择和确定实施的优先次序。					
	5. Top management should consider organizational impact like internal learning benefits & cross-functional benefits to project selection & prioritization. 高层管理人员应考虑对组织的影响，如有益于内部的文化和有益于跨部门的工作，以此来确定项目选择和确定实施的优先次序。					
	6. Top management should put sufficient emphasis on six sigma project management.					

	高层管理人员应该大力强调六西格玛项目管理。					
	7. Top management should be able to keep track of & control the six sigma projects to ensure their success. 高层管理者应该能够掌握和控制六西格玛项目的进度，以确保其能成功的执行。					
	8. Top management should be able to conduct modification on the six sigma projects based on the outcome of project tracking. (E.g. Six sigma tools, implementation schedule, etc. adopted in the projects) 高层管理人员应能够依据对六西格玛项目跟踪结果为基础，对六西格玛项目进行修改。(如在项目所采纳的六西格玛工具，实施时间表等。)					
	Clear Expectations　明确的期望					
	1. Top management should be aware of the importance of setting clear expectation of six sigma projects during six sigma implementation. 高层管理人员应清楚了解，在六西格玛执行过程中，设定六西格玛項目的明确期望的重要性。					
	2. Top management should participate in setting up a clear expectation on six sigma implementation. 高层管理人员应参与制定一个明确的六西格玛实施的期望。					
	3. Top management should ensure the objectives & targets of six sigma projects being established before implementation. 高层管理人员应确保六西格玛项目的目标指标在其实施之前建立。					
	4. Top management should ensure the expectation of six sigma implementation being communicated & understood by all staff of the company, especially the six sigma project team. 高层管理人员应确保实施六西格玛的愿景传达到公司全体员工，特别是要得到六西格玛项目团队的理解。					
	Selection of Project Leaders　项目负责人的选择					
	1. Top management should be able to select appropriate project leaders for six sigma implementation. 高层管理人员应选择合乎要求的六西格玛负责人，来实施西格玛的执行及管理。					
	2. Top management should establish clear guideline & criteria in the selection of project leaders for six sigma implementation. 高层管理人员应为六西格玛的实施，建立明确清晰的作业指导及准则，以选择合適的六西格玛项目负责人。					
	3. Top management should ensure the project leaders selected are capable to undertake & lead six sigma projects. 高层管理人员应确保选定的项目负责人有能力承担和主导六西格玛项目。					
	4. Top management should ensure the project leaders selected are well aware of their responsibilities & authorities in six sigma					

	implementation. 高层管理人员应确保选定的项目负责人在实施六西格玛进程中，清楚了解自己的职责和权限。					
	Management by Fact　基于事实的管理					
	1. Top management should be aware of the importance of management by fact during six sigma implementation. 高层管理人员应清楚的知道在六西格玛的实施过程中：基于事实的决策方法的重要性。					
	2. Top management should be able to influence the six sigma project team regarding the importance of collecting fact & making decision by fact. 高层管理人员应能要求六西格玛团队清楚了解收集真实数据和基于事实作出决策的重要性。					
	3. Top management should ensure a sophisticated data collection system available to facilitate the generation of adequate accurate information & data for investigation during six sigma implementation. 高层管理人员应确保在六西格玛执行过程中，有一个可用及成熟的数据收集系统，以便能夠获得足夠的精确的信息和数据作出調查和研究。					
	4. Top management should ensure six sigma project team can have free access to necessary information & data within company during six sigma implementation. 在实施六西格玛的过程中，高层管理人员应确保六西格玛项目团队可以轻松获取必要的信息和公司内部的数据。					
	5. Top management should ensure the information & data collected are fully verified & validated by six sigma project team during six sigma implementation. 在实施六西格玛的过程中，高层管理人员应确保六西格玛项目团队收集的信息资料能真实准确的验证。					
	6. Top management should ensure the six sigma project team has the capability to conduct analysis & make decision based on fact during six sigma implementation. 在实施六西格玛的过程中，最高管理层应确保六西格玛项目团队有能力基于事实进行分析和作出决定。					
Organizational Ability　组织能力	***Linking Six Sigma to Customers　把六西格玛关联到以顾客为中心***					
	1. The company should have a customer-oriented culture for six sigma implementation. 公司在推行六西格玛的过程中，应建立一个以顾客为关注焦点的公司文化。					
	2. The six sigma project team should be able to link six sigma projects to customers. 六西格玛项目团队应能把六西格玛项目关联到顾客。					
	3. The six sigma project team should begin the six sigma projects in defining key customers that they serve.					

	六西格玛项目团队应在开始执行六西格玛项目时就定义公司所服务的主要客户。					
	4. The six sigma project team should clearly determine customer requirements. 六西格玛项目团队应该清楚地确定客户的要求。					
	5. The six sigma project team should be able to identify the core processes & define their related key outputs which have impact on customer satisfaction during six sigma implementation. 六西格玛项目团队在六西格玛项目执行过程中，应能识别关键过程，定义关键过程相关的关键输出及其对顾客满意的影响。					
	6. The six sigma project team should be able to gather customer data for determining Voice of Customer (VOC). 六西格玛项目团队应能收集客户的咨询以确定客户的要求和期望（VOC）。					
	7. The six sigma project team should adopt the data collected & VOC to analyze & prioritize customer requirements & hence link these to the business strategy in six sigma implementation. 六西格玛项目团队在项目的执行过程中，应采取通过数据收集，及已确定的客户的期望以分析及把客户要求作优先次序的处理，并将这些关联到企业的经营策略。					
	Project Management Skills　项目管理技巧					
	1. The six sigma project team should possess the necessary skills in project management. 六西格玛项目团队在项目管理中应具备必要的技能。					
	2. The six sigma project team should properly be assigned with a team leader & the roles of the members should be clearly defined. 六西格玛项目团队应选择一名合适的团队负责人，团队的成员的角色和职责应清楚的界定。					
	3. The six sigma project team should be able to monitor & control the six sigma projects during implementation. 六西格玛实施过程中，六西格玛项目团队应能监视和控制过程。					
	4. The six sigma projects should be reviewed periodically & clear set of measures & metrics be conducted in the tracking of six sigma implementation. 六西格玛项目团队应在跟踪六西格玛执行的过程中，进行定期评审，并订出明确的量度标准和规则。					
	5. The six sigma project team should employ appropriate six sigma tools & techniques to facilitate & monitor six sigma implementation. 六西格玛项目团队应采用适当的六西格玛工具和技术来促进和监察六西格玛的实施。					
	6. The six sigma project team should periodically report & put forward the progress & key issues of the six sigma projects to top management during six sigma implementation. 六西格玛项目团队应在六西格玛的执行过程中，向最高管理层定					

	期的汇报，反馈项目的进展，六西格玛项目的关键问题点。					
	7. The six sigma project team should prepare to fine-tune & modify the six sigma projects, if needed, based on the outcome of review with top management. 如有必要，按高层管理人员的审查结果，六西格玛项目团队应能微调修改六西格玛项目。					
	8. The six sigma project team should create a lesson-learned mechanism to capture the key issues of previous projects. 六西格玛项目团队应建立一个经验累积机制来反映以前项目的关键问题点。					
	Understanding of Six Sigma Methodology, Tools, & Techniques 六西格玛方法，工具与技巧的理解					
	1. The six sigma project team should be well trained & should understand the six sigma methodology, tools & techniques. 六西格玛项目团队应是训练有素及了解六西格玛方法、工具与技巧的实施。					
	2. The six sigma project team should be able to apply six sigma methodology, tools & techniques in six sigma implementation. 在实施过程中，六西格玛项目团队应能灵活运用六西格玛方法，工具与技巧。					
	3. The six sigma project team should understand the principles behind the DMAIC cycle. 六西格玛项目团队应明白 DMAIC 背后的原理。					
	4. The six sigma project team should be able to choose the appropriate tools & techniques that are required within the six sigma problem solving framework. 六西格玛项目团队应该能够选择合适的工具及技术(在六西格玛解决问题过程中所需要的)。					
	5. In addition to tools & techniques, the six sigma project team should have a clear understanding of the common metrics including costs of poor quality, throughput yield, defect rate, & so forth in six sigma implementation. 在实施六西格玛过程中，除了工具和技巧，六西格玛项目团队应对劣质成本、产能、不良率等有清晰的认知和理解。					
	6. The six sigma project team should be aware of the importance to make decision & report the progress of six sigma projects to top management based on the applied six sigma tools & techniques. 六西格玛项目团队应基于项目已实施的工具和技巧，明确了解对决断能力及向最高管理人员汇报六西格玛的进展的重要性。					
	Communication 沟通交流					
	1. It is important that proper communication channels should be established within the company to facilitate information flow relating to six sigma implementation. 在六西格玛项目实施中，于公司内部建立合适的沟通渠道以便于					

