Implementation of Six Sigma in Australian Manufacturing Small and Medium Enterprises

By

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Masters of Commerce

Deakin University

August, 2012
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Date: August, 2012
Dedication

To my great parents Khurshid and Kausar

To my lovely wife Rabia

To my beautiful kids Laiba and Umar-Khayyam

To my adoring sisters and late brother
Acknowledgements

Starting with the name of ALLAH, the most Beneficent and the most Merciful

Reaching this moment of writing the acknowledgement is something I have long awaited. The completion of this thesis would not have been possible without the support, encouragement and sacrifice of many individuals.

Firstly, I would like to acknowledge the enormous support and guidance offered to me by my supervisors, Dr Dianne Waddell and Dr Ambika Zutshi. Both of them were very supportive throughout this journey, right from the proposal writing to the final submission of this thesis. I would like to extend my gratitude to Deakin University for giving me the chance to gain this degree and to all the educational and administrative staff at the School of Management and Marketing who contributed directly and indirectly to this achievement.

I would like to acknowledge my mother, for her good wishes and prayers for me, and my late father, who is not with me anymore but I always felt his presence around me. I would also like to remember my late brother at these happy moments of my life. And to my sisters who always prayed for my success.

Lastly, but by no means the least, I wish to thank my adorable wife, Rabia, the best thing that ever happened to me. I am so lucky to be with you. Thank you for standing by me, for your support and love. Finally, lots and lots of love to Laiba.
for her care and waiting at dinner; and Umar-Khayyam, for the constant enthusiastic reception, irrespectively of how late was my home arrival.

And to all my friends and colleagues in Australia and Pakistan, I am deeply grateful for all your prayers, encouragement and support during the long journey of deliberating this thesis.
Abstract

Six Sigma has become one of the most popular standards of quality in large organisations. However, its application in small and medium-sized enterprises (SMEs) is still at the infancy stage. National and international markets are experiencing the effects of globalisation, and the challenging business environment demands perfection in each operational dimension. Among various advanced quality management methodologies, Six Sigma could be the one suitable remedy for achieving operational excellence, but the number of manufacturing SMEs who have adopted Six Sigma is quite discouraging. The literature also highlights the lack of acceptance of Six Sigma by manufacturing SMEs.

Australia is a developed economy, but the manufacturing SMEs of Australia reflect the international situation with respect to Six Sigma implementation. The present study discusses the status of quality management practices in manufacturing SMEs in Australia and investigates the reasons why they are not implementing the Six Sigma methodology.

This study is based on work carried out in the UK (Kumar 2007; Kumar & Antony 2008). Therefore, the pre-tested questionnaire launched in the UK was redesigned to suit the Australian environment. The survey helped to short-list the number of SMEs that had already implemented Six Sigma projects successfully.
The study progressed further through exploring the experiences of an SME via a case study.

This study emphasises that Six Sigma can be implemented in manufacturing SMEs. Moreover, this study identifies the motivation for adopting Six Sigma by Australian manufacturing SMEs. It was found that a normative isomorphic change mechanism, under institutional theory, is exclusively involved in the adoption of the Six Sigma methodology. This study also discusses various critical success factors and impeding factors involved in the implementation of quality improvement initiatives, in general, as well as of Six Sigma, in particular. This study contributes anecdotal evidence to the literature that, as in large organisations, successful Six Sigma implementation in SMEs can provide financial gains and operational excellence. This study also contributes by identifying the current status of quality management practices in Australian manufacturing SMEs.

There are a few limitations of this study. First, the limited number of Six Sigma practising SMEs restricted the generalisation of the findings. Secondly, due to the unavailability of a database exclusive to Australian manufacturing SMEs, the survey was sent to all ISO 9001 certified organisations regardless of their size. Moreover, due to resource constraints, the study focused only on SMEs belonging to the manufacturing sector and the service sector was not discussed.
Conference Papers

The findings/results from Chapters 2 and 4 have been presented in the following national and international conferences.


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<th>Full Form</th>
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<tbody>
<tr>
<td>ABS</td>
<td>Australia Bureau of Statistics</td>
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<tr>
<td>AQA</td>
<td>Australian Quality Award</td>
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<tr>
<td>BBC</td>
<td>British Broadcasting Corporation</td>
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<td>BSI</td>
<td>British Standards Institution</td>
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<tr>
<td>CEO</td>
<td>Chief executive officer</td>
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<td>COSBOA</td>
<td>Council of Small Businesses of Australia</td>
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<td>CSF</td>
<td>Critical success factors</td>
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<td>CTQ</td>
<td>Critical-to-quality</td>
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<tr>
<td>DPMO</td>
<td>Defects per million opportunities</td>
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<tr>
<td>EFQM</td>
<td>European Foundation for Quality Management</td>
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<tr>
<td>GE</td>
<td>General Electric</td>
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<tr>
<td>GFC</td>
<td>Global financial crisis</td>
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<tr>
<td>GM</td>
<td>General manager</td>
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<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
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<tr>
<td>JAS-ANZ</td>
<td>Joint Accreditation System of Australia and New Zealand</td>
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<tr>
<td>KT</td>
<td>Kepner-Tregoe</td>
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<tr>
<td>MBNQA</td>
<td>Malcolm Baldrige National Quality Award</td>
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<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>NIST</td>
<td>National Institute of Science and Technology</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-Operation and Development</td>
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<tr>
<td>QA</td>
<td>Quality assurance</td>
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<td>QC</td>
<td>Quality control</td>
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<td>QFD</td>
<td>Quality function deployment</td>
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<td>QI</td>
<td>Quality improvement</td>
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<td>QM Phase I</td>
<td>Quality management Phase I</td>
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<td>QM Phase II</td>
<td>Quality management Phase II</td>
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<td>QM Phase III</td>
<td>Quality management Phase III</td>
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<tr>
<td>RBA</td>
<td>Reserve Bank of Australia</td>
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<td>RQ</td>
<td>Research question</td>
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<tr>
<td>SME</td>
<td>Small and medium-sized enterprises</td>
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<tr>
<td>TOC</td>
<td>Theory of constraints</td>
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<td>TQM</td>
<td>Total quality management</td>
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<td>UNIDO</td>
<td>United Nations Industrial Development Organization</td>
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Chapter 1: Introduction

1.1 Introduction

Six Sigma has become one of the most popular standards of quality in large organisations. However, its application in small and medium-sized enterprises (SMEs) is still at the infancy stage (Antony 2008b; Antony, Kumar & Madu 2005; Kaushik et al. 2012; Khurshid, Kumar & Waddell 2012; Kumar & Antony 2008). The low number of manufacturing SMEs to adopt Six Sigma globally is quite discouraging. The current study is designed to explore the facts about Australian manufacturing SMEs. A framework is developed to highlight the process of Six Sigma implementation. The systematic approach of the current study is introduced in the following sections.

This chapter introduces the topic of Six Sigma implementation in SMEs, explains the key issues related to the topic and provides an overview of the structure of the study. Subsequent chapters present the overall background of the research, a review of the literature and an introduction to the research hypotheses. After establishing the gap in the current body of knowledge, an appropriate research methodology is introduced. Data were collected by following the research methodology and the results are then analysed and discussed. A framework explaining the process of Six Sigma implementation is developed. Implications for future research are identified.
1.2 Research Background

SMEs constitute the bulk of businesses around the globe and, therefore, play an important role in the development of the national economy of any country (Ahmad, Mazhar & Jan 2009; Antony, Kumar & Madu 2005; Kureshi, Qureshi & Sajid 2010; Soti, Shankar & Kaushal 2012). For example, SMEs are the main contributors to economic output and employment (Antony, Kumar & Madu 2005; Husband & Mandal 1999; Wattanapruttipaisan 2002; Wymenga et al. 2011). The Australia Bureau of Statistics [ABS] (2011) revealed that more than 96 per cent of organisations fall into the category of SMEs. The Reserve Bank of Australia (RBA) also presented a report verifying the significance of SMEs to the Australian economy (Connolly, Norman & West 2012). Similarly, the Australian government’s Department of Innovation, Industry, Science and Research pointed out that SMEs contributed around 57 per cent of industry value added in 2009–2010 (Industry Policy and Economic Analysis Branch 2011), compared with 42 per cent contributed by large businesses (ABS 2011).

Current issues such as the global financial crisis (GFC), along with the continuously evolving phenomenon of globalisation, create significant challenges for organisations. The GFC resulted in approximately 51 million jobs being placed at risk globally (British Broadcasting Corporation [BBC] 2009), with the hardest hit category being the SMEs. At the same time, globalisation is challenging economies worldwide with its demand for the redistribution of economic frontiers and the decentralisation of operations. The concept of
manufacturing from scratch to the finished product under ‘one roof’ has almost vanished. Now, organisations mostly rely on obtaining parts and gadgets for their product from other companies to assemble under ‘one roof’. The majority of these supplier companies are SMEs. For example, a car usually consists of approximately 30,000 parts and the big players of the automotive industry depend on SMEs for these parts. Toyota reported that, in Australia, around 1,795 suppliers were engaged in the year 2010–2011 and approximately 70 per cent of the components were purchased from local suppliers (Toyota 2012). This results in an ever-increasing reliance on SMEs for the running of the main operations (Wattanapruttipaisan 2002). Globalisation also presents the SMEs with the additional challenge of competing internationally.

Keeping in mind the importance of SMEs and the challenges of globalisation, it is necessary to examine the existing philosophies, methodologies and frameworks for running efficient operations by SMEs so that new ways can be developed to address the aforementioned challenges. Nowadays, quality management has become an important operational concept. Quality management enhances the capabilities of organisations to remain effective and become competitive (Pulakanam & Voges 2010), and to embrace the globalised business environment successfully.

Quality management issues are critical and important for all businesses (Kureshi, Qureshi & Sajid 2010). Organisations have used a number of quality management philosophies and methodologies in recent times (Gadenne & Sharma 2009;
Hansson 2003). Some of the well-known quality management philosophies and methodologies are quality control (QC), quality assurance (QA), total quality control, quality circles, Kaizen, total quality management (TQM) and ISO 9000 standards. The SMEs’ operating business environment demands quality at each operational step. Hence, quality management has emerged as an effective competitive tool amongst Australian SMEs (Gadenne & Sharma 2009). Quality management can provide a foundation for achieving competitive pricing and increasing profit margins. Therefore, it can be assumed that adoption of quality management by SMEs could become an important determinant of success and a way to survive in the global market.