	信息交流是十分重要的。					
	2. The company should be aware of the importance to communicate to all employees on the why & how of six sigma implementation. 公司应该认识到对所有员工进行沟通的重要性 :包括对他们解释为什么及如何实施六西格玛。					
	3. The six sigma project team should be aware of the importance of communicating the six sigma project progress & implementation outcomes to top management. 六西格玛项目团队应该知道对六西格玛项目的进度状况 ,向高层管理人员汇报执行结果的沟通的重要性。					
	4. The six sigma project team should regularly gather & meet to review the six sigma project progress & discuss for any fine-tuning & modification needed during implementation. (E.g. Six sigma tools, implementation schedule, etc. adopted in the projects) 六西格玛项目团队应定期收集 ,开会评审六西格玛项目的进展情况，讨论任何微调及在实施过程中的修改。(如在项目所采纳的六西格玛工具，实施时间表等)					
	5. The six sigma project team members should be provided with an open & free communication environment. 六西格玛项目团队成员应该被提供一个开放与自由交流的环境。					
	6. The six sigma project team should be able to communicate the six sigma implementation information on a timely basis. 六西格玛项目团队应能及时传达六西格玛执行进展的资讯。					
	7. Appropriate training should be provided to the six sigma project team relating to communication skills. 应该提供适当的沟通技巧培训给六西格玛项目的团队 ,用以提升其沟通技巧。					
	8. The six sigma project team should be authorized to communicate on any critical issues &/ or the project outcomes regarding six sigma implementation to top management. 六西格玛项目团队应被授权向最高管理层沟通及反映任何六西格玛项目执行的重点事项及/或项目的成果。					
	Adoption of Cultural Change　企业文化变化的适应性					
	1. The company should be able to adopt & accommodate a change of the culture in the company. 公司应有能力接纳顺应公司内企业文化的变化。					
	2. The six sigma project team should be able to lead the change of mindset of the employees towards the goals of six sigma implementation. 六西格玛项目团队应有能力引导员工思维的改變 ,朝著六西格玛项目执行的目标迈进。					
	3. The company should be able to educate the employees on the benefits of six sigma implementation in order to overcome their resistance. 公司应对员工宣导实施六西格玛能给公司带来的好处 ,以克服他					

	们的抵抗意识。					
	4. The company should adopt various reward & recognition schemes to motivate employees towards the introduction & implementation of six sigma. 公司应采用各种奖励及表扬方案，以此来推动员工对六西格玛的开展及执行的激情。					
	5. The company should ensure the fears of employees towards six sigma implementation to be overcome as early & effective as possible. 公司应尽早和尽可能有效克服员工对六西格玛实施的恐惧心理。					
	6. The six sigma project team should act as mediator between top management & employees to the adoption of cultural change. 六西格玛项目团队应作为高层管理人员和员工之间的协调者，使员工适应这种文化变迁。					
	7. The six sigma project team should announce the result of six sigma projects including successes, obstacles & challenges in order to avoid making similar mistakes & therefore, to adopt only the very best practices for the sake of enhancing the adoption of cultural change. 六西格玛项目团队应通告六西格玛项目的结果，包括成就，障碍和挑战，以避免类似的错误再次发生及得以选取最好的实施技巧以协助顺利地适应公司文化的变革。					
1. Please advise, according to your point of view, to what extent will the effective implementation of six sigma: 按您的意見，請說明有效實施六西格瑪可達至以下情況的程度：						
A. contribute to reduction in production cost. 可達至降低生產成本。						
B. contribute to reduction in materials cost. 可達至降低物料成本。						
C. contribute to reduction in labor cost. 可達至降低勞工成本。						
D. contribute to an overall cost reduction. 可達至降低整體成本。						
E. help enhance productivity. 幫助提高生產力。						
F. help enhance staff's capability towards their works. 幫助提高員工的工作能力。						
G. help shorten production lead-time. 幫助縮短生產週期。						
H. help enhance overall efficiency. 幫助提高整體效率。						
I. enhance products quality. 提高產品質量。						
J. enhance service quality. 提高服務質量。						
K. reduce customer complaints.						

	減少客戶投訴。					
L.	induce provision of an attractive price to customers. 可引至提供一個更吸引的價格給客戶。					
M.	enhance overall customer satisfaction. 提高整體的客戶滿意度。					
N.	help encourage staff to improve their work procedure continually. 幫助鼓勵員工持續改善他們的工作程序。					
O.	help create a company culture for continuous improvement. 幫助建立一種追求持續改善的公司文化。					
P.	contribute to continuous process improvement. 可達至持續的流程改善。					
Q.	contribute to continuous product quality improvement. 可達至持續的產品質量改善。					
R.	contribute to continuous service quality improvement. 可達至持續的服務質量改善。					
S.	motivate staff's willingness to spare more time in six sigma project. 激勵員工投入更多時間於六西格瑪計劃。					
T.	enhance staff's commitment in six sigma project. 提昇員工對六西格瑪計劃的投入。					
U.	enhance overall staff involvement in six sigma project. 提昇員工對六西格瑪計劃的整體參與性。					
2.	How do you rate the following elements in contributing to respective implementation outcomes as stated below: 請您對以下各項因素可引至相應的實施效果的相關程度, 作出您的評價：					
A.	"Management's Intention & Commitment" to implementation outcome "Reduced Cost". 六西格瑪計劃的實施過程中, "管理層的意願與承諾"可引至"減低成本"的效果。					
B.	"Management's Intention & Commitment" to implementation outcome "Enhanced Efficiency". 六西格瑪計劃的實施過程中, "管理層的意願與承諾"可引至"提昇效率"的效果。					
C.	"Management's Intention & Commitment" to implementation outcome "Continuous Improvement". 六西格瑪計劃的實施過程中, "管理層的意願與承諾"可引至"持續改善"的效果。					
D.	"Management's Intention & Commitment" to implementation outcome "Improved Staff Involvement". 六西格瑪計劃的實施過程中, "管理層的意願與承諾"可引至"改善員工的參與性"的效果。					
E.	"Top Management Ability" to implementation outcome "Reduced Cost". 六西格瑪計劃的實施過程中, "高層管理能力"可引至"減低成本"的效果。					
F.	"Top Management Ability" to implementation outcome "Enhanced Efficiency". 六西格瑪計劃的實施過程中, "高層管理能力"可引至"提昇效率"的效果。					

G.	“Top Management Ability” to implementation outcome “Increased Customer Satisfaction”. 六西格瑪計劃的實施過程中, “高層管理能力”可引至”提高客戶滿意度”的效果。					
H.	“Top Management Ability” to implementation outcome “Continuous Improvement”. 六西格瑪計劃的實施過程中, “高層管理能力”可引至”持續改善”的效果。					
I.	“Top Management Ability” to implementation outcome “Improved Staff Involvement”. 六西格瑪計劃的實施過程中, “高層管理能力”可引至”改善員工的參與性”的效果。					
J.	“Organizational Ability” to implementation outcome “Reduced Cost”. 六西格瑪計劃的實施過程中, “組織能力”可引至”減低成本”的效果。					
K.	“Organizational Ability” to implementation outcome “Enhanced Efficiency”. 六西格瑪計劃的實施過程中, “組織能力”可引至”提昇效率”的效果。					
L.	“Organizational Ability” to implementation outcome “Increased Customer Satisfaction”. 六西格瑪計劃的實施過程中, “組織能力”可引至”提高客戶滿意度”的效果。					
M.	“Organizational Ability” to implementation outcome “Continuous Improvement”. 六西格瑪計劃的實施過程中, “組織能力”可引至”持續改善”的效果。					
N.	“Organizational Ability” to implementation outcome “Improved Staff Involvement”. 六西格瑪計劃的實施過程中, “組織能力”可引至”改善員工的參與性”的效果。					

3. How do you rate your degree of satisfaction to the following factors during six sigma implementation:
在 貴司實施六西格玛的过程中，请您指出您对以下因素的满意度：

1 – Very Dissatisfied 非常不满意　　3 – Neutral 中立　　5 – Very Satisfied 非常满意

Key Factors 关键因素		Evaluation 评分				
		1	2	3	4	5
A.	Resources Allocation 资源分配					
B.	Management Participation & Involvement 管理者的参与及投入					
C.	Linking six sigma to business strategies 把六西格玛关联到企业经营战略					
D.	Project selection, prioritization & tracking 项目选择，确定优先次序与跟踪					
E.	Clear expectations 明确的期望					
F.	Selection of project leaders 项目负责人的选择					
G.	Management by fact 基于事实的管理					
H.	Linking six sigma to customers 把六西格玛关联到以顾客为中心					
I.	Project management skills 项目管理技巧					

J.	Understanding of six sigma methodology, tools, & techniques 六西格玛方法，工具与技巧的理解					
K.	Communication 沟通交流					
L.	Adoption of cultural change 企业文化变化的适应性					

On the whole, how successful do you consider in your company's six sigma implementation? 整体而言，您认为 贵司六西格玛执行方面有多成功？

- ☐ Very successful 非常成功
- ☐ Successful 成功
- ☐ Neutral 一般
- ☐ Not successful 不成功
- ☐ Very unsuccessful 非常不成功

Please provide justification to your opinion above: 请您详细描述您为何作出上述的意见：

_____

_____

Respondent Profile 被访人概况

1. What is the nature of major business of your company? (Please check one)
   贵公司主要的业务性质是？（请选一）
   - ☐ Manufacturing 制造
   - ☐ Servicing 服务
   - ☐ Others 其他

     Please specify 请说明: _____

2. What is the major products (for Manufacturing field) / services (for Servicing field) that your company provides? 贵公司提供的主要产品（适用于生产领域）/ 服务（适用于服务领域）是什么？

   _____

3. What is your level of position in your company? 您在 贵司的职位？
   - ☐ Top Management 高层管理者
   - ☐ Middle Management 中层管理者
   - ☐ Elementary Level Staff 普通员工

4. What is your role in six sigma implementation in your company? 您在 贵司的六西格玛项目中扮演的是什么角色？
   - ☐ Champion 总指挥
   - ☐ Master Black Belt 黑带大师
   - ☐ Black Belt 黑带
   - ☐ Green Belt 绿带
   - ☐ Trainee 受训者