It should also be acknowledged that large organisations extensively subcontract part of their operations to SMEs and thus depend on SMEs for required products and services (Antony, Kumar & Labib 2008; Antony, Kumar & Madu 2005; Wattanapruttipaisan 2002). Any compromise on quality by SMEs could jeopardise the whole supply chain, resulting in raising costs of the operations (Kumar 2007). Some of the quality issues related to the cost of poor quality are recalls, reworks, rejects and returns by customers. Therefore, quality management issues affect the competitiveness of organisations, such as occurred in the recent worldwide recall of Toyota cars, which cost the company about US$2 billion (BBC 2010a), and the extent of rework can be estimated by the number of recalled cars to be around 1.8 million across Europe alone (BBC 2010b). The costs associated with such issues are significant and may result in the closure of businesses. At the same time, poor quality practices in large organisations have a
negative effect on their business, putting their suppliers—the SMEs—at risk (Wattanapruttipaisan 2002).

Addressing quality management issues would help SMEs to deal with the changing environment in the era of globalisation. Among different quality management methodologies, Six Sigma is one of the most focused and aggressive (Kumar et al. 2008). Six Sigma is an advancement in quality management to make organisations more competitive (Zhang, Hill & Gilbreath 2009). Kumar et al. (2008) stress that Six Sigma is applicable to any type and any size of organisation. There is no doubt that Six Sigma has proved its potential in large organisations (Antony, Kumar & Madu 2005; Zhang, Hill & Gilbreath 2009), but its efficacy in SMEs is yet to be widely established (Antony 2008a; Antony, Kumar & Madu 2005; Deshmukh & Chavan 2012; Kumar 2007; Wessel & Burcher 2004). The literature suggests that SMEs show a lack of interest towards the Six Sigma methodology (Antony, Kumar & Madu 2005; Kumar & Antony 2009). Recent research confirms that the implementing of Six Sigma in UK SMEs is almost negligible (Antony 2008b; Antony, Kumar & Madu 2005; Kumar & Antony 2008). Wessel and Burcher (2004) also state that German SMEs show little interest in Six Sigma implementation. Even Australian SMEs show reluctance towards advanced quality management programs such as Six Sigma (Burcher, Lee & Waddell 2010). Therefore the objective of this thesis is to explore the various factors involved and to develop a framework for the implementation of Six Sigma in Australian manufacturing SMEs.
1.3 Reason for the Research

The purpose of this study was to develop a framework for the successful implementation of Six Sigma in SMEs. The study will identify various impeding factors for the implementation of Six Sigma in the manufacturing sector in Australia. It further explores the fundamentals necessary for the successful adoption and sustainable implementation of Six Sigma methodology in SMEs.

The majority of the literature highlights success stories and financial breakthroughs achieved with the help of quality management techniques such as Six Sigma in large organisations (Evans & Lindsay 2011; Klefsjö, Wiklund & Edgeman 2001; O’Donnell-Young & Pilotto 2006). However, its adoption by SMEs is still negligible (Kaushik et al. 2012). Studies in the UK and Germany show that manufacturing SMEs are reluctant to implement the Six Sigma methodology (Antony, Kumar & Madu 2005; Kumar & Antony 2008; Wessel & Burcher 2004). The proven benefits to large organisations seem to have failed to convince a vast majority of SMEs to implement Six Sigma. One reason for this could be that SMEs are unaware of the Six Sigma methodology (Antony, Kumar & Labib 2008; Antony, Kumar & Madu 2005). This study will explore the facts in Australian manufacturing SMEs and compare the results with the outcomes of the previous studies. This provides the main rationale for undertaking this study.

The need to identify the magnitude of top management commitment and the level of motivation required for the successful endeavour of Six Sigma adoption and
implementation will also be presented in this study; and is based upon the findings from one organisation that has been successfully practising the Six Sigma programme for the last six years. The findings will hence lay the foundation for developing a benchmark for other SMEs that follow this road.

1.4 Research Questions

The aim of the study is to develop a framework explaining the mechanism of the Six Sigma adoption and implementation process in SMEs. This aim will be addressed by answering the following research questions:

- Why is the rate of Six Sigma implementation negligible in manufacturing SMEs?
- What is the effect of adoption and implementation of Six Sigma on organisational performance?
- What are the barriers when implementing Six Sigma in SMEs? How can these be overcome?
- What are the significant critical success factors (CSFs) required for the implementation of Six Sigma in SMEs? How do they affect Six Sigma?
- What process is required to instigate the implementation of advanced quality management techniques such as Six Sigma in the manufacturing SMEs?

1.5 Statement of Significance

The findings of the study will contribute to the knowledge in the three areas:
• the adoption of Six Sigma
• the implementation of Six Sigma
• performance improvement.

First, the adoption of Six Sigma is rare in SMEs worldwide (Kaushik et al. 2012; Kumar & Antony 2008; Kumar et al. 2012). Although the literature lists a high number of large organisations practising Six Sigma (Evans & Lindsay 2011; O’Donnell-Young & Pilotto 2006), it is a negligible number in the case of SMEs (Kaushik et al. 2012; Khurshid, Kumar & Waddell 2012). Why are SMEs not adopting Six Sigma? Braunscheidel et al. (2011) used institutional theory to assess the motivation for the adoption of Six Sigma in a few organisations in the USA. However, the current study explores the reasons behind the very low rate of Six Sigma adoption in Australian manufacturing SMEs.

Second, the literature extensively discusses implementation of Six Sigma by various organisations around the globe (Braunscheidel et al. 2011; General Electric Company 2011; Godfrey 2002; Henderson & Evans 2000; Yang et al. 2007); however, implementation of Six Sigma in manufacturing SMEs presents a real dilemma. An in-depth case study is established to share the experience of an Australian manufacturing SME that has been successfully running the entire Six Sigma program for the last six years.

Third, the literature highlights the achievements from Six Sigma application in terms of performance improvements in large organisations (Evans & Lindsay 2011; O’Donnell-Young & Pilotto 2006). In general, a reduction in process
variations is termed as a way of expressing performance improvement. This study will explore the Six Sigma practices in Australian SMEs.

1.6 Proposed Research Framework

This study adopts the framework proposed by Braunscheidel et al. (2011), but with slight modifications. Braunscheidel et al. (2011) used institutional theory to assess the motivation for the adoption of Six Sigma. They analysed the influence of Six Sigma adoption and implementation on organisational performance in various types and sizes of organisations. To understand the change process, they used the mechanism of institutional isomorphic changes as described by DiMaggio and Powell (1983). The proposed framework is as follows:

![Figure 1.1: Conceptual Framework Derived from Braunscheidel et al. (2011)](image)

DiMaggio and Powell (1983) described three isomorphic processes: coercive, mimetic and normative. Coercive mechanisms may include the influence of social
partners, such as industrial associations, chambers of commerce, various sector-specific and general legislations, and the government. Mimetic mechanisms are mainly the result of uncertainties present in the sector. These uncertainties push organisations to imitate the strategies and practices of other successful organisations in the sector. In contrast, normative mechanisms are mainly the result of professionalism and the knowledge base of the employees of that organisation.

1.7 Scope of the Study

The study is constrained by a number of boundaries. First, the study focuses on the adoption and implementation of the Six Sigma methodology without considering other advanced quality management methodologies. Secondly, the study focuses on SMEs belonging to the manufacturing sector and does not discuss the service sector.

There are three reasons behind the selection of the manufacturing sector over the service sector. First, manufacturing SMEs are under extreme pressure all over the world due to intense competition from China and other rapidly growing economies. Second, operations in the manufacturing set-up are more tangible and similar to each other compared to that of services, which allows for generalisations to be made. Third, the magnitude of the study would expand if the services sector were included to a point beyond the resource constraints (temporal and financial) of a master thesis.
1.8 Organisation of Thesis

The sequence of chapters is summarised in Figure 1.2.

Figure 1.2: Research Procedure

To begin this thesis, Chapter 1 establishes an outline of the intended study and provides the reader with an introduction to the topic, based on the significance of SMEs to the economy and the importance of quality management, with particular reference to Six Sigma application in SMEs. The rationale behind the current study is discussed. The inclusion of problem statements and research questions helps to identify the aims and objectives related to the study. The study points towards three mechanisms for the successful endeavour of Six Sigma: the mechanisms behind the adoption, implementation and performance enhancement based on institutional theory.

Chapter 2 discusses some basic concepts of quality management. The Six Sigma methodology, which is a type of quality management, is introduced in detail with the help of the existing literature. The literature highlights that the implementation of Six Sigma is quite rare in manufacturing SMEs. Further, it is noted that the concept of Six Sigma is still in its conceptual transition stage and there is a need
to establish a theoretical framework for the adoption of the Six Sigma methodology at the SME level.

Chapter 3 presents in detail the complete research process. A discussion of various research philosophies helps to understand the concept of research paradigms. This leads to the description of different research approaches, which is followed by an elaboration of the research strategies and the research method undertaken to collect data for this study.

Chapter 4 discusses the findings of the questionnaire survey conducted to obtain an overview of the status of quality management initiatives adopted by the manufacturing SMEs in Australia.

Chapter 5 explains the analysis of the case study. The findings from the case study help to understand the experience of an Australian manufacturing SME that implemented Six Sigma six years ago. This chapter provides an in-depth investigation to comprehend the motivation behind Six Sigma adoption. Moreover, various salient features pertaining to Six Sigma implementation are explored. Evidence of the benefits achieved as a result of successful Six Sigma implementation provides a platform for comparison with other SMEs.

Chapter 6 discusses compares and analyses the findings from the literature with the results of the survey and the conclusions drawn from the case study. This chapter finalises the research framework. The potential significance of the current
study for Australian manufacturing SMEs is also highlighted in this chapter. The limitations of the study and recommendations for future studies are further features of this chapter.

1.9 Summary

This chapter discussed the background of the current study by highlighting the significance of SMEs to the economy and the importance of quality management, with particular reference to Six Sigma application in SMEs. The rationale behind the current study was discussed. The introduction of problem statements and research questions helped to identify the aims and objectives related to the current study. The focus of the present study points towards three mechanisms for the successful endeavour of Six Sigma: the mechanisms behind the adoption, implementation and performance enhancement. These mechanisms led to the formulation of the conceptual research framework based on the institutional theory. This study only focused on Australian manufacturing SMEs.
Chapter 2: Literature Review

2.1 Introduction

As mentioned in the previous chapter, the aim of this study is to develop a framework to explain the mechanism of the Six Sigma adoption and implementation process in SMEs. To explore this aim, it is essential to understand the actual positioning of Six Sigma in the literature, especially in the context of its relationship with quality management. Accordingly, this chapter follows a sequence that starts from understanding quality management, and leads to an in-depth discussion on Six Sigma, various adoption models, implementation strategies and the importance of SMEs. It further explores the need to implement Six Sigma in manufacturing SMEs. Various salient features of SMEs are discussed along with their importance to the economy and the challenges facing them.