5. Are you acting as an internal or external six sigma role in your company? 您在 贵司的六西格玛项目中，担任的是内部还是外部的执行角色？
   - ☐ Internal 内部
   - ☐ External 外部

6. Are you acting as a permanent or part-time six sigma role in your company? 您在贵司的六西格玛项目中担任的是全职、还是兼职的角色？
   - ☐ Permanent 全职
   - ☐ Part-time 兼职

7. How many employees are there in your company? 贵司有多少雇员？
   - ☐ 1-50
   - ☐ 51-100
   - ☐ 101-200
   - ☐ 201-500
   - ☐ 501-1,000
   - ☐ Over 1,000 1,000 人以上

8. How many year(s) have you been assuming this six sigma role in your company? 您在 贵司担任六西格玛执行人员的角色共有多少年？
   - ☐ Less than 1/2 year 少于 1/2 年
   - ☐ 1/2-1 year 1/2-1 年
   - ☐ 1-2 years 1-2 年
   - ☐ 2-3 years 2-3 年
   - ☐ More than 3 years 3 年以上

9. How many year(s) have your company been implementing six sigma? 贵司的六西格玛项目执行了多少年？
   - ☐ Less than 1 year 少于 1 年
   - ☐ 1-2 year 1-2 年
   - ☐ 2-3 years 2-3 年
   - ☐ 3-4 years 3-4 年
   - ☐ 4-5 years 4-5 年
   - ☐ More than 5 years 5 年以上

10. What is your education level? 您的教育水平？
    - ☐ Secondary school or below 初中或以下
    - ☐ Post-Secondary school to Professional Diploma 高中至专业文凭
    - ☐ University graduate 大学学士
    - ☐ Master 硕士
    - ☐ PhD 博士

11. What is your education background? 您的教育背景？
    - ☐ Engineering 工程
    - ☐ Business / commercial 商贸
    - ☐ Others 其它

      Please specify 请描述: _____

12. How long does one six sigma project take on the average? 六西格玛项目平均要执行多长时间？

- ☐ Less than 3 months 少于 3 个月
- ☐ 4-6 months 4-6 个月
- ☐ 7-12 months 7-12 个月
- ☐ 13-18 months 13-18 个月
- ☐ 19 months or above 19 个月以上

13. What is your position in your company while participating in six sigma implementation?
当您在 贵司参与六西格玛项目时，您在 贵司的职位是？

_____

14. In total, how many people involve in six sigma training in your company? 总体而言，有多少人参加了 贵司的六西格玛培训？

- ☐ 1-5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-20
- ☐ 21-25
- ☐ 26-30
- ☐ 31-35
- ☐ 36-40
- ☐ 41 or above 41 位或以上

15. In total, how many people involve in six sigma implementation in your company? 总体而言，有多少人参与了 贵司的六西格玛的实施？

- ☐ 1-5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-20
- ☐ 21-25
- ☐ 26-30
- ☐ 31-35
- ☐ 36-40
- ☐ 41 or above 41 位或以上

16. How many six sigma master black belts are there in your company?
贵司有多少位黑带大师？

- ☐ 1-2
- ☐ 3-4
- ☐ 5 or above 5 位或以上

17. How many six sigma black belts are there in your company?
贵司有多少位黑带？

- ☐ 1-2
- ☐ 3-4
- ☐ 5-7
- ☐ 8-10
- ☐ 11 or above 11 位或以上

18. How many six sigma green belts are there in your company?
贵司有多少位绿带？

- ☐ 1-2
- ☐ 3-4
- ☐ 5-7
- ☐ 8-10
- ☐ 11 or above 11 位或以上

19. How many six sigma project(s) does your company complete annually on the average?
贵司每年平均完成多少个六西格玛项目？

- ☐ 1-2
- ☐ 3-4
- ☐ 5-6
- ☐ 7-8
- ☐ 9-10
- ☐ 11 or above 11 個或以上

20. What is the average saving from each of the six sigma projects in your company?
在 贵公司于每个六个西格玛项目平均节省了多少钱？

- ☐ Below HK$100,000 港币 100,000 以下
- ☐ HK$100,000-HK$200,000
- ☐ HK$200,001-HK$300,000
- ☐ HK$300,001-HK$500,000
- ☐ HK$500,001-HK$800,000
- ☐ More than HK$800,000 港币 800,000 以上

~ This is the end of questionnaire. Thank you for your participation! ~

调查问卷完成，谢谢您的参与！

Appendix III

Survey Questionnaire (Revised Version after Focus Group Study)

A Roadmap Model for Effective Implementation of Six Sigma

有 效 执 行 六 西 格 玛 的 策 略 模 型

Survey Questionnaire

调 查 问 卷

I am a research student of the Institute of Textiles and Clothing of the Hong Kong Polytechnic University. Currently, I am conducting a research relating to a roadmap model of readiness for six sigma approach and the key factors through to its effective implementation. As your company has conducted / been conducting six sigma project(s) and you are one of the members in your company involved in the said project(s), I shall be grateful if you can, based on your experience with six sigma, provide your feedback to the following questions.

本人是香港理工大学 — 纺织及制衣学系的研究生。目前，我正在进行一项有关六西格玛计划实施可行性评估的策略模型和有效实施六西格玛的关键因素的研究。由于您司已经执行/ 正在执行六西格玛项目，并且您是 贵司在上述项目所涉及的成员之一，我将致以万分感谢您能根据您对六西格玛的执行经验，对以下问题提供您的反馈信息。

Your participation will be truly appreciated as your responses will be invaluable in providing information for the aforesaid research study. Please be assured that all information collected from this survey will be used solely for academic purpose and will be kept strictly confidential. Thank you!

我真诚的感谢您的参与，您的反馈将为上述研究提供宝贵的研究资料。请您放心，这项调查所收集到的所有信息将只用于学术用途，并会被严格保密。谢谢！

Instruction: Based on your experience in six sigma implementation, please put a "✓" mark in the space provided to indicate the degree of concurrence to each of the circumstance stated in the "Survey Statement" in contributing to the "Evaluation Element (Eva. Elmt.)" that affects the readiness for six sigma approach and subsequent outcome of effective six sigma implementation.

指引： 基于您对六西格玛的推行经验，请您根据表格中的调查项目(这些调查项目对六西格玛的准备和有效执行都有影响)，填写您对各项的同意程度于表中的评分栏。

1 – Very Unimportant/ Unrelated **3 – Neutral** **5 – Very Important/ Related**
1 – 非常不重要/ 非常不相关 **3 – 中立** **5 – 非常重要/ 非常相关**

Eva. Elmt. 评估类别	Survey Statement 调查项目	Evaluation 评分				
		1	2	3	4	5
Management's Intention & Commitment 管理层的意愿与承诺	***Resources Allocation 资源分配***					
	1. Company should provide sufficient monetary & non-monetary resources for six sigma projects. 公司应为六西格玛项目提供足够的资源：包括资金和非资金资源。					
	2. Company should treat six sigma implementation as top priority. 公司应优先考虑六西格玛的执行。					
	3. Company, especially for that in China, should be prepared to employ sufficient qualified staff of appropriate educational & intellectual capacity background for six sigma implementation. 公司，特别是在中国的公司，针对六西格玛，应该聘请有能力胜任六西格玛执行项目的合格员工 :这些员工需要拥有合适的教育背景和善于思维的能力。					
	4. Company should set up an appropriate reward system to appraise six sigma implementation. 公司应设立适当的奖励制度，以推进六西格玛的实施。					
	5. Company should allow staff to allocate part of their working hours to take part in six sigma implementation. 公司应允许员工利用正常的部分工作时间去参与六西格玛的执行。					
	Management Participation & Involvement 管理层的参与及投入					
	1. Company should encourage management's participation & involvement in six sigma implementation. 公司应鼓励管理人员参与及投入于六西格玛项目的实施。					
	2. Company should set up a six sigma steering committee comprising management of company to facilitate six sigma implementation. 公司应成立一个包括公司管理层的督导委员会，促进公司的六西格玛的实施。					

	3.	Management of company should lead & participate in six sigma implementation. 公司管理层应领导及参与六西格玛的实施。					
	4.	Management of company should allocate sufficient time to participate & involve in six sigma implementation. 公司管理层应分配足够的时间参加与投入六西格玛的实施。					
	5.	Management of company should ensure the implementation of six sigma is on the right track. 公司管理层应确保六西格玛在正确的轨道上实施。					
	6.	Management of company should constantly review six sigma implementation progress with six sigma teams. 公司管理层应经常与六西格玛团队评审六西格玛的执行进度。					
	7.	Management of company should provide, if needed, inputs & recommendations during six sigma implementation. 在六西格玛实施过程中，公司管理层应提供必要的信息输入和建议。					
Top Management Ability 高层管理能力	***Project Selection, Prioritization & Tracking 项目选择，确定优先次序与跟踪***						
	1.	Top management should review the progress regularly during six sigma implementation & compare its subsequent results to that of the business strategies. 高层管理人员应定期检讨六西格玛的实施进度，并以其实施的结果与经营策略作对比。					
	2.	Top management should prepare to modify its six sigma approach, if needed, during implementation in fulfilling the business strategies. 高层管理人员应在六西格玛实施过程中有必要時，适时修改六西格玛的过程方法，以滿足公司的经营策略。					
	3.	Top management should be aware of the importance of project prioritization & selection to the success of six sigma implementation. 高层管理人员应明确了解项目的优先次序和选择的重要性，以便能成功的推行六西格玛。					
	4.	Top management should emphasize the importance of customer-oriented & meeting customer requirements to project selection & prioritization. 高层管理人员应強調以顾客为关注焦点和达到客户要求的重要性，作為项目选择和确定实施的优先次序的重要因素。					
	5.	Top management should relate likelihood of success within a reasonable timeframe to project selection & prioritization。 高层管理人员应把项目在合理的期限内，能成功实施的可能性关联到项目选择和确定实施的优先次序。					
	6.	Top management should consider organizational impact like internal learning benefits & cross-functional benefits to project selection & prioritization. 高层管理人员应考虑对组织的影响，如有益于内部的文化和有益于跨部门的工作，以此来确定项目选择和确定实施的优先次序。					