2.2 Quality Management

Quality management is a set of ‘coordinated activities that direct and control an organisation with regard to quality’ (International Organization for Standardization 2000a, p. 8). Quality management is a generic term used collectively to describe different philosophies, phenomena and methodologies, such as quality planning, quality improvement (QI) and quality control (QC). The scope of quality management extends from simple techniques such as inspection, a suggestion system, quality circles and Kaizen, to advanced concepts such as
Lean, Six Sigma, TQM and the Balance Scorecard. Hence, managing quality is significant for the success of businesses (Dale 1999).

Quality management received immense attention in the post-war reconstruction of Japan (Fisher & Nair 2009). Fisher and Nair (2009) state that quality management turned out to be the most significant economic contribution for Japan. Experts such as Dr Shewhart and Dr Deming introduced the concepts of quality and statistics (Petersen 1999; Wilcox 2004), which later proved to be the backbone of Japan’s surprisingly improved and developed economy (Glassop 1995). Extensive focus on quality assisted Japan not only to recover from the devastating effects of the war, but it also facilitated the country’s emergence as a leading world economy. This also resulted in turning the focus of the entire world to quality and quality management (Dahlgaard & Dahlgaard-Park 2006).

Quality is a relative term and no one definition exists (Dale 1994, 1999; Van der Wiele, Dale & Williams 1997). Garvin (1984) presented eight product quality dimensions: performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality. Further, it is important to note that any product can be checked for quality against these dimensions singly or collectively. As for the conceptual development of quality, Dale (1999) and van der Wiele, Dale and Williams (1997) present a transitional model.

According to Dale (1999) and van der Wiele, Dale and Williams (1997), the evolutionary steps of the quality concept show a complete conceptual transition,
moving from inspection to QC to QA, and then to TQM. However, as shown in Figure 2.1, quality evolution can also be described as starting from inspection and moving to QC, then to QA, and then perhaps to quality management Phase I (QM Phase I), quality management Phase II (QM Phase II) and possibly quality management Phase III (QM Phase III), thus highlighting how all these stages are closely interrelated (Khurshid, Waddell & Glassop 2010). In other words, the journey to measure and improve quality begins with product inspection and leads to process control, system management, incorporating cultural change and, finally, performance management or, perhaps, sustainable organisation, (see Figure 2.1).

![Figure 2.1: Evolution of Quality as Collated by Author from Dale (1994, 1999); van der Wiele, Dale and Williams (1997); and Khurshid, Waddell and Glassop (2010)](image)

In examining the sequence, one can perceive that, to achieve performance enhancement effectively, it is essential to follow the sequence. This is because all
the transitional stages are interlinked and omission of any stage could result in the development of an ineffective quality management system. For example, at the stage of process control, QC cannot be carried out without product inspection; similarly, QA activity includes QC and so on.

Most of the time, the industry adopts the latest version of quality management without proper execution of the prior stages, which is why the majority of implementations turn out to be sour experiences and the methodology is usually termed as a fad (Ponzi & Koenig 2002; Ramberg 2000; Zhivago 2007). This seems to be true in the case of SMEs in which quality management adoption is largely the result of push by their customers and not by choice of the SMEs themselves (Brown, van der Wiele & Loughton 1998). Further, the absence of theoretical foundations for the implementation of quality management in SMEs is another gap to be considered. Although Anderson, Rungtusanatham and Schroeder (1994) tried to establish the theoretical basis for quality management, overall the literature is silent. As a result, most often, SMEs show an absence of proper conceptual understanding of quality management; thus, an ineffective quality management system, without any proper strategy to improve the performance, is established and implemented. Critical analysis suggests that, for the most part, in SMEs, there is nothing wrong with any of the quality management techniques and much is dependent on the intention behind its adoption along with the commitment of the top management.
As discussed earlier, the term quality management is quite broad and it includes a variety of methodologies and philosophies. Among various quality management programs, ISO 9000, TQM and Six Sigma are frequently discussed in the literature and are overviewed in the following sections.

2.2.1 ISO 9000 Standard

The ISO 9000 standard series is the most implemented quality management standard in the world (British Standards Institution [BSI] 2011), across all types of organisations, large as well as SMEs. BSI (2011) reports that over one million organisations in 178 countries are using the ISO 9000 standard to address their quality management needs. The implementation of ISO 9000 standard is more as compared to other quality management programs in organisations belonging to Organisation for Economic Co-Operation and Development (OECD) countries, as identified by Mellor and Hyland (2005). The ISO 9000 standard series has also received recognition in the literature (Antony, Kumar & Madu 2005; Wessel & Burcher 2004).

ISO 9000 is helpful and essential for understanding the basic philosophy of quality management. ISO 9000 is based on a process approach model with the intention of implementing it with the help of the Deming Cycle that is, Plan (P), Do (D), Check (C) and Act (A) (ISO 2008; Moosa & Sajid 2010). The International Organization for Standardization (ISO) describes eight quality management principles that provide a basis for establishing and implementing quality management in any organisation, regardless of type, size and product they
produce (ISO 2008; Pfeifer, Reissiger & Canales 2004). Table 2.1 presents the eight quality management principles mentioned in the ISO 9000 standard (ISO 2000a, pp. v–vi).

Table 2.1: Quality Management Principles

<table>
<thead>
<tr>
<th>EIGHT QUALITY MANAGEMENT PRINCIPLES</th>
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<tbody>
<tr>
<td>1) Customer focus</td>
<td>Organizations depend on their customers and therefore should understand current and future customer needs, should meet customer requirements and strive to exceed customer expectations.</td>
</tr>
<tr>
<td>2) Leadership</td>
<td>Leaders establish unity of purpose and direction of the organization. They should create and maintain the internal environment in which people can become fully involved in achieving the organization's objectives.</td>
</tr>
<tr>
<td>3) Involvement of people</td>
<td>People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit.</td>
</tr>
<tr>
<td>4) Process approach</td>
<td>A desired result is achieved more efficiently when activities and related resources are managed as a process.</td>
</tr>
<tr>
<td>5) System approach to management</td>
<td>Identifying, understanding and managing interrelated processes as a system contributes to the organization's effectiveness and efficiency in achieving its objectives.</td>
</tr>
<tr>
<td>6) Continual improvement</td>
<td>Continual improvement of the organization's overall performance should be a permanent objective of the organization.</td>
</tr>
<tr>
<td>7) Factual approach to decision making</td>
<td>Effective decisions are based on the analysis of data and information.</td>
</tr>
<tr>
<td>8) Mutually beneficial supplier relationships</td>
<td>An organization and its suppliers are interdependent and a mutually beneficial relationship enhances the ability of both to create value.</td>
</tr>
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</table>


Nevertheless, the process of implementing ISO 9000 by organisations raises many questions. Thomas and Webb (2003) argue that SMEs lack the intellectual capacity and financial resources to implement the ISO 9000 standard in its true spirit. Further, Jansen (2008) highlights some common reasons for the poor quality of implementing ISO 9000, especially in SMEs, such as a lack of proper
understanding of the standard, absence of top management commitment, resource limitations, poor employee commitment and extensive documentation controls.

In spite of these constraints, ISO 9000 is the most implemented quality management standard in the world (Al-Rawahi & Bashir 2011; BSI 2011; ISO 2010; Pfeifer, Reissiger & Canales 2004). The gradual progression of ISO standards over the years has resulted in the establishment of basic requirements for a quality management system (Robitaille 2007). This started with various QA models in 1987 and carried on to the formation in 1994 of a QA model with the perspective of becoming proactive through preventing defects in the operational processes. It then further progressed, in 2000, to establishing the requirements for a quality management system. The latest version is entitled ‘Quality Management System—Requirements’, usually written as ISO 9001:2008.

The ISO 9000 series is an internationally recognised basic quality management standard (BSI 2011) and ISO certified organisations can adopt advanced quality management methodologies quite easily (Pfeifer, Reissiger & Canales 2004). Van der Wiele, Dale and Williams (1997) and Douglas, Coleman and Oddy (2003) explain that there is a high level of possibility of transforming ISO 9000 certified organisations to TQM excellence. Indeed, they encourage SMEs to broaden their vision to strive for TQM implementation. Pfeifer, Reissiger and Canales (2004) consider ISO 9000 implementation as the first step towards Six Sigma implementation. However, the reality is that, in the case of SMEs, the adoption of advanced quality management methodologies is still in its infancy.
As described earlier, the ISO 9000 standard is the world’s most adopted quality management standard (BSI 2011; Robitaille 2007). The literature highlights that there are many factors involved in the wide adoption of the ISO 9000 standard (Douglas, Coleman & Oddy 2003). Factors such as pressure from customers, pressure from the parent organisation, promotional benefits, competitors’ registration, internal efficiency improvement, market share maintenance/improvement and customer service improvement are some of the reported motivations behind ISO 9001 adoption (Johannsen 1996; Kaziliunas 2010; Magd & Curry 2003; Martínez-Costa & Martínez-Lorente 2003).

Gradually, it has become the norm for a business to obtain ISO certification (British Assessment Bureau 2012; Juran & De Feo 2010). Mostly, demand from the customer was the catalyst that pushed more organisations to become certified (Barrier & Zuckerman 1994; Martínez-Costa & Martínez-Lorente 2003). Nonetheless, in that push, organisations often drifted from the actual aim of improving the overall structure of quality management to focusing on achieving the certification for the business. Such certified organisations merely complied with the minimum requirements of the standard, with superficial systems that resulted in either harvesting incomplete advantages from implementing the ISO 9000 standard or achieving one-time benefits without the element of sustainability.
2.2.2 Total Quality Management

The TQM concept tries to establish a complete picture of quality in all the processes of an organisation (Dahlgaaard & Dahlgaard-Park 2006). Long-term strategy and the involvement of employees at all levels is the core of this philosophy. It is an evolutionary type of methodology that believes in steady and incremental developments at all levels, both horizontal and vertical, within an organisation. The main objective of TQM is to satisfy the customer and increase profit margins through lowering internal wastages, with the involvement of the employees at each step (Andersson, Eriksson & Torstensson 2006).

Many countries have developed TQM business excellence models. Examples of quality excellence awards include the Malcolm Baldrige National Quality Award (MBNQA) administered by the National Institute of Science and Technology (NIST) in the USA, the European Quality Award of the European Foundation for Quality Management (EFQM), the Deming Prize of Japan, the Australian Quality Award (AQA), the Canadian Quality Award and the National Quality Award of Brazil. These awards were developed to motivate and to recognise the organisations in the field of quality management. If we go through the criteria of these different awards, we can detect a close resemblance to the eight quality management principles along with its thoroughness in evaluating the organisation’s performance (see Figure 2.2).
Figure 2.2: Different TQM Assessment Models as Collated by Author through Various Online Sources
Organisations began to adopt TQM because it was recognised as the ultimate award in the field of quality. Especially after the Second World War, the emergence of Japan as an economic power highlighted the importance of fundamentals of quality and TQM philosophy. Further, almost all the recognised economies have established various administrative or regulatory bodies to deal with conceptual affairs related to designing, developing and assessing TQM philosophy. Therefore, almost every organisation has dreamt of obtaining the excellence award in the field of TQM (Harry 2012). Hence, the popularity and interest in TQM can be observed through the existence of the academic and professional literature in the field (Rahman 2001).