	7. Top management should put sufficient emphasis on six sigma project management. 高层管理人员应该大力强调六西格玛项目管理。					
	8. Top management should be able to keep track of & control the six sigma projects to ensure their success. 高层管理者应该能够掌握和控制六西格玛项目的进度，以确保其能成功的执行。					
	9. Top management should be able to conduct modification on the six sigma projects based on the outcome of project tracking. (E.g. Six sigma tools, implementation schedule, etc. adopted in the projects) 高层管理人员应能够依据对六西格玛项目跟踪结果为基础，对六西格玛项目进行修改。(如在项目所采纳的六西格玛工具，实施时间表等。)					
	Project Team Management　項目團隊管理					
	1. Top management should participate in setting up a clear expectation on six sigma implementation. 高层管理人员应参与制定一个明确的六西格玛实施的期望。					
	2. Top management should ensure the expectation of six sigma implementation being communicated & understood by all staff of the company, especially the six sigma project team. 高层管理人员应确保实施六西格玛的愿景传达到公司全体员工，特别是要得到六西格玛项目团队的理解。					
	3. Top management should ensure six sigma project team can have free access to necessary information & data within company during six sigma implementation. 在实施六西格玛的过程中，高层管理人员应确保六西格玛项目团队可以轻松获取必要的信息和公司内部的数据。					
	4. Top management should ensure the information & data collected are fully verified & validated by six sigma project team during six sigma implementation. 在实施六西格玛的过程中，高层管理人员应确保六西格玛项目团队收集的信息资料能真实准确的验证。					
	5. Top management should establish clear guideline & criteria in the selection of project leaders for six sigma implementation. 高层管理人员应为六西格玛的实施，建立明确清晰的作业指导及准则，以选择合適的六西格玛项目负责人。					
	6. Top management should ensure the project leaders selected are capable to undertake & lead six sigma projects. 高层管理人员应确保选定的项目负责人有能力承担和主导六西格玛项目。					
	7. Top management should ensure the project leaders selected are well aware of their responsibilities & authorities in six sigma implementation. 高层管理人员应确保选定的项目负责人在实施六西格玛进程中，清楚了解自己的职责和权限。					

	Management by Objective & Fact　基于目標和事实的管理					
	1. Top management should be aware of the importance of setting clear expectation of six sigma projects during six sigma implementation. 高层管理人员应清楚了解，在六西格玛执行过程中，设定六西格玛項目的明确期望的重要性。					
	2. Top management should be aware of the importance of management by fact during six sigma implementation. 高层管理人员应清楚的知道在六西格玛的实施过程中：基于事实的决策方法的重要性。					
	3. Top management should be able to influence the six sigma project team regarding the importance of collecting fact & making decision by fact. 高层管理人员应能要求六西格玛团队清楚了解收集真实数据和基于事实作出决策的重要性。					
	4. Top management should ensure a sophisticated data collection system available to facilitate the generation of adequate accurate information & data for investigation during six sigma implementation. 高层管理人员应确保在六西格玛执行过程中，有一个可用及成熟的数据收集系统，以便能夠获得足夠的精确的信息和数据作出調查和研究。					
	5. Top management should ensure the six sigma project team has the capability to conduct analysis & make decision based on fact during six sigma implementation. 在实施六西格玛的过程中，最高管理层应确保六西格玛项目团队有能力基于事实进行分析和作出决定。					
	6. Top management should be able to select appropriate project leaders for six sigma implementation. 高层管理人员应选择合乎要求的六西格玛负责人，来实施西格玛的执行及管理。					
	Linking Six Sigma to Business Strategies　把六西格玛关联到企业经营战略					
	1. Top management should be able to develop feasible strategic planning based on current external environment, existing culture & performance of the company which is linked with six sigma implementation. 高层管理人员应能基于把六西格玛的执行关联到外界环境的趋势、现有的文化和公司业绩，从而开发可行的战略计划。					
	2. Top management should be aware of the importance of linking six sigma to business strategies & long-term goals of the company. 高层管理人员应清楚了解把六西格玛关联到公司的经营策略与公司的远期目标的重要性。					
	3. Top management should be able to involve related departments and staff for discussion when setting up the business strategies.					

		高层管理人员应当能与相关部门和工作人员参与讨论，制定公司的经营策略。					
	4.	Top management should link the six sigma projects to the established business strategies. 高层管理人员应把六西格玛关联到已制定的经营策略。					
	5.	Top management should relate feasibility, financial & organizational benefits to project selection & prioritization. 高层管理人员应把项目的可行性、所用的资金、组织的效益关联到项目选择和确定实施的优先次序。					
Organizational Ability 组织能力	***Communication & Organizational Culture 沟通交流及企业文化***						
	1.	The company should be able to adopt & accommodate a change of the culture in the company. 公司应有能力接纳顺应公司内企业文化的变化。					
	2.	The six sigma project team should be able to lead the change of mindset of the employees towards the goals of six sigma implementation. 六西格玛项目团队应有能力引导员工思维的改變，朝著六西格玛项目执行的目标迈进。					
	3.	The company should be able to educate the employees on the benefits of six sigma implementation in order to overcome their resistance. 公司应对员工宣导实施六西格玛能给公司带来的好处，以克服他们的抵抗意识。					
	4.	The six sigma project team should act as mediator between top management & employees to the adoption of cultural change. 六西格玛项目团队应作为高层管理人员和员工之间的协调者，使员工适应这种文化变迁。					
	5.	The company should be aware of the importance to communicate to all employees on the why & how of six sigma implementation. 公司应该认识到对所有员工进行沟通的重要性：包括对他们解释为什么及如何实施六西格玛。					
	6.	The six sigma project team should be aware of the importance of communicating the six sigma project progress & implementation outcomes to top management. 六西格玛项目团队应该知道对六西格玛项目的进度状况，向高层管理人员汇报执行结果的沟通的重要性。					
	7.	Appropriate training should be provided to the six sigma project team relating to communication skills. 应该提供适当的沟通技巧培训给六西格玛项目的团队，用以提升其沟通技巧。					
	8.	The six sigma project team should be authorized to communicate on any critical issues &/ or the project outcomes regarding six sigma implementation to top management. 六西格玛项目团队应被授权向最高管理层沟通及反映任何六西格玛项目执行的重点事项及/或项目的成果。					

	Understanding of Six Sigma Methodology, Tools, Techniques & Progress Review 六西格玛方法，工具，技巧的理解与進度檢討					
	1. It is important that proper communication channels should be established within the company to facilitate information flow relating to six sigma implementation. 在六西格玛项目实施中，于公司内部建立合适的沟通渠道以便于信息交流是十分重要的。					
	2. The six sigma project team should be able to monitor & control the six sigma projects during implementation. 六西格玛实施过程中，六西格玛项目团队应能监视和控制过程。					
	3. The six sigma projects should be reviewed periodically & clear set of measures & metrics be conducted in the tracking of six sigma implementation. 六西格玛项目团队应在跟踪六西格玛执行的过程中，进行定期评审，并订出明确的量度标准和规则。					
	4. The six sigma project team should employ appropriate six sigma tools & techniques to facilitate & monitor six sigma implementation. 六西格玛项目团队应采用适当的六西格玛工具和技术来促进和监察六西格玛的实施。					
	5. The six sigma project team should be well trained & should understand the six sigma methodology, tools & techniques. 六西格玛项目团队应是训练有素及了解六西格玛方法、工具与技巧的实施。					
	6. The six sigma project team should be able to apply six sigma methodology, tools & techniques in six sigma implementation. 在实施过程中，六西格玛项目团队应能灵活运用六西格玛方法，工具与技巧。					
	7. The six sigma project team should understand the principles behind the DMAIC cycle. 六西格玛项目团队应明白 DMAIC 背后的原理。					
	8. The six sigma project team should be able to choose the appropriate tools & techniques that are required within the six sigma problem solving framework. 六西格玛项目团队应该能够选择合适的工具及技术(在六西格玛解决问题过程中所需要的)。					
	Linking Six Sigma to Customers 把六西格玛关联到以顾客为中心					
	1. The company should have a customer-oriented culture for six sigma implementation. 公司在推行六西格玛的过程中，应建立一个以顾客为关注焦点的公司文化。					
	2. The six sigma project team should be able to link six sigma projects to customers. 六西格玛项目团队应能把六西格玛项目关联到顾客。					
	3. The six sigma project team should begin the six sigma projects in defining key customers that they serve.					

	六西格玛项目团队应在开始执行六西格玛项目时就定义公司所服务的主要客户。					
	4. The six sigma project team should clearly determine customer requirements. 六西格玛项目团队应该清楚地确定客户的要求。					
	5. The six sigma project team should be able to identify the core processes & define their related key outputs which have impact on customer satisfaction during six sigma implementation. 六西格玛项目团队在六西格玛项目执行过程中，应能识别关键过程，定义关键过程相关的关键输出及其对顾客满意的影响。					
	6. The six sigma project team should be able to gather customer data for determining Voice of Customer (VOC). 六西格玛项目团队应能收集客户的咨询以确定客户的要求和期望（VOC）。					
	7. The six sigma project team should adopt the data collected & VOC to analyze & prioritize customer requirements & hence link these to the business strategy in six sigma implementation. 六西格玛项目团队在项目的执行过程中，应采取通过数据收集，及已确定的客户的期望以分析及把客户要求作优先次序的处理，并将这些关联到企业的经营策略。					
	Employee Attitude & Engagement　员工态度与投入心态					
	1. The company should adopt various reward & recognition schemes to motivate employees towards the introduction & implementation of six sigma. 公司应采用各种奖励及表扬方案，以此来推动员工对六西格玛的开展及执行的激情。					
	2. The company should ensure the fears of employees towards six sigma implementation to be overcome as early & effective as possible. 公司应尽早和尽可能有效克服员工对六西格玛实施的恐惧心理。					
	3. The six sigma project team members should be provided with an open & free communication environment. 六西格玛项目团队成员应该被提供一个开放与自由交流的环境。					
	4. The six sigma project team should be able to communicate the six sigma implementation information on a timely basis. 六西格玛项目团队应能及时传达六西格玛执行进展的资讯。					
	Project Management Skills　项目管理技巧					
	1. The six sigma project team should regularly gather & meet to review the six sigma project progress & discuss for any fine-tuning & modification needed during implementation. (E.g. Six sigma tools, implementation schedule, etc. adopted in the projects) 六西格玛项目团队应定期收集，开会评审六西格玛项目的进展情况，讨论任何微调及在实施过程中的修改。(如在项目所采纳的六西格玛工具，实施时间表等)					
	2. The six sigma project team should possess the necessary					

	skills in project management. 六西格玛项目团队在项目管理中应具备必要的技能。					
3.	The six sigma project team should properly be assigned with a team leader & the roles of the members should be clearly defined. 六西格玛项目团队应选择一名合适的团队负责人，团队的成员的角色和职责应清楚的界定。					
4.	The six sigma project team should periodically report & put forward the progress & key issues of the six sigma projects to top management during six sigma implementation. 六西格玛项目团队应在六西格玛的执行过程中，向最高管理层定期的汇报，反馈项目的进展，六西格玛项目的关键问题点。					
5.	The six sigma project team should prepare to fine-tune & modify the six sigma projects, if needed, based on the outcome of review with top management. 如有必要，按高层管理人员的审查结果，六西格玛项目团队应能微调修改六西格玛项目。					
6.	In addition to tools & techniques, the six sigma project team should have a clear understanding of the common metrics including costs of poor quality, throughput yield, defect rate, & so forth in six sigma implementation. 在实施六西格玛过程中，除了工具和技巧，六西格玛项目团队应对劣质成本、产能、不良率等有清晰的认知和理解。					
1. Please advise, according to your point of view, to what extent will the effective implementation of six sigma: 按您的意見, 請說明有效實施六西格瑪可達至以下情況的程度：						
A.	contribute to reduction in production cost. 可達至降低生產成本。					
B.	contribute to reduction in materials cost. 可達至降低物料成本。					
C.	contribute to reduction in labor cost. 可達至降低勞工成本。					
D.	contribute to an overall cost reduction. 可達至降低整體成本。					
E.	help enhance productivity. 幫助提高生產力。					
F.	help enhance staff's capability towards their works. 幫助提高員工的工作能力。					
G.	help shorten production lead-time. 幫助縮短生產週期。					
H.	help enhance overall efficiency. 幫助提高整體效率。					
I.	enhance products quality. 提高產品質量。					
J.	enhance service quality. 提高服務質量。					
K.	reduce customer complaints.					

	減少客戶投訴。					
L.	induce provision of an attractive price to customers. 可引至提供一個更吸引的價格給客戶。					
M.	enhance overall customer satisfaction. 提高整體的客戶滿意度。					
N.	help encourage staff to improve their work procedure continually. 幫助鼓勵員工持續改善他們的工作程序。					
O.	help create a company culture for continuous improvement. 幫助建立一種追求持續改善的公司文化。					
P.	contribute to continuous process improvement. 可達至持續的流程改善。					
Q.	contribute to continuous product quality improvement. 可達至持續的產品質量改善。					
R.	contribute to continuous service quality improvement. 可達至持續的服務質量改善。					
S.	motivate staff's willingness to spare more time in six sigma project. 激勵員工投入更多時間於六西格瑪計劃。					
T.	enhance staff's commitment in six sigma project. 提昇員工對六西格瑪計劃的投入。					
U.	enhance overall staff involvement in six sigma project. 提昇員工對六西格瑪計劃的整體參與性。					
2.	How do you rate the following elements in contributing to respective implementation outcomes as stated below: 請您對以下各項因素可引至相應的實施效果的相關程度, 作出您的評價：					
A.	"Management's Intention & Commitment" to implementation outcome "Reduced Cost". 六西格瑪計劃的實施過程中, "管理層的意願與承諾"可引至"減低成本"的效果。					
B.	"Management's Intention & Commitment" to implementation outcome "Enhanced Efficiency". 六西格瑪計劃的實施過程中, "管理層的意願與承諾"可引至"提昇效率"的效果。					
C.	"Management's Intention & Commitment" to implementation outcome "Continuous Improvement". 六西格瑪計劃的實施過程中, "管理層的意願與承諾"可引至"持續改善"的效果。					
D.	"Management's Intention & Commitment" to implementation outcome "Improved Staff Involvement". 六西格瑪計劃的實施過程中, "管理層的意願與承諾"可引至"改善員工的參與性"的效果。					
E.	"Top Management Ability" to implementation outcome "Reduced Cost". 六西格瑪計劃的實施過程中, "高層管理能力"可引至"減低成本"的效果。					
F.	"Top Management Ability" to implementation outcome "Enhanced Efficiency". 六西格瑪計劃的實施過程中, "高層管理能力"可引至"提昇效率"的效果。					

G.	"Top Management Ability" to implementation outcome "Increased Customer Satisfaction". 六西格瑪計劃的實施過程中, "高層管理能力"可引至"提高客戶滿意度"的效果。					
H.	"Top Management Ability" to implementation outcome "Continuous Improvement". 六西格瑪計劃的實施過程中, "高層管理能力"可引至"持續改善"的效果。					
I.	"Top Management Ability" to implementation outcome "Improved Staff Involvement". 六西格瑪計劃的實施過程中, "高層管理能力"可引至"改善員工的參與性"的效果。					
J.	"Organizational Ability" to implementation outcome "Reduced Cost". 六西格瑪計劃的實施過程中, "組織能力"可引至"減低成本"的效果。					
K.	"Organizational Ability" to implementation outcome "Enhanced Efficiency". 六西格瑪計劃的實施過程中, "組織能力"可引至"提昇效率"的效果。					
L.	"Organizational Ability" to implementation outcome "Increased Customer Satisfaction". 六西格瑪計劃的實施過程中, "組織能力"可引至"提高客戶滿意度"的效果。					
M.	"Organizational Ability" to implementation outcome "Continuous Improvement". 六西格瑪計劃的實施過程中, "組織能力"可引至"持續改善"的效果。					
N.	"Organizational Ability" to implementation outcome "Improved Staff Involvement". 六西格瑪計劃的實施過程中, "組織能力"可引至"改善員工的參與性"的效果。					

3. How do you rate your degree of satisfaction to the following factors during six sigma implementation:
在 貴司實施六西格玛的过程中，请您指出您对以下因素的满意度：

1 – Very Dissatisfied 非常不满意　　3 – Neutral 中立　　5 – Very Satisfied 非常满意

Key Factors 关键因素		Evaluation 评分				
		1	2	3	4	5
A.	Resources Allocation 资源分配					
B.	Management Participation & Involvement 管理者的参与及投入					
C.	Linking six sigma to business strategies 把六西格玛关联到企业经营战略					
D.	Project selection, prioritization & tracking 项目选择，确定优先次序与跟踪					
E.	Clear expectations 明确的期望					
F.	Selection of project leaders 项目负责人的选择					
G.	Management by fact 基于事实的管理					
H.	Linking six sigma to customers 把六西格玛关联到以顾客为中心					
I.	Project management skills 项目管理技巧					

J.	Understanding of six sigma methodology, tools, & techniques 六西格玛方法，工具与技巧的理解					
K.	Communication 沟通交流					
L.	Adoption of cultural change 企业文化变化的适应性					

On the whole, how successful do you consider in your company's six sigma implementation? 整体而言，您认为 贵司六西格玛执行方面有多成功？

- ☐ Very successful 非常成功
- ☐ Successful 成功
- ☐ Neutral 一般
- ☐ Not successful 不成功
- ☐ Very unsuccessful 非常不成功

Please provide justification to your opinion above: 请您详细描述您为何作出上述的意见：

_____

_____

Respondent Profile 被访人概况

1. What is the nature of major business of your company? (Please check one)
   贵公司主要的业务性质是？（请选一）
   - ☐ Manufacturing 制造
   - ☐ Servicing 服务
   - ☐ Others 其他

     Please specify 请说明: _____

2. What is your level of position in your company? 您在 贵司的职位？
   - ☐ Top Management 高层管理者
   - ☐ Middle Management 中层管理者
   - ☐ Elementary Level Staff 普通员工