However, in the past few years, the literature has extensively discussed TQMs’ failure stories and vague outcomes. Harry (2012) described the story of the downfall of TQM as:

Some companies that won the National Baldrige Award were not perceived by the public to make ‘quality’ products or to be business exemplars. Furthermore, when the financial performance of Baldrige winners became the subject of scrutiny, the conclusion was that they did not necessarily perform better than non-award-winning companies. (Harry 2012)

Kober, Subraamanniam and Watson (2012), while studying Australian SMEs, failed to identify any link between TQM implementation and the improved financial performance of the company. However, Prajogo and Brown (2006) concluded that Australian SMEs showed better quality performance on the way to adopting TQM compared to when they were limited to ISO 9001 implementation.
Yusof and Aspinwall (2000) highlighted various TQM implementation frameworks along with any possibility of implementing them in UK SMEs. They concluded that to implement TQM at the SME level is a complex and difficult process compared to its implementation in large organisations. In contrast, Parkin and Parkin (1996) reported that UK SMEs have implemented TQM successfully, with the exception of a very important parameter—customer satisfaction. As customer focus is the most important principle of quality management (ISO 2000a, pp. v—vi), the omission of a customer focus parameter by UK SMEs raises many questions on the quality of TQM implementation in UK SMEs, as described by Parkin and Parkin (1996).

It is important to note that TQM is considered a fad (Andersson, Eriksson & Torstensson 2006; Miller & Hartwick 2002; Van der Wiele, Williams & Dale 2000) due to the absence of tangible outcomes, resource intensiveness and wide scope of implementation (Andersson, Eriksson & Torstensson 2006). Therefore, one can conjecture that, due to the limited scope of operation in SMEs, TQM it would be a difficult choice for SMEs to adopt TQM, especially when assessed against the stringent requirements of TQM assessment models.

2.3 Six Sigma

Six Sigma is an advancement in quality management to make organisations more competitive (Zhang, Hill & Gilbreath 2009), with the goal of achieving business excellence (Huq 2006). Since the inception of Six Sigma, enhancing
organisational competitiveness seems to be very common in the business sectors (Aboelmaged 2011). Six Sigma became a progressive methodology for reducing process variation by focusing on continuous and breakthrough improvements (Andersson, Eriksson & Torstensson 2006). However, Huq (2006) explains that a change in mindset, as well as the development of skills to use all the tools of Six Sigma effectively, is required to reach the lofty goal of 3.4 defects per million opportunities (DPMO).

Six Sigma programs are strongly based on the viability of process/project selection with respect to its criticality and expected financial gains. Kumar et al. (2008) defend the Six Sigma methodology by claiming it as a potent management initiative to achieve and sustain excellence in operations and services. Further, O’Donnell-Young and Pilotto (2006) describe three themes of Six Sigma: customer focus, data focus and process focus. These themes are again explained in eight quality management principles (see Table 2.1). To make SMEs more competitive, the significance of these themes are quite valid. Kumar et al. (2008) differentiate Six Sigma from other quality management techniques based on three points: it is result oriented, it has a systematic methodology and it provides a very strong training platform. In addition, Schroeder et al. (2008) describe four points that differentiate Six Sigma from TQM: it is focused on financial and business results, it has a structured methodology with a high level of training, it uses specific metrics and it has full-time improvement experts. Hence, it contributes to the overall performance improvement of the organisation (Zu, Fredendall & Douglas 2008).
The discovery of Six Sigma opens a new chapter of debate in quality management circles. Academic literature, business magazines and media are full of discussions on Six Sigma (Brue 2006; Brue & Howes 2005; Folaron 2003; Godfrey 2002; Harry 2012; Khurshid, Waddell & Glassop 2010; Kumar et al. 2008; Senapati 2004; Soti, Shankar & Kaushal 2012; Weeks 2011). Different viewpoints on Six Sigma are discussed in the following subsections.

2.3.1 Origin

Six Sigma was invented by Motorola in 1987 as a method for achieving business excellence (Narasimhan 2009). However, Folaron (2003) explored the historical background of Six Sigma further, and linked its roots to the year 1798, while Harry and Schroeder (2000) related it to the efforts of many mathematicians, statisticians and quality specialists of the 1920s. Subsequently, Dr Mikel Harry and Bill Smith combined the analysis methods, defined and refined, with the analysis tools of statistical process control (Pyzdek 2001).

Pyzdek (2001) explains that Motorola created the method as a means of survival. Motorola had significant issues with high costs and poor product quality. When the Japanese bought one of Motorola’s television manufacturing plants in the 1970s, they implemented drastic changes to its operations to make it more efficient and made it more profitable with the same resources and equipment. Motorola’s chairman, Bob Galvin, decided it was time to act (Raisinghani et al. 2005). Bill Smith, a reliability engineer at Motorola, set an objective for product failure at the rate of two parts per billion, rather than to continue with the current
industry standard of Three Sigma (99.973 per cent), and he made this the new standard (Pyzdek 2001). Motorola named and registered this concept as ‘Six Sigma’ (Raisinghani et al. 2005). Table 2.2 provides some examples of error rates at three and six sigma levels.

<table>
<thead>
<tr>
<th>Three Sigma (99.973 per cent)</th>
<th>Six Sigma (99.9999998 per cent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20,000 lost articles of mail per hour</td>
<td>7 lost articles per hour</td>
</tr>
<tr>
<td>15 minutes of unsafe drinking water each day</td>
<td>1 unsafe minute of drinking water per 7 months</td>
</tr>
<tr>
<td>5,000 incorrect surgical operations per week</td>
<td>1.7 incorrect operations procedures/week</td>
</tr>
<tr>
<td>2 short or long landings at most major airports each day</td>
<td>1 short or long landing every 5 years at each airport</td>
</tr>
<tr>
<td>200,000 wrong drug prescriptions each year</td>
<td>68 wrong drug prescriptions each year</td>
</tr>
</tbody>
</table>

Source: Adapted from Goh, TN (2011) & Gygi et al. (2005)

As Table 2.2 highlights, the volume of errors at Six Sigma are significantly lower than the errors produced under a Three Sigma target. Thus, Six Sigma is analogous with being error free.

After embracing Six Sigma, Motorola was able to attract the attention of other business organisations in the USA. It showed remarkable improvement in all processes by registering a fivefold sales growth with profits rising nearly 20 per cent per year (Klefsjö, Wiklund & Edgeman 2001). O’Donnell-Young and Pilotto (2006) state that Motorola documented more than US$16 billion as savings. It became the first company to win the American national quality award known as MBNQA in the field of quality management (Harry 2012; Pyzdek 2001). These
achievements of Motorola led to an increased interest in Six Sigma among other organisations (Pyzdek 2001), including Allied Signals and General Electric (GE).

Larry Bossidy, the chief executive officer (CEO) of Allied Signal in 1994, brought in Six Sigma as a business initiative to ‘produce high-level results, improve work processes, expand all employees’ skills and change the culture’ (Godfrey 2002, p. 14). Then, in 1995, GE started its quest for Six Sigma (Schroeder et al. 2008). Jack Welch (CEO of GE) showed his full commitment to the program, to the extent that GE applied it to every area of business (O’Donnell-Young & Pilotto 2006). O’Donnell-Young and Pilotto (2006) reported that Six Sigma saved GE about US$6.6 billion in annual savings. These savings reported by the pioneering organisations played a major role in creating acceptance for Six Sigma among other entrepreneurs. Hence, Nonthaleerak and Hendry (2008) still consider Six Sigma as a recent QI initiative that has gained popularity and acceptance in many industries across the globe.

If Six Sigma is analogous to error-free processes (Garber 2005), then why is the rate of Six Sigma negligible in manufacturing SMEs throughout the world? Many efforts have been made to answer this question (Antony, Kumar & Madu 2005; Kaushik et al. 2012; Kumar 2007; Kumar & Antony 2008; Kumar, Antony & Douglas 2009; Kumar et al. 2008; Pfeifer, Reissiger & Canales 2004), but no conclusive answer has been identified. Moreover, it seems that SMEs remain lethargic about adopting Six Sigma.
Since its inception, the literature highlights three generations of Six Sigma methodology, showing the transformation in its focus. According to Harry and Crawford (2004) and Antony (2007), the first generation (1988–1994) focused on defect reduction, the second generation (1994–2000) emphasised cost reduction and the third generation (2000 to date) stresses the creation of value for the customer and the enterprise by fusing Six Sigma with Lean—another quality management methodology. These three generations represent the conceptual evolution of Six Sigma. Nevertheless, very little has been documented in the context of SMEs (Gnanaraj, Devadasan & Shalij 2010). Whether this is a matter of defect reduction or cost reduction or, perhaps, value creation, Six Sigma can present a number of advantages to SMEs, such as a reduction of scrap rate, cycle time, delivery time and production cost, and an increase in sales and product reliability (Kumar 2007).

The literature has repeatedly mentioned the conceptual confusions surrounding the basic definition of Six Sigma (Aboelmaged 2010). This is reviewed in the next subsection, along with the various different concepts of Six Sigma.

2.3.2 Definition

The literature shows a variation in perception of the concept of Six Sigma among practitioners, scholars and academics (Antony 2004; Klefšjö, Wiklund & Edgeman 2001; Schroeder et al. 2008). Kumar and Antony (2009) consider it one of the most effective process improvement methodologies, but Andersson, Eriksson and Torstensson (2006) and Chakravorty (2009) label it a program that
only enhances customer satisfaction and obtains financial gains. In contrast, Kwak and Anbari (2006) and Thomas, Barton and Chuke-Okafor (2009) claim it is a business strategy, whereas Antony (2008a) views it as an approach to reduce process variations. Hence, much confusion exists around the concept of Six Sigma (Aboelmaged 2010) and an agreed conceptual definition is still waiting to be developed (Schroeder et al. 2008).

Six Sigma is defined by most practitioners as a statistics, a program, a philosophy and a methodology (Andersson, Eriksson & Torstensson 2006; Antony 2002; General Electric Company 2011; Henderson & Evans 2000; Klefsjö, Wiklund & Edgeman 2001; Kwak & Anbari 2006). Brue and Howes (2005, p. 6) provide three meanings of Six Sigma depending on the context. According to them, ‘it is a level of quality’ that works as a statistical basis of measurement, ‘a problem solving methodology’ for reducing process variation and ‘a management philosophy’ to address the issues of all stakeholders. Henderson and Evans (2000), Antony (2002), Andersson, Eriksson and Torstensson (2006) and Chakrabarty and Tan (2007, p. 195) present the definition of Six Sigma, on the basis of statistics, as ‘a QI program with a goal of reducing the number of defects to as low as 3.4 parts per million opportunities or 0.0003 per cent’ (see Figure 2.3). Antony and Coronado (2001, p. 119) present Six Sigma as ‘a business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer needs and expectations’.

With respect to organisations such as GE, Six Sigma is claimed as a part of their culture and described as ‘a highly disciplined process that helps [them to] focus
on developing and delivering near-perfect products and services’ (General Electric Company 2011).

In addition, Six Sigma is claimed to be a set of different statistical and management tools (Klefsjö, Wiklund & Edgeman 2001) used in a systematic manner (Andersson, Eriksson & Torstensson 2006; Klefsjö, Wiklund & Edgeman 2001; Kumar et al. 2008) for some specific process/project, resulting in achieving better financial results by decreasing the defects/process variations and increasing the overall efficiency level of the organisation (Antony 2008a; Thomas, Barton & Chuke-Okafor 2009).

Magnusson, Kroslid and Bergman described Six Sigma as a:

business process which creates significant financial results through defining, measuring, analysing, improving and controlling the vital business processes such that it reduces the wastages and enhances customer satisfaction by the efficient utilization of resources. (cited in Andersson, Eriksson & Torstensson 2006, p. 283)
However, for the current study, the definition of Six Sigma is the one presented by Antony and Coronado (2001). They define Six Sigma as ‘a business strategy used to improve business profitability, to improve the effectiveness and efficiency of all operations to meet or exceed customer needs and expectations’ (Antony & Coronado 2001, p. 119). Analysis of the above definitions suggests that, although Six Sigma articulates a well-structured implementation strategy, all core concepts are based on the principles of TQM (Dahlgaard & Dahlgaard-Park 2006). This leads to the debate about the positioning of Six Sigma as well as its relationship with other quality management philosophies such as TQM. The following section summarises the relationship between Six Sigma and TQM.

2.3.3 Relationship with Total Quality Management

Pfeifer, Reissiger and Canales (2004, p. 241) state the views of successful users of Six Sigma as a ‘modern form of quality management’ due its resemblance with pre-existing quality management techniques such as TQM. Klefsjö, Wiklund and Edgeman (2001). Moosa and Sajid (2010) also claim Six Sigma as a methodology for TQM, and O’Rourke (2005) suggests that the principles of TQM were amalgamated with the tools of statistical process control and then organised using a structured problem-solving method. Similarly, Dahlgaard and Dahlgaard-Park (2006) advocate the supremacy of TQM and consider that Six Sigma follows the same philosophy as TQM. However, the literature describes four points in which Six Sigma differs from TQM: it is focused on financial and business results, it has a structured methodology with a high level of training, it uses specific metrics and it has full-time improvement experts (Schroeder et al. 2008).
Nevertheless, for SMEs, it seems that it is not an issue whether Six Sigma is different or part of TQM or vice versa. This is because the adoption of any advanced quality management system usually leads to enhanced performance, reduced process variation and reduced waste, and as a result could lead to more profits through satisfied customers (Dale 1999; Evans & Lindsay 2011).

As is the case with TQM, the adoption rate of Six Sigma by SMEs is very low compared to that of large organisations (Antony, Kumar & Madu 2005; Burcher, Lee & Waddell 2010; Husband & Mandal 1999; Kumar & Antony 2008; Kumar, Antony & Douglas 2009; Wessel & Burcher 2004). Kumar and Antony (2008) and Antony (2008a) stress that the attractive tangible outcomes and better financial results provide compelling reasons for SMEs to implement Six Sigma. However, Antony, Kumar and Madu (2005), Kumar and Antony (2008) and Kumar, Antony and Douglas (2009) identify various impeding factors, such as top management support, resource scarcity and internal culture. Six Sigma adoption by SMEs is still a valid area to explore.

Six Sigma comprises some unique ingredients that segregate it from the rest of all quality management techniques (Andersson, Eriksson & Torstensson 2006; Kumar et al. 2008). These important constituents are: the implementation team, the implementation strategy and tools. These will be discussed in the subsequent sections. The next section discusses some basics of Six Sigma in order to understand its compatibility issues, especially in the context of SMEs.
2.3.4 Theoretical Perspective of Six Sigma

The literature is full of information related to Six Sigma application, but the theoretical perspective is still missing (Aboelmaged 2010; Antony 2008b; Linderman et al. 2003). However, Mcadam and Hazlett (2010) point out that there are signs of an upcoming Six Sigma theoretical foundation based on a wide range of pre-existing organisational theories, but the developmental pace is too slow compared to that of its practical applications. Braunscheidel et al. (2011) measured the motivation behind Six Sigma adoption using institutional theory, and Schroeder et al. (2008) proposed a Six Sigma initial definition and theory using a grounded theory approach. However, Zu, Fredendall and Douglas (2008) have discovered that, overall, very limited research has been carried out on Six Sigma and its effect on quality management theory and application. Therefore, one of the goals of the current study is to determine a theoretical perspective for the adoption of Six Sigma at the SME level.

2.4 Six Sigma Adoption

As the literature suggests, the adoption of Six Sigma is uncommon in SMEs (Deshmukh & Chavan 2012; Pulakanam & Voges 2010). Braunscheidel et al. (2011) used institutional theory to assess the motivation for the adoption of Six Sigma. They analysed the effect of Six Sigma adoption and implementation on organisational performance in various types and size of organisations. Therefore, one of the objectives of this study was to explore the facts related to Six Sigma adoption and its overall effect on performance in Australian manufacturing SMEs.
through understanding the mechanism of institutional isomorphic change, as described by DiMaggio and Powell (1983).

DiMaggio and Powell (1983) described three isomorphic processes: coercive, mimetic and normative. To assess the Six Sigma adoption process in SMEs (see Figure 2.4), an analysis of the above-mentioned isomorphic processes will help to understand the actual mechanism and the possible motivational factors involved in making the decision to adopt Six Sigma.

![Figure 2.4: Conceptual Framework Derived from Braunscheidel et al. (2011)](image)

To administer change in the organisation, these three mechanisms can influence an organisation either independently or in concert with each other. Coercive mechanisms may include the influence of social partners, such as industrial associations, chambers of commerce, various sector-specific and general legislations, and the government. Mimetic mechanisms are mainly the result of uncertainties present in the sector. These uncertainties push organisations to imitate the strategies and practices of other successful organisations in the sector. In such situations, the organisations are more susceptible to triggering changes in
the organisation. In contrast, normative mechanisms are mainly the result of professionalism and the knowledge base of the employees of that organisation. This knowledge base could be the result of formal education from academic institutions or through professional firms offering various short or diploma courses and professional training to the employees of the organisation. These fundamentals of isomorphic processes contributed significantly to the design of the basic conceptual framework for the current study.

2.5 Six Sigma Implementation

After making the decision to practice Six Sigma in the organisation, the next step is the ‘how’ part, that is, how can Six Sigma be implemented effectively? Schroeder et al. (2008) and Zu, Fredendall and Douglas (2008) explain that there are three distinctive practices that are critical for implementing Six Sigma concepts and methods. These practices are Six Sigma role structure, Six Sigma structured improvement procedure and Six Sigma focus on metrics.

2.5.1 Six Sigma Role Structure

Many scholars view the Six Sigma concept differently. For example, Schroeder et al. (2008, p. 540) called the Six Sigma methodology a ‘parallel-meso structure’ due to its unique implementation team hierarchy. However, when Motorola created Six Sigma, it did not have any formal nomenclature as it has today (Mader 2008). Kumar et al. (2008) declared that, nowadays, the implementation team required for Six Sigma has its own uniqueness. This classification, along with the
type of focused training required to equip the team for the specific tasks, also maintains its distinction from other quality management methodologies. The current concept of Six Sigma is almost incomplete without studying the structure and nomenclature of its implementation team.

The Six Sigma implementation team hierarchy comprises the Champion, the Master Black Belt, Black Belts, Green Belts, and White or Yellow Belts (Andersson, Eriksson & Torstensson 2006; Kumar et al. 2008; Pfeifer, Reissiger & Canales 2004). The respective titles are given by various training and consultancy firms, mainly based on total training hours spent and number of Six Sigma projects completed or handed over, either in teams or as an individual. A brief description of the implementation hierarchy (Andersson, Eriksson & Torstensson 2006; Evans & Lindsay 2011; Henderson & Evans 2000; Kwak & Anbari 2006; Pfeifer, Reissiger & Canales 2004; Schroeder et al. 2008) is as follows:

- The Champion is the highest ranked individual who understands Six Sigma and is dedicated to its success. He or she is the main sponsor of the task.

- Master Black Belt provides technical and organisational training and leadership to junior members on the Six Sigma program.

- Black Belts basically lead the teams and measure, analyse, improve and control the crucial factors that contribute to customer satisfaction. Usually
they hold full-time positions to enhance the productivity and growths of organisations.

- Green Belts are responsible for identifying the areas of improvement and training the project team members to gather data. Pfeifer, Reissiger and Canales (2004) described Green Belts as process owners and Black Belts as project officers.

- White or Yellow Belts are the front row executers of activities.

As is clear from the above explanation, the titles of the implementation hierarchy represent some unique skills and experience; therefore, a strong infrastructure of training is required. Such training is usually conducted in-house; however, third-party consultants may also train employees on their premises.

Training is a very significant component of the Six Sigma methodology (Antony 2008b; Kumar et al. 2008). Antony (2007); and Kumar et al. (2008) state that Six Sigma creates a powerful infrastructure for training, and this is because Six Sigma requires a much-focused human resource approach to achieving the desired objectives. Therefore, training is necessary for all employees of the organisations, regardless of their position. Organisations usually train both the horizontal and the vertical hierarchy. Quality managers also most of the time require updating of their skills and the latter is effectively highlighted for the Australian quality managers (Stewart & Waddell 2003).
Large organisations have huge resources allocated for training purposes and, therefore, training their employees for Six Sigma is not a problem. However, for SMEs, resources are crucial. Therefore, Kumar et al. (2008) propose the need to adopt a much simpler single hierarchy comprising a white belt system only to address the basic training needs of statistical and management tools. This would ensure the minimising of training costs as well as resource deficiencies. The kind of team required in SMEs and how the mechanism works will also be explored in this study. Whether it is ‘parallel-meso structure’ or the development of a multi-skilled, multi-tasking workforce, the aim is to identify the actual mechanism that exists in Six Sigma practising SMEs.