3. What is your role in six sigma implementation in your company? 您在 贵司的六西格玛项目中扮演的是什么角色？
   - ☐ Champion 总指挥
   - ☐ Master Black Belt 黑带大师
   - ☐ Black Belt 黑带
   - ☐ Green Belt 绿带
   - ☐ Trainee 受训者

4. Are you acting as an internal or external six sigma role in your company? 您在 贵司的六西格玛项目中，担任的是内部还是外部的执行角色？
   - ☐ Internal 内部
   - ☐ External 外部

5. Are you acting as a permanent or part-time six sigma role in your company? 您在贵司的六西格玛项目中担任的是全职、还是兼职的角色？
   - ☐ Permanent 全职
   - ☐ Part-time 兼职

6. How many employees are there in your company? 贵司有多少雇员？
   - ☐ 1-50
   - ☐ 51-100
   - ☐ 101-200
   - ☐ 201-500
   - ☐ 501-1,000
   - ☐ Over 1,000 1,000 人以上

7. How many year(s) have you been assuming this six sigma role in your company? 您在 贵司担任六西格玛执行人员的角色共有多少年？
   - ☐ Less than 1/2 year 少于 1/2 年
   - ☐ 1/2-1 year 1/2-1 年
   - ☐ 1-2 years 1-2 年
   - ☐ 2-3 years 2-3 年
   - ☐ More than 3 years 3 年以上

8. How many year(s) have your company been implementing six sigma? 贵司的六西格玛项目执行了多少年？
   - ☐ Less than 1 year 少于 1 年
   - ☐ 1-2 year 1-2 年
   - ☐ 2-3 years 2-3 年
   - ☐ 3-4 years 3-4 年
   - ☐ 4-5 years 4-5 年
   - ☐ More than 5 years 5 年以上

9. What is your education level? 您的教育水平？
   - ☐ Secondary school or below 初中或以下
   - ☐ Post-Secondary school to Professional Diploma 高中至专业文凭
   - ☐ University graduate 大学学士
   - ☐ Master 硕士
   - ☐ PhD 博士

10. What is your education background? 您的教育背景？
    - ☐ Engineering 工程
    - ☐ Business / commercial 商贸
    - ☐ Others 其它

      Please specify 请描述: _____

11. How long does one six sigma project take on the average? 六西格玛项目平均要执行多长时间？
    - ☐ Less than 3 months 少于 3 个月
    - ☐ 4-6 months 4-6 个月
    - ☐ 7-12 months 7-12 个月
    - ☐ 13-18 months 13-18 个月
    - ☐ 19 months or above 19 个月以上

12. What is your position in your company while participating in six sigma implementation?
当您在　贵司参与六西格玛项目时，您在　贵司的职位是？

_____

13. In total, how many people involve in six sigma training in your company? 总体而言，有多少人参加了　贵司的六西格玛培训？

- ☐ 1-5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-20
- ☐ 21-25
- ☐ 26-30
- ☐ 31-35
- ☐ 36-40
- ☐ 41 or above　41 位或以上

14. In total, how many people involve in six sigma implementation in your company? 总体而言，有多少人参与了　贵司的六西格玛的实施？

- ☐ 1-5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-20
- ☐ 21-25
- ☐ 26-30
- ☐ 31-35
- ☐ 36-40
- ☐ 41 or above　41 位或以上

15. How many six sigma master black belts are there in your company?
贵司有多少位黑带大师？

- ☐ 1-2
- ☐ 3-4
- ☐ 5 or above　5 位或以上

16. How many six sigma black belts are there in your company?
贵司有多少位黑带？

- ☐ 1-2
- ☐ 3-4
- ☐ 5-7
- ☐ 8-10
- ☐ 11 or above　11 位或以上

17. How many six sigma green belts are there in your company?
贵司有多少位绿带？

- ☐ 1-2
- ☐ 3-4
- ☐ 5-7
- ☐ 8-10
- ☐ 11 or above 11 位或以上

18. How many six sigma project(s) does your company complete annually on the average?
贵司每年平均完成多少个六西格玛项目？

- ☐ 1-2
- ☐ 3-4
- ☐ 5-6
- ☐ 7-8
- ☐ 9-10
- ☐ 11 or above 11 個或以上

19. What is the average saving from each of the six sigma projects in your company?
在 贵公司于每个六个西格玛项目平均节省了多少钱？

- ☐ Below HK$100,000 港币 100,000 以下
- ☐ HK$100,000-HK$200,000
- ☐ HK$200,001-HK$300,000
- ☐ HK$300,001-HK$500,000
- ☐ HK$500,001-HK$800,000
- ☐ More than HK$800,000 港币 800,000 以上

~ This is the end of questionnaire. Thank you for your participation! ~

调查问卷完成，谢谢您的参与！

REFERENCES

1. Ahire, S.L., Golhar, Y.D. and Waller, M.A., 1996. Development and validation of TQM implementation constructs. Decision Sciences 27 (1), 23-56.

2. Ahire, S.L., Landeros, R. and Golhar, Y.D., 1995. Total quality management: a literature review and an agenda for future research. Production and Operation Management 4 (3), 277-306.

3. Ahire, S.L. and Ravichandran, T., 2001. An innovation diffusion model of TQM implementation. IEEE Transactions on Engineering Management 48 (4), 445-464.

4. Ahmed, S.M., Aoieong, R.T., Tang, S.L. and Zheng, D.X.M., 2005. A comparison of quality management systems in the construction industries of Hong Kong and the USA. International Journal of Quality & Reliability Management 22 (2), 149-161.

5. Anbari, F.T., 2002. Six sigma method and its applications in project management, proceedings of the project management institute annual seminars and symposium [CD], San Antonio, Texas. Oct 3-10. Project Management Institute, Newtown Square, PA.

6. Andel, T., 2007. Lean & six sigma traps to avoid. Material Handling Management, March.

7. Andersson, R., Eriksson, H., Torstensson, H., 2006. Similarities and differences between TQM, six sigma and lean. The TQM Magazine 18 (3), 282-296.

8. Antony, J., 2004. Some pros and cons of six sigma: an academic perspective. The TQM Magazine 16 (4), 303-306.

9. Antony, J., 2007. Is six sigma a management fad or fact? Assembly Automation 27 (1), 17-19.

10. Antony, J., Banuelas, R., 2001. A strategy for survival. Manufacturing Engineer 80 (3), 119-121.

11. Antony, J., Banuelas, R., 2002. Key ingredients for the effective implementation of Six Sigma program. Measuring Business Excellence 6

(4), 20-27.

12. Antony, J., Escamilla, J.L., Caine, P., 2003. Lean sigma. Manufacturing Engineer 82 (4), 40-42.

13. Armitage, A. and Keeble-Allen, D. 2007. Measuring organizational success. Quality World, 32-35.

14. Arnheiter, E.D., Maleyeff, J., 2005. The integration of lean management and Six Sigma. The TQM Magazine 17 (1), 5-18.

15. Beckmerhagen, I.A., Berg, H.P., Karapetrovic, S.V. and Willborn, W.O., 2004. On the effectiveness of quality management system audits. The TQM Magazine 16 (1), 14-25.

16. Benedetto, A.R., 2003. Adapting manufacturing-based six sigma methodology to the service environment of a radiology film library. Journal of Healthcare Management 48 (4), 263-280.

17. Brady, J.E. and Allen, T.T., 2006. Six sigma literature: a review and agenda for future research. Quality and Reliability Engineering International 22, 335-367.

18. Breyfogle III, F.W., Cupello J.M., Meadows B., 2001. Managing six sigma: a practical guide to understanding, assessing, and implementing the strategy that yields bottom-line success. John Wiley & Sons Inc.

19. Brun, A., 2011. Critical success factors of Six Sigma implementations in Italian companies. International Journal of Production Economics 131 (1), 158-164.

20. Buch, K.K., Tolentino, A., 2006. Employee expectancies for six sigma success. Leadership & Organization Development Journal 27 (1), 28-37.

21. Buch, K.K., Tolentino, A., 2006. Employee perceptions of the rewards associated with six sigma. Journal of Organizational Change Management 19 (3), 356-364.

22. Buss, P., Ivey, N., 2001. Dow chemical design for six sigma rail delivery project, proceedings of the 2001 Winter Simulation Conference 2001, 1428-1251.

23. Catherwood, P., 2002. What's different about six sigma. Manufacturing Engineer 81 (8), 186-189.

24. Caudron, S., 2002. TRENDS Just Say No to Training Fads. T AND D 56 (6), 38-43.

25. Caulcutt, R., 2001. Why is Six Sigma so successful? Journal of Applied Statistics 28 (3-4), 301-306.

26. Chakravorty, S.S., 2009. Six sigma programs: An implementation model. International Journal Production Economics 119, 1-16.

27. Chan, C.O. and Sun, H.Y., 2004. A model for implementing Six Sigma in China SMEs. 9th International Conference of ISO9000 and TQM, Bangkok, Thailand.

28. Chen, J., 2006. DMAIC integration necessary for success. Six Sigma Forum Magazine 8, 22-28.

29. Churchill, C.A., 1996. Basic Marketing Research, Dryden, Chicago, IL.

30. Cohen, J., Cohen, P., West, S.G., Aiken, L.S., 2003. Applied multiple regression/correlation analysis for the behavioral sciences (3rd ed.). Mahwah, NJ: LEA

31. Coronado, R.B., Antony, J., 2002. Critical success factors for the successful implementation of six sigma projects in organizations. The TQM Magazine 14 (2), 92-99.

32. Daft, R.L., 1978. A dual-core model of organizational innovation. Academy of Management Journal 21 (2), 193-210.

33. de Feo, J., Bar-El, Z., 2002. Creating strategic change more efficiently with a new design for six sigma process. Journal of Change Management 3 (1), 60-80.

34. Dean, J.W. Jr and Bowen, D.E., 1994. Management theory and total quality: improving research and practice through theory development.

Academy of Management Journal 19 (3), 392-418.

35. Douglas, A., Coleman, S. and Oddy, R., 2003. The case for ISO 9000. The TQM Magazine 15 (5), 316-324.

36. Dziwetzki, M.E., 2004. Zertifizierungspraxis im europaischen Ausland – Eine andere Welt", Qualitat und Zuverlassigkeit 49 (1), 25-26.

37. Eckes, G., 2000. General Electric's Six Sigma Revolution.

38. Eckes, G., 2002. The Six Sigma revolution: How General Electric and others turned process into profits. John Wiley & Sons.

39. Eckhouse, 2003. In pursuit of perfection. Bechtel Briefs, August. Available online via <http://www.bechtel.com/sixsigma.htm> (accessed March 2, 2004).

40. Ehrlich, B.H., 2002. Transactional six sigma and lean servicing: leveraging manufacturing concepts to achieve world-class service. CRC Press.

41. Elsberry, R.B., 2000. Six sigma: applying a corporate model to radiology. Decisions in Imaging Economics 13 (7), 56-66.

42. Erwin, J., Douglas, P., 2000. It's not difficult to change company culture. SuperVision 61 (11), 6-11.

43. Ettinger, W., 2001. Six sigma adapting GE's lesson to health care. Trustee 54 (8), 10-16.

44. Fernie, J. and Sparks, L. (Eds), 1998. Logistics and retail management, insights into current practice and trends from leading experts, Kogan Page Ltd, London.

45. Fine, C.H., 1998. Clockspeed: Winning industry control in the age of temporary advantage. Basic Books.

46. Flynn, B.B., Schroeder, R.G., Sakakibara, S., 1994. A framework for quality management research and an associated measurement instrument. Journal of operations management 11 (4), 339-366.

47. Forza, C. and Vinelli, A., 1996. Design towards quick response: an analytical scheme for the change. International Journal of Clothing Science and Technology 8 (4), 28-43.

48. General Electric, 2004. What is six sigma: the roadmap to customer impact. Available online via <http://www.ge.com/sixsigma/sixsigma.pdf.> (assessed February 27, 2004).

49. George, M., 2002. Lean six sigma – combining six sigma quality with lean speed, McGraw-Hill, New York, NY.

50. Goh, T.G., 2002. A Strategic assessment of six sigma. Quality and Reliability Engineering International 18 (4), 403-410.

51. Halliday, S., 2001. So what is exactly...six sigma? Works management 54 (1), 15.

52. Haln, G.J., Doganaksoy, N., and Hoerl, R., 2000. The evolution of six sigma. Quality Engineering 12, 317-326.

53. Hammer, M., 2002. Process management and the future of six sigma. Engineering Management Review, IEEE 30 (4), 56-56.

54. Harry, M., Schroeder, R., 2005. Six sigma: the breakthrough management strategy revolutionizing the world's top corporations. Random House LLC.

55. Henderson, K.M., Evans, J.R., 2000. Successful implementation of Six Sigma: benchmarking general electric company. Benchmarking: An

International Journal 7 (4), 260-282.

56. Heskett, J.L., Sasser, W.E., Schlesinger, L.A., 1997. The service profit chain. New York.

57. Heskett, J.L., Schlesinger, L., 1994. Putting the service-profit chain to work. Harvard Business Review 72 (2), 164-174.

58. Hoerl, R.W. and Snee, R.D., 2002. Statistical thinking – improving business performance. Duxbury, Thomas Learning, Belmont, CA.

59. Hopkins, S.A., Nie, W., Hopkins, W.E., 2004. A comparative study of quality management in Taiwan's and China's electronics industry. International Journal of Quality & Reliability Management 21 (4), 362-376.

60. Ingle, S., Roe, W., 2001. Six sigma black belt implementation. The TQM Magazine 13 (4), 273-280.

61. Itex – Information Technology for the Textile & Clothing Industry, 1997. The Itex Surveys, Brussels.

62. Jiang, B., Frazier, G.V., Heiser, D., 2007. China-related POM research: a literature review and suggestions for future research. International Journal of Operations & Production Management 27 (7), 662-684.

63. Jiju, A., 2004. Some pros and cons of six sigma: an academic perspective. The TQM Magazine 16 (4), 303-306.

64. Jiju, A., 2006. Six sigma for service processes. Business Process Management Journal 12 (2), 234-248.

65. Jiju, A., 2007. Is six sigma a management fad or fact? Assembly Automation 27 (1), 17-19.

66. Jiju Antony and Ricardo Banuelas, 2002. Key ingredients for the

effective implementation of six sigma program. Measuring Business Excellence 6 (4) 20-27.

67. Johnson, A., Swisher, B., 2003. How six sigma improves R&D. Research Technology Management 46 (2), 12-15.

68. Jones, D., 1998. Firms air for six sigma efficiency. USA Today, July 21, 1998 Money Section.

69. Klefsjo, B., Wiklund, H., Edgeman, R.L., 2001. Six sigma seen as a methodology for total quality management. Measuring Business Excellence 5 (1), 31-35.

70. Kwak, Y.H., Anbari, F.T., 2006. Benefits, obstacles, and future of six sigma approach. Technovation 26 (5), 708-715.

71. Kwan, C.Y., 2006. An investigation on the factors affecting young Chinese consumers' decision-making behavior towards casual wear purchase. The Hong Kong Polytechnic University.

72. Lau, R., Zhao, X., Xiao, M., 2004. Assessing quality management in China with MBNQA criteria. International Journal of Quality & Reliability Management 21 (7), 699-713.

73. Lazarus, I.R., Butler, K., 2001. The promise of six sigma. Managed Healthcare Executive 11 (9), 22-26.

74. Lee, C.Y., 2004. TQM in small manufacturers: an exploratory study in China. International Journal of Quality & Reliability Management 21 (2), 175-197.

75. Lee, Choong Y. and Zhou, Xiaomu, 2000. Quality management and manufacturing strategies in China. International Journal of Quality & Reliability Management 17 (8), 876-898.

76. Lee, T.Y., Wong, W.K., Yeung, K.W., 2011. Developing a readiness self-assessment model (RSM) for Six Sigma for China enterprises. International Journal of Quality & Reliability Management 28 (2), 169-194.

77. Li, J., Anderson, A.R. and Harrison, R.T., 2003. Total quality management principles and practices in China. International Journal of Quality & Reliability Management 20 (9), 1026-1050.

78. Linderman, K., Schroeder, R.G., Zaheer, S., Choo, A.S., 2003. Six Sigma: a goal-theoretic perspective. Journal of operations management 21 (2), 193-203.

79. Liu, Y., 1994. TQM in the socialist market economy of China. Asia Pacific Journal of Quality Management 3 (3), 36-44.

80. Lo, C.K., Wiengarten, F., Humphreys, P., Yeung, A.C., Cheng, T., 2013. The impact of contextual factors on the efficacy of ISO 9000 adoption. Journal of Operations Management 31 (5), 229-235.

81. Ma, Y.Z., Yue, G., Wang, L.l., Sangbok, R., 2008. The Critical Success Factors of Six Sigma in China Manufacturing Industry. Asian Journal on Quality 9 (2), 39-56.

82. Margaret Bruce, Lucy Daly, Neil Towers, 2004. Lean or agile: A solution for supply chain management in the textiles and clothing industry. International Journal of Operations & Production Management 24 (2), 151-170.

83. Magnusson, K., Kroslid, D., Bergman, B., Häyhänen, P., Mills, D., 2003. Six Sigma: the pragmatic approach. Studentlitteratur.

84. McClusky, R., 2000. The rise, fall, and revival of six sigma. Measuring

Business Excellence 4 (2), 6-17.

85. Merkin, R.S., 2006. Uncertainty avoidance and facework: A test of the Hofstede model. International Journal of Intercultural Relations 30 (1), 213-228.

86. Moreton, M., 2003. Featured company: Bechtel. ASQ Six Sigma Forum Magazine 3 (1), 44.

87. Näslund, D., 2008. Lean, six sigma and lean sigma: fads or real process improvement methods? Business Process Management Journal 14 (3), 269-287.

88. Nave, D., 2002. How to compare Six Sigma, lean and the theory of constraints. Quality Progress 35 (3), 73-78.

89. Neuman, R.P., Cavanagh, R., 2000. The six sigma way: How GE, Motorola, and other top companies are honing their performance. McGraw Hill Professional.

90. Numally, J.C., 1978. Psychometric theory. NY: McGraw-Hill

91. Obert, T.L. and Spencer, B.A., 1996. An exploratory study of the link between strategic types and quality implementation. Journal of Business Strategies 13, 89-106.

92. Pfeifer, T., 2002. Quality management – strategies, methods, techniques. Hanser, Munchen.

93. Pfeifer, T., Reissiger, W., Canales, C., 2004. Integrating Six Sigma with quality management systems. The TQM Magazine 16 (4), 241-249.

94. Poksinska, B., Dahlgaard, J.J. and Antoni, M., 2002. The state of ISO9000 certification: a study of Swedish organizations. The TQM Magazine 14 (5), 297-306.