2.5.2 Six Sigma Structured Improvement Procedure

The success of any technique is highly dependent on its implementation strategy. The literature discusses two basic Six Sigma strategies (Andersson, Eriksson & Torstensson 2006; Evans & Lindsay 2011; Kumar et al. 2008; Linderman et al. 2003; Moosa & Sajid 2010; Thomas, A & Barton 2006):

I. DMAIC:

1. (D) Define  Who are the customers and what are their priorities?
2. (M) Measure  How is the process measured and how is it performing?
3. (A) Analyse  What are the most important causes of defects?
4. (I) Improve  How do we remove the causes of the defects?
5. (C) Control  How can we maintain the improvement?
II. DMADV:

1. (D) Define  Who are the customers and what are their priorities?

2. (M) Measure How is the process measured and how is it performing?

3. (A) Analyse What are the most important causes of defects?

4. (D) Design What should be the design?

5. (V) Verify How do we verify the design performance and its ability to meet customer needs?

DMAIC is a methodology used to improve an existing system, whereas DMADV is used for the design and development of new initiating processes or product (Magnusson, Kroslid & Bergman cited in Andersson, Eriksson & Torstensson 2006, p. 287). The literature shows that any organisation can customise these methodologies according to their needs. For instance, Yang et al. (2007) explain ‘how’ and ‘why’ Samsung tailored the standard implementation strategy to make it suitable for their needs. In addition to helping Samsung to integrate two different concepts, supply chain management and Six Sigma, the modification assisted the company to register more than $10 billion in profits in 2004. Hence, it is perceived that SMEs can modify the implementation strategies according to their needs. This also indicates that there are no stringent rules to follow and the process of adoption and implementation is quite flexible. Therefore, it is one of the objectives of this study to identify the steps and processes required to instigate the implementation of Six Sigma in manufacturing SMEs.
Further, as there is currently no centralised body to oversee the affairs of Six Sigma, such as the ISO in the case of the ISO 9000 standard series, this situation provides ample opportunity for freelance consultants to modify or propagate the basic concepts of Six Sigma. Senapati (2004) highlighted the role of consultants in the propagation of Six Sigma. This has resulted in ambiguities, as well as a rise in the overall implementation cost, which is unaffordable for most SMEs due to their resource constraints. However, the absence of a centralised controlling body for Six Sigma allows SMEs to tailor the methodology according to their needs. This option is not available in the case of other quality management techniques such as ISO 9000. Hence, careful consideration by SMEs can put them in an advantageous position.

The implementation strategies (DMAIC & DMADV) work by using different tools and techniques. Antony (2006, p. 241) differentiated between tools and techniques, stating ‘a tool has a clearly defined role and is often narrow in focus whereas a technique has a wider application and requires specific skills, creativity and training’. In general, tools are used to collect and analyse different types of data. Figure 2.5 depicts the different tools that are used during various stages, along with a flow diagram of the whole Six Sigma implementation program.
SMEs normally lack the means to collect and analyse data effectively; therefore, their decision-making process is often intuition based (Ekanem & Smallbone 2007). A factual approach to decision making is very important for quality management (Pfeifer, Reissiger & Canales 2004) and is the seventh basic quality management principle (ISO 2000a; Pfeifer, Reissiger & Canales 2004). However, a factual approach to decision making is facilitated by using the appropriate tool(s) for a particular activity. Both academic and practitioner literature discuss the various tools to be used for activities such as data collection and data analysis under DMAIC, DMADV or, perhaps, any other customised Six Sigma implementation strategy (Evans & Lindsay 2011; Henderson & Evans 2000; Nonthaleerak & Hendry 2008; Schroeder et al. 2008; Thomas, A & Barton 2006; Zhang, Hill & Gilbreath 2009) (see Figure 2.5).
2.5.2.1 Tools

The literature discusses different schemes of tools but a large portion of contribution lies with the seven basic quality and management tools (Andersson, Eriksson & Torstensson 2006). Ishikawa (1985) explains that the strength of the Japanese industry lies in the extensive use of these seven basic quality tools, as every worker is expert in their use. Therefore, it is recommended that a thorough effort be made to educate everyone in the use of the seven basic quality tools, especially at the SME level. Further, Henderson and Evans (2000) maintain that Six Sigma provides a framework that combines these basic quality tools with a high level of management support. To achieve the desired objectives, Six Sigma is flexible about selection from the suite of available tools or techniques. The implementation team specialises in solving and simplifying various situations under focus, and is expert in simple to complex statistics, and even individual techniques, such as quality function deployment (QFD) and the Kano model. As shown in Figure 2.5, the implementation strategy allows the implementation teams to decide which tool, or set of tools, they want to use to produce the desired results.

Many researchers believe that the majority of the tools used in Six Sigma are the same as those used in TQM (Andersson, Eriksson & Torstensson 2006; Klefsjö, Wiklund & Edgeman 2001; Pfeifer, Reissiger & Canales 2004; Senapati 2004). However, Kumar et al. (2008) argue that it is not only the type of tools that is important, but it is the objective use of the tools that makes Six Sigma different. As mentioned earlier, in Japan, every worker is expert in the use of basic quality
tools (Ishikawa 1985), and the industrial development of Japan is not a hidden fact.

2.5.3 Six Sigma Focus on Metrics (Performance)

Throughout the Six Sigma campaign, the entire emphasis is on quantifying every variable and measuring it. Quantitative metrics, such as process sigma measurements, critical-to-quality (CTQ) metrics, defect measures and process capability calculations, are quite common (Linderman et al. 2003; Pyzdek 2001). These metrics are utilised to improve the goals. This system is unique to Six Sigma and it translates the entire operational process in terms of numeric measurement and, therefore, reduces the chances of any ambiguity while making decisions. Further, it provides an effective way to evaluate overall performance of the process under focus.

The literature has discussed various indicators to highlight performance improvement resulting from Six Sigma implementation (Aboelmaged 2010; Andersson, Eriksson & Torstensson 2006; Antony 2002; Bendell 2006; Kwak & Anbari 2006). The most discussed performance improvement indicators include increase in profitability, improved sales, increased productivity, reduction of variations, reduced defects, reduced scrap rates, reduced delivery times, reduced work in progress, increased customer retention and increased employee satisfaction with enhanced levels of commitments (Aboelmaged 2010; Andersson, Eriksson & Torstensson 2006; Antony 2002; Bendell 2006; Kwak & Anbari 2006).
Through face-to-face and online services, a number of consultants are offering Six Sigma toolkits and guides suggesting various ways to execute Six Sigma projects (Zhang, Hill & Gilbreath 2009). The question is whether they are helpful to SMEs, or perhaps SMEs are not aware of Six Sigma and the available literature, as has been identified in the UK and Germany (Kumar 2007; Kumar & Antony 2008; Wessel & Burcher 2004). The literature shows examples of large organisations becoming world class by implementing Six Sigma (Godfrey 2002; Harry & Schroeder 2000; Henderson & Evans 2000), whereas SMEs are behind in acquiring this prestigious status. Thus, we need to identify whether Six Sigma is not suitable for SMEs or if some confusion exists regarding the concept of Six Sigma methodology. To progress the current study, it is necessary to understand the SME sector, its importance to the economy and the challenges it faces. As the scope of the present study is Australian SMEs, the discussion is predominantly specific to Australia.

2.6 Small and Medium Enterprises

SME is a diverse term (Rodney 2010). It includes organisations from manufacturing as well as service sectors. However, the focus of this research is on SMEs in the manufacturing sector. Different countries have different criteria for defining SMEs. As mentioned in Table 2.3, SMEs are defined on the basis of the number of employees working in the organisation, their financial turnover or the asset value, and the number of annual working hours or, in some cases, the volume of production (Harjula 2008; OECD 2000; Schaper & Volery 2004).
Table 2.3: A Cross-section of Definitions and Thresholds Used for SMEs

<table>
<thead>
<tr>
<th>Country</th>
<th>Number of Employees</th>
<th>Balance Sheet</th>
<th>Turnover</th>
<th>Investments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>&lt;20 Small</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20–199 Medium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>&lt;500</td>
<td></td>
<td></td>
<td>&lt;$50 Mil</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>&lt;50 Small</td>
<td></td>
<td>&lt;€10 Mil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;250 Medium</td>
<td></td>
<td>&lt;€43 Mil</td>
<td></td>
</tr>
<tr>
<td>Hong Kong</td>
<td>Small</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;100 in Manufacturing</td>
<td>&lt;50 other sectors.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>&lt;50–300</td>
<td></td>
<td></td>
<td>&lt;¥50 Mil–¥300Mil</td>
</tr>
<tr>
<td>Malaysia</td>
<td>&lt;150 Small</td>
<td></td>
<td></td>
<td>&lt;RM25 Mil</td>
</tr>
<tr>
<td>New Zealand</td>
<td>&lt;6 Small</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norway</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>&lt;200 (Non-manufacturing)</td>
<td></td>
<td>S$15 Mil</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>&lt;50 Small</td>
<td></td>
<td>&lt;€10 Mil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;250 Medium</td>
<td></td>
<td>&lt;€43 Mil</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>0–49 Small</td>
<td></td>
<td>&lt;£2.8 Mil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0–249 Medium</td>
<td></td>
<td>&lt;£11.2 Mil</td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>&lt;100 Small</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;500 Medium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>European Union</td>
<td>&lt;50 Small</td>
<td></td>
<td>&lt;€10 Mil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;250 Medium</td>
<td></td>
<td>&lt;€43 Mil</td>
<td></td>
</tr>
</tbody>
</table>

Source: (Adapted from Harjula 2008, Schaper & Volery 2004; OECD 2008 Cited in Rodney, H 2010 p. 20)

The Australian Bureau of Statistics (ABS) defines SMEs based on the number of employees. ABS defines SMEs thus: ‘Small businesses are businesses employing fewer than 20 workers, and medium-sized enterprises are those comprising between 20 and less than 200 employees’ (ABS 2001, p. 1).

As stated earlier, SMEs constitute the bulk of businesses around the globe and, therefore, play an important role in the development of the national economy of any country (Husband & Mandal 1999). For example, SMEs are the main
contributors to economic output and employment (Antony, Kumar & Madu 2005; Husband & Mandal 1999; Wattanapruttipaisan 2002). ABS (2011) revealed that more than 96 per cent of organisations fall into the category of SMEs. The RBA also presented a report verifying the significance of SMEs to the Australian economy (Connolly, Norman & West 2012). Similarly, the Australian government’s Department of Innovation, Industry, Science and Research (2011) pointed out that SMEs contributed around 57 per cent of industry value added in 2009–2010, compared with 42 per cent contributed by large businesses (ABS 2011).

In addition to the significance of SMEs, the business environment plays an important role in regulating economies, whether national or corporate. Today, the business environment is quite challenging and requires a continuous effort for survival. Current issues such as the GFC, along with the continuously evolving phenomenon of globalisation, create significant challenges for organisations. The GFC resulted in approximately 51 million jobs being put at risk globally (BBC 2009), with the hardest hit category being SMEs. At the same time, globalisation is challenging economies worldwide with its demand for the redistribution of economic frontiers and the decentralisation of operations. This results in an ever-increasing reliance on SMEs for the running of the main operations (Wattanapruttipaisan 2002). Similarly, globalisation presents SMEs with additional challenges from international competition.
2.6.1 Role of Small and Medium Enterprises in the Economy

SMEs are the backbone of any developed economy (Antony, Kumar & Labib 2008). The magnitude of their importance can be estimated by examining the report by the Department of Trade and Industry of the European Union (2000), which states that only one per cent of businesses have more than 50 employees (cited in Antony, Kumar & Labib 2008, p. 483). Ahmad, Mazhar and Jan (2009) referred to Rowe (2008) and claimed that the UK economy consists of 99 per cent SMEs. Out of the 4.8 million UK businesses, less than a per cent are large corporations. The Australian Bureau of Statistics (2011, 2012) revealed that more than 99 per cent of organisations fall in the category of SMEs. Australia Bureau of Statistics (2012) pointed out that SMEs contributed around 57 per cent of industry value added in 2009–10 and 2010-11, compared with 42 per cent contributed by large businesses, (see Appendix I). These figures establish that SMEs are indeed vital for any sustainable economy.

Another important feature of any developed economy lies in analysing the export figures and the contribution of each industrial sector. Australian exports account for around 1 per cent of global exports and 21.1 per cent of the value of domestic production (Ergas & Orr 2007). Australian SMEs are playing a significant role as exporter in the Australian economy. In 2010-11 medium sized enterprises represented 49 per cent of all good exporters. They exported 5 per cent of the total value of goods exports. Similarly small businesses made up 42 per cent of all goods exporters by number and contributed less than 1 per cent of the total value
of goods exports (Australia Bureau of Statistics 2012a). See Appendix I, for the
details of the contribution of Australian SMEs to exports.

As noted in the preceding section, SMEs are responsible for providing the bulk of
employment in most economies (Husband & Mandal 1999; Thomas & Webb
2003). Employment figures are among a few factors that determine the
performance of any economy (Shields 2003). Small businesses in the USA are the
main contributors of employment according to 2008 data (U.S. Small Business
Administration 2011). Further, Antony, Kumar and Madu (2005), Husband and
Mandal (1999) and Wattanapruttipaisan (2002) claim that SMEs are responsible
for employment generation in the economy. We can establish that one way to
judge an ‘out of crisis’ economy is by looking at the unemployment figures.

Keeping in view the importance of employment and the volume of businesses, it
is clear that government and other regulatory authorities need to treat SMEs
distinctively. Many countries have designated SME departments that facilitate the
needs of this sector, such as the US Small Business Administration and the
Council of Small Businesses of Australia (COSBOA), but there is a need to
establish sustainable SME development policies. The scope of such positive
activities should extend to vocational and academic institutions, through designing
and developing curricula according to the needs of SMEs. The introduction of
quality management techniques into curricula could contribute to making the
SME sector more effective, efficient and, thereby, profitable.
2.6.2 Challenges for Small and Medium Enterprises (Quality)

SMEs face many challenges compared to large organisations in addressing quality issues (Yusof & Aspinwall 2000). Time, financial and human resources are some real and tangible challenges facing SMEs (Schaper & Volery 2004; Yusof & Aspinwall 2000). Decision making in SMEs is a very important aspect and significantly affects resource management, but SMEs run and make decisions based on intuitive instincts (Ekanem & Smallbone 2007). Therefore, a factual approach to decision making, with proper strategic planning based on organisational goals, could lead to better and long-term results. Hence, this will help to utilise available resources in an efficient way.

The adoption of quality management approaches by SMEs is slow (Ghobadian & Gallear 1997; Kumar et al. 2008). Antony (2008a, p. 420) presents his viewpoint along with the perspective of other Six Sigma professional and academic experts on the question; ‘can Six Sigma be effectively implemented in SMEs?’ His research highlighted that SMEs can implement Six Sigma more effectively than large organisations, if there is involvement and commitment from the top management.

The literature highlights a number of CSFs, such as communication, fact-based decision making, cultural change and leadership, as significant for the implementation of Six Sigma for organisations (Coronado & Antony 2002; Moosa & Sajid 2010; Nonthaleerak & Hendry 2008). Kumar (2007) compiled all the CSFs (see Table 2.4) mentioned in the literature (Antony, Kumar & Madu 2005;
Coronado & Antony 2002) and attempted to verify their validity for SMEs exclusively. The top five CSFs identified by Kumar (2007) were management involvement and commitment; linking Six Sigma to customers; cultural change; education and training; and a vision and plan statement supported by the CEO.

Table 2.4: List of Critical Success Factors

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Critical Success Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Leadership</td>
</tr>
<tr>
<td>2</td>
<td>Organisational Infrastructure</td>
</tr>
<tr>
<td>3</td>
<td>Cultural Change</td>
</tr>
<tr>
<td>4</td>
<td>Education and Training</td>
</tr>
<tr>
<td>5</td>
<td>Fact-based Decision Making</td>
</tr>
<tr>
<td>6</td>
<td>Linking Quality Improvement (QI) Initiative to Customers</td>
</tr>
<tr>
<td>7</td>
<td>Linking QI Initiative to Business Strategy</td>
</tr>
<tr>
<td>8</td>
<td>Linking QI Initiative to Employees</td>
</tr>
<tr>
<td>9</td>
<td>Linking QI Initiative to Suppliers</td>
</tr>
<tr>
<td>10</td>
<td>Communication</td>
</tr>
<tr>
<td>11</td>
<td>Project Management Skills</td>
</tr>
<tr>
<td>12</td>
<td>Project Prioritisation and Selection</td>
</tr>
<tr>
<td>13</td>
<td>Usage of Innovative Techniques and IT Systems</td>
</tr>
<tr>
<td>14</td>
<td>Networking with Government and Academia</td>
</tr>
</tbody>
</table>

Source: Collated from Kumar (2007); Kumar and Antony (2008); Näslund (2008)

As discussed earlier, SMEs are the backbone of the world’s economy (Antony, Kumar & Labib 2008; Wymenga et al. 2011). Aboelmaged (2011) identified the existence of different barriers in the implementation of Six Sigma. He classified them as soft impediments and hard impediments. Soft impediments included aspects such as knowledge and support, whereas professionals and finances were categorised under hard impediments. A similar investigation was conducted among Australian SMEs, and the relationship of hard and soft quality management factors were analysed with the performance of the firms (Gadenne &
Gadenne and Sharma (2009) identified that the overall performance of SMEs were highly influenced by ‘hard’ factors such as benchmarking; quality management; continuous improvement; and efficiency improvement. ‘Soft’ factors included top management philosophy; training; internal and external communication; and supplier relationships.

Kumar, Antony and Douglas (2009, p. 629) have identified a number of reasons for SMEs in the UK not to implement Six Sigma: ‘Lack of knowledge; Lack of resources; Approach relevance issues; Lack of proper awareness; and Cost issues’.

In addition, other inhibitory factors may include lack of vision, lack of support from large business partners, and considering the ISO 9000 standard as the ultimate quality management methodology to fulfil quality needs (Antony, Kumar & Madu 2005).

Small organisations, in particular, lack sufficient human resources (Yusof & Aspinwall 2000) to delegate roles and designate the typical Six Sigma hierarchy required for its classical implementation (Kumar et al. 2008). However, Mader (2008) explains that, when Motorola decided to implement Six Sigma, they did not have any Black Belts; what they required was the top management’s commitment combined with extensive employee training. Higher consultancy charges are another inhibitory factor and a significant challenge identified by small organisations. In this regard, Antony (2008b) emphasised the role of
academic institutions to develop a cost-effective Six Sigma methodology and to make it digestible for SMEs (Kumar et al. 2008).

Medium organisations lack the necessary quality awareness, and the absence of proper vision can be viewed as a significant challenge. Finances also play a critical role, but with the help of proper strategic planning this issue could be addressed. Huq (2006) claimed that higher levels of quality can be achieved by adopting Six Sigma through developing a unique combination of resources and competencies to understand the benefits of Six Sigma. Further, any prior existing quality management practice will help to instigate the process of Six Sigma implementation rapidly.

As for the problem of resource management in SMEs, this could be resolved by following a cluster development methodology, as identified by the United Nations Industrial Development Organization (UNIDO). Clusters are agglomerations of interconnected companies and associated institutions (UNIDO 2000). UNIDO launched its cluster development program in 1995 (Clara, Russo & Gulati 2000). Organisations can share their resources to support each other by building networks and establishing consortiums. Under this methodology, government, regulatory bodies, academics and other support institutions establish networks to facilitate SME activity.

The use of cluster-based methodology for the implementation of Six Sigma in SMEs is new (Pantano, O’Kane & Smith 2006) and only one research article by
Pantano, O’Kane and Smith (2006), published in conference proceedings, could be found in the literature. Pantano, O’Kane and Smith (2006) presented a cluster-based Six Sigma deployment framework for SMEs belonging to the automotive industry. They advise that this framework is also relevant for developing economies.

Husband and Mandal (1999) studied Australian SMEs and used various dimensions of SMEs for their research. According to them, the issues related to the adoption of quality management practices cannot be generalised to SMEs because SMEs normally have unique features that are crucial for maintenance within their specific organisation. Thus, they stress that a sector-specific SME implementation strategy may help to resolve issues related to quality management, in general, and, in particular, the Six Sigma system. Kureshi, Qureshi and Sajid (2010) also recommend conducting sector-specific research within SMEs to address issues related to quality management. Further, the basics of the cluster-based methodology also rely on a similar type of organisation, which are usually SMEs.

Antony, Kumar and Madu (2005) compiled the strengths and weaknesses of SMEs and explored the possible areas of importance through an extensive literature review on Six Sigma and TQM (see Table 2.5). Addressing the weaknesses and foregrounding the strengths could ease the situation and may result in formulating an SME-based implementation strategy.
Table 2.5: SME Strengths and Weaknesses

<table>
<thead>
<tr>
<th>SME STRENGTHS</th>
<th>SME WEAKNESSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexible and hence changes can be introduced fairly quickly</td>
<td>Low degree of standardisation and formalisation</td>
</tr>
<tr>
<td>Flat with few layers of management and fewer departmental interfaces</td>
<td>Focus is on operational matters rather than planning</td>
</tr>
<tr>
<td>Top management highly visible and hence provides leadership by example</td>
<td>There are chances that management will lay off employees when the work becomes superfluous, which makes SMEs work harder to retain high-calibre staff</td>
</tr>
<tr>
<td>Absence of bureaucracy in management teams</td>
<td>Limited investment in IT</td>
</tr>
<tr>
<td>Tend to have high employee loyalty</td>
<td>No incentive or reward programs in many cases due to budget and resource constraints</td>
</tr>
<tr>
<td>Managers and operatives are more likely to be directly involved with the customers</td>
<td>Lack of strategic planning and inspiring vision</td>
</tr>
<tr>
<td>Rapid execution and implementation of decisions</td>
<td>Responsible for many facets of the business and many decisions; decisions are generally made for short-term profitability</td>
</tr>
<tr>
<td>Training likely to be focused</td>
<td>Lack of skills, time and resources; no specified training budget</td>
</tr>
<tr>
<td>Culture of learning and change rather than control</td>
<td>Incidence of ‘gut feeling’ decisions more prevalent; often operate in a fire fighting mode for survival</td>
</tr>
<tr>
<td>People oriented</td>
<td>Not systems oriented</td>
</tr>
<tr>
<td>More responsive to market needs and more innovative in their ability to meet customers’ demands</td>
<td>Extent of training and staff development in SMEs is limited and informal</td>
</tr>
<tr>
<td>Likely to deploy improvements quickly and gain rapid benefits</td>
<td>Adamant and dictatorial nature of owner can damage new initiatives</td>
</tr>
<tr>
<td>Loose and informal working relationships and absence of standardisation</td>
<td>Formation of strategy process is intuitive rather than analytical</td>
</tr>
</tbody>
</table>

Source: Adapted from Antony et al. (2005)

2.7 Summary

This chapter explored some fundamental concepts of quality management by examining the transitions in the concept of quality and highlighting TQM assessment models. Considering Six Sigma is part of quality management this chapter introduces some basics concepts about this methodology. The literature highlights that the implementation of Six Sigma is uncommon in manufacturing.
SMEs. It is observed that the previous research was conducted on the entire manufacturing SME sector, and there is a need to address this matter by addressing sector-specific issues. The literature points towards some barriers in its implementation, but further verifications are required, based on different sectors. It is also noted that the concept of Six Sigma is still in its conceptual transition stage and there is a need to establish a theoretical framework for the adoption of the Six Sigma methodology at the SME level. Moreover, impeding factors, such as establishing a classical Six Sigma implementation hierarchy and a lack of conceptual awareness, pose some threats for its adoption and implementation at the SME level. To understand the mechanism of Six Sigma adoption and implementation in SMEs, a conceptual model adapted from the work of Braunschweidel et al. (2011) is presented in Figure 2.6.

Figure 2.6: Conceptual Framework Derived from Braunschweidel et al. (2011)
This chapter identified the following questions that need to be further explored:

- Why is the rate of Six Sigma implementation negligible in manufacturing SMEs?
- What is the effect of the adoption and implementation of Six Sigma on organisational performance?
- What are the impediments in the way of implementing Six Sigma in SMEs? Can these be overcome?
- What process is required to instigate the implementation of advanced quality management techniques such as Six Sigma in manufacturing SMEs?

The next chapter discusses the research strategy selected to explore and answers the above-listed questions.
Chapter 3: Research Methods

3.1 Introduction

The purpose of this chapter is to elaborate on the research methodology undertaken to gather data for the exploratory study. SMEs belonging to the manufacturing sectors of Australia, and those that have implemented advanced quality management methodologies such as Six Sigma, were selected for this study.

This chapter discusses the research design in detail. The appropriate research method is explored through explaining various research paradigms, establishing a valid research strategy, and providing details of the data collection technique and analysis.

3.2 Research Design

Figure 3.1 shows that the present study progressed by setting research objectives that led to an in-depth review of the literature. The literature review helped to identify the gap in knowledge and, hence, the ensuing research questions. This was followed by the designing of an appropriate research method to address the research question, which, in turn, guided the data collection method. After the data collection, the data were analysed and research findings were drawn. These research findings were validated against the research objectives, and conclusions were drawn, along with recommendations for further research.
3.2.1 Research Objectives

Setting research objectives is very important for conducting purposeful research. A well-defined research scope and objectives ensure the success of the research, while the research findings, when compared against the research objectives, provide confidence in the entire research process.

The following research objectives were established for this research endeavour:

1. to establish a theoretical basis for the adoption of advanced quality management techniques such as Six Sigma by Australian manufacturing SMEs
2. to explore CSFs essential for the successful implementation of Six Sigma in Australian manufacturing SMEs
3. to identify the factors inhibiting the adoption of Six Sigma by SMEs
4. to evaluate the effects of Six Sigma on Australian manufacturing SMEs after successfully implementing Six Sigma.

The scope of the research comprises the following two areas:
1. quality management (in general) and Six Sigma (in particular)
2. Australian Manufacturing SMEs.

3.2.2 Research Problem

Six Sigma has proved its potential to address quality-related issues in large organisations (Antony, Kumar & Madu 2005), but its efficacy in SMEs is yet to be widely established (Antony 2008a; Antony, Kumar & Madu 2005; Wessel & Burcher 2004). The literature suggests that SMEs show a lack of interest towards the Six Sigma methodology (Antony, Kumar & Madu 2005; Kumar & Antony 2009). Recent research confirms that the trend of implementing Six Sigma in UK SMEs is almost negligible (Antony 2008b; Antony, Kumar & Madu 2005; Kumar & Antony 2008). In addition, Wessel and Burcher (2004) state that German SMEs show little interest in Six Sigma implementation. Even Australian SMEs show reluctance towards quality management programs for various reasons (Husband & Mandal 1999).
3.2.2.1 Research Questions

The aim of the current study was to develop a framework explaining the mechanism of the Six Sigma adoption and implementation process in SMEs. Moreover, the scope of the current study revolves around Australian manufacturing SMEs. In order to progress the current study, the following research questions were designed, with the help of the literature:

- Why is the rate of Six Sigma implementation negligible in manufacturing SMEs?
- What is the effect (if any) of adoption and implementation of Six Sigma on organisational performance?
- What are the barriers when implementing Six Sigma in SMEs? How can these be overcome?
- What are the significant CSFs required for the implementation of Six Sigma in SMEs? How do they affect Six Sigma?
- What process is required to instigate the implementation of advanced quality management techniques such as Six Sigma in manufacturing SMEs?

The identification of the research questions through the literature review led to determining the appropriate research methodology. The majority of the research questions are ‘what’ questions, which points towards the exploratory nature of the current study (Yin 2009, p. 9). The exploratory nature of this study suggested the case study method as the appropriate way to carry out the research (Yin 2009). A
questionnaire survey was also conducted to understand and assess the status of quality management practices in manufacturing SMEs. Therefore, mixed methodology is the type of research methodology used to conduct the current study. Mixed methodology is known, and adopted, for its greater validity (Creswell et al. 2003; Johnson & Onwuegbuzie 2004; Tashakkori & Teddlie 2003). Further, as the survey questionnaire is a replication of a previously conducted study in the UK, it ensures the confidence on the validity of the survey instrument.

The following section highlights the appropriate research paradigm and various data collection methods used for this study.

3.3 Research Paradigm

A paradigm is defined as the ‘basic belief system or world view that guides action’ (Guba & Lincoln 1994, p. 107). Saunders, Lewis and Thornhill (2003) suggest three research paradigms: positivism, interpretivism/phenomenological and realism. Positivist research is highly structured, relies on quantifiable data, uses statistical analysis and, thus, results in quantitative research methodology (Neuman 2003). In contrast, phenomenological research involves subjective data and is dependent upon participants (Creswell 2009; Neuman 2003). Social research falls under this category. Qualitative research methodology represents phenomenological research. In between these two poles lies realism, based on reality. Realists attempt to understand a social reality in the context of broader
social forces and structures or processes that influence people’s views and behaviours (Creswell 2009). Researchers generally use one of the research paradigms for their research. However, nowadays, mixed method is also finding acceptance in addressing complex issues and it is essential for conducting data triangulations for greater research validity (Neuman 2003).

One of the objectives of this study was to explore how SMEs can implement Six Sigma. Accordingly, it was important to identify the factors restricting SMEs from implementing Six Sigma to understand how to transform the organisational culture from the conventional way of executing operations to the Six Sigma environment. Therefore, this study followed the phenomenological paradigm in which the researcher’s objective was to reveal ‘the details of the situation to understand the reality’ (Saunders, Lewis & Thornhill 2003, p. 84). The exploratory nature of the study prescribed the use of qualitative research methods as more suitable to obtain the in-depth perspectives of the participants, as they allow them to express themselves properly (Bouma & Ling 2004).

The research in the field of quality management has also been predominantly qualitative in nature (Aboelmaged 2010). Aboelmaged (2010) found that qualitative research methodology is extensively used to conduct research in the field of Six Sigma. Therefore, this study also uses qualitative research methodology as the preferred method of data collection because it gives flexibility to the researcher in identifying significant hidden facts, which could not be revealed through quantitative methods (Silverman 2000). Nonetheless, a
questionnaire survey was also administered in this study with the objective of identifying the status of quality management practices in SMEs. Further, the questionnaire was predominantly designed to collect information primarily for descriptive analysis and no other significant quantitative analysis was undertaken.

Qualitative research methodology is well known to be exploratory in nature, (Neuman 2003; Yin 2003, 2009). The qualitative study is defined by Creswell (1994, p. 1) as ‘an inquiry process … based on building a complex, holistic picture, formed with words, reporting detailed views on informants, and conducted in a natural setting’. Creswell (2007) states that this methodology is essential when there is a need for a detailed understanding of the issue.

Qualitative data can be gathered through various methods. Methods such as interviews, case studies, focus groups, observations and archives are designed to explore certain phenomenon and hidden facts (Neuman 2003). Therefore, the outcome of qualitative research results in generating textual types of data. In addition, it provides the opportunity for respondents to express their views on different issues. Thus, the importance of qualitative research in describing social and management sciences theory is well known (Seale et al. 2004).

Creswell (2007) highlighted the distinctive features of qualitative research and claimed that these are based on ontological, epistemological, axiological, rhetorical and methodological aspects. He pointed out that qualitative research starts by initiating the inquiry but, later on, it follows the pattern of scientific
research. Therefore, the primary data-gathering phase consists of obtaining information about the in-depth experiences of practitioners during the implementation and execution of Six Sigma methodology, along with the support of the archives.

As the phenomenological paradigm suggests, qualitative research methodology is an appropriate way to conduct this study, and because it answers the ‘what’, ‘why’ and ‘how’ questions posed by this study, the aim was to generalise findings related to Six Sigma implementation in SMEs. Moreover, as the ‘what’, ‘why’ and ‘how’ questions are used mainly for exploratory purposes (Yin 2009), initially a survey was undertaken to identify