95. Prajogo, D.I. and McDermott, D.M., 2005. The relationship between total quality management practices and organizational culture. International Journal of Operations & Production Management 25 (11), 1101-1122.

96. Pyzdek, T., 2001. The Six Sigma Revolution, Quality America, Tuscon, AZ, available at: www.qualityamerica.com/knowledgecentre/articles/PyzdekSixSigRev.htm.

97. Pyzdek, T., Keller, P.A., 2003. The Six Sigma handbook: a complete guide for green belts, black belts, and managers at all levels. McGraw-Hill New York.

98. Quality World, December 2007.

99. Quality World, February 2008.

100. Raghunathan, T.S., Rao, S.S. and Solis, L.E., 1997. A comparative study of quality practices: USA, China and India. Industrial Management & Data Systems 97 (5). 1-11.

101. Rajagopalan, R., Francis, M., Suarez, W., 2004. Developing novel catalysts with six sigma. Research Technology Management 46 (1), 13-16.

102. Rancour, T. and McCracken, M., 2000. Applying six sigma methods for breakthrough safety performance. American Society of Safety Engineer, October, 31-34.

103. Rao, S.S., Raghunathan, T.S. and Solis, L.E., 1997. A comparative study of quality practices and results in India, China and Mexico. Journal of Quality Management 2, 235-250.

104. Ravichandran, T., 2000. Swiftness and intensity of administrative

innovation adoption: an empirical study of TQM in information systems. Decision Sciences 31 (3), 691-724.

105. Reed, M., 2000. Six sigma eavesdropping on the Net!!!!. Quality Australia 15 (1), 10.

106. Reichheld, F.F., Sasser Jr, W.E., 1989. Zero defections: quality comes to services. Harvard Business Review 68 (5), 105-111.

107. Reinforced Plastics – What is six sigma? July/ August 2004, 46-49.

108. Revere, L., Black, K., 2003. Integrating six sigma with total quality management: a case example for measuring medication errors. Journal of Healthcare Management 48 (6), 377-391.

109. Revere, L., Black, K., Huq, A., 2004. Integrating Six Sigma and CQI for improving patient care. The TQM Magazine 16 (2), 105-113.

110. Roberts, C.M., 2004. Six sigma signals. Credit Union Magazine 70 (1), 40-43.

111. Romano, Pietro and Vinelli, Andrea, 2001. Quality management in a supply chain perspective: Strategic and operative choices in a textile-apparel network. International Journal of Operations & Production Management 21 (4), 446-460.

112. Roth A. and Miller, J., 1990. Manufacturing strategy, manufacturing strength, managerial success, and economic outcomes. In Ettlie, J.E., Burstein, M.C. and Feigenbaum, A. (Eds), Manufacturing Strategy, Kluwer Academic Publishers, Boston, MA, 97-108.

113. Rucker, R., 2000. Citibank increased customer loyalty with defect-free processes. Journal of Quality and Participation, 32-36.

114. Saadat, M., Antony, J., 2007. Is Six Sigma a management fad or fact?

Assembly Automation 27 (1), 17-19.

115. Schmieder, M., 2003. Vorsichtige Annaherung – anwendung von six sigma in Deutschland. Qualitat und Zuverlassigkeit 48 (7), 689-700.

116. Schneiderman, A.W., 1999. Q: when is six sigma not six sigma? A: when it's the six sigma metric! Available at: http://www.schneiderman.com (accessed 1 February 2009).

117. Schurr, S., 2002. Magische 3,4 und mehr – design for six sigma verwirklicht den integrierten methodeneinsatz", Qualitat und Zuverlassigkeit 47 (3), 246-247.

118. Shafer, S.M. and Moeller, S.B., 2012. The effects of six sigma on corporate performance: an empirical investigation. Journal of Operations Management 30, 521-532.

119. Shani, A.B. and Docherty, P., 2003. Learning by design: Building sustainable organizations. Blackwell Publishing, Oxford.

120. Sila, I., 2007. Examining the effects of contextual factors on TQM and performance through the lens of organizational theories: an empirical study. Journal of Operations Management 25 (1), 83-109.

121. Solis, L.E., Rao, S.S. and Ragunathan, T.S., 2001. The best quality management practices in small and medium enterprises: an international study. International Journal of Manufacturing Technology and Management 3 (4/5), 416-443.

122. Spector, R.E., 2006. How constraints management enhances lean and six sigma. Supply chain management review 10 (1) (Jan./Feb. 2006), 42-47.

123. Stephens, K.S., 1989. China's emerging quality emphasis. Quality Progress, December, 56-61.

124. Su, Q., Li, Z., Zhang, S.A. and Liu, Y.Y., 2008. The impacts of quality management practices on business performance. International Journal of Quality & Reliability Management 25, 809-823.

125. Sun, H., 2000. A comparison of quality management practices in Shanghai and Norwegian manufacturing companies. International Journal of Quality & Reliability Management 17 (6), 636-660.

126. Sung, Q.M., 2000. The current condition and the future of SME in China. Academy Journal of Jiang Hai 4, 27-33.

127. Swink, M., Jacobs, B.W., 2012. Six sigma adoption: Operating performance impacts and contextual drivers of success. Journal of Operations Management 30 (6), 437-453.

128. Tennant, G., 2002. Design for six sigma: Launching new products and services without failure, Gower, Aldershot.

129. Thatcher, M.E., Oliver, J.R., 2001. The impact of technology investments on a firm's production efficiency, product quality, and productivity. Journal of Management Information Systems 18 (2), 17-45.

130. The ISO survey of certification 2013, 2013. International Organization for Standardization.

131. The People's Daily, 2008. China's GDP Increases 14 Fold in 30 Years. The People's Daily.

132. Thevnin, C., 2004. Effective management commitment enhances six sigma success. Handbook of Business Strategy, 195-200.

133. Thomas A. and Barton R., 2006. Developing an SME based six sigma strategy. Journal of Manufacturing Technology Management 17 (4), 417-434.

134. Tilo, P., Reissiger, W. and Canales, C. 2004. Integrating six sigma with quality management systems, The TQM Magazine 16 (4), 241-249.

135. Topfer, A., 2002. Ansatz und Nutzen von Six Sigma, in Topfer, A. (Ed.), Business Excellence. Wie Sie Wettbewerbsvorteile und Wertsteigerung erzielen, Frankfurter Allgemeine Zeitung GmbH, Frankfurt, 319-333.

136. Tuan, C. and Ng, L.F.Y., 1997. System building and implementations of TQM in Greater China : an overview. International Journal of Quality Science 3 (2), 171-189.

137. Vickery, S., Droge, C. and Markland, R., 1992. The contribution of manufacturing to business performance: an empirical study of the furniture industry. Proceedings of the Annual Meeting of the 1992 Decision Science Institute, Atlanta, GA, 1380-1382.

138. Watson, G.H., 2003. Six Sigma: An Evolving Stage in the Maturing of Quality, Quality into 21st Century. ASQ Quality Press, Milwaukee Wisconsin.

139. Weiner, M., 2004. Six sigma. Communication World 21 (1), 26-29.

140. Wessel G. and Burcher P., 2004. Six sigma for small and medium-sized enterprise. The TQM Magazine 16 (4), 264-272.

141. Woo H.L., 2002. Review of six sigma and its relevance to facility management. Hong Kong Polytechnic University.

142. Wu, J.R., 2009. China Overtakes Germany in GDP, Becomes Third-Largest Economy. The Wall Street Journal (15 January), pp. A6.

143. Xu, K., Jayaram, J., Xu, M., 2006. The effects of customer contact on conformance quality and productivity in Chinese service firms. International Journal of Quality & Reliability Management 23 (4),

367-389.

144. Yeung, A.C.L., Cheng, T.C.E. and Lai, K.H., 2005. An empirical model for managing quality in the electronics industry. Production and Operations Management 14, 189-204.

145. Yue, G. and Ma, Y.Z., 2006. Some issues on six sigma management. Statistics and Management 25 (3), 351-357.

146. Yusof, S.M. and Aspinwall, E., 1999. Critical success factors for total quality management implementation in small and medium enterprises. Total Quality Management 10, 803-809.

147. Zhao, X., Flynn, B.B., Roth, A.V., 2006. Decision Sciences Research in China: A Critical Review and Research Agenda—Foundations and Overview*. Decision Sciences 37 (4), 451-496.

148. Zhao, X., Flynn, B.B., Roth, A.V., 2007. Decision Sciences Research in China: current status, opportunities, and propositions for research in supply chain management, logistics, and quality management. Decision Sciences 38 (1), 39-80.

149. Zhao, X., Yeung, A.C., Lee, T., 2004. Quality management and organizational context in selected service industries of China. Journal of operations management 22 (6), 575-587.

150. Zhao, X.D., Young, S.T. and Zhang, J.C., 1995. A survey of quality issues among Chinese executives and workers. Production and Inventory Management Journal, First Quarter 1995, 44-48.

151. Zimmerman, J.P., Weiss, J., 2005. Six sigma's seven deadly sins. Quality 44, 62-66.

152. Zu, X., Fredendall, L.D., Douglas, T.J., 2008. The evolving theory of

quality management: the role of Six Sigma. Journal of operations management 26 (5), 630-650.

153. Zu X.X., Zhou H.M., Zhu X.W., Yao D.Q., 2011. Quality management in China: the effects of firm characteristics and cultural profile. International Journal of Quality & Reliability Management 28 (8), 800-821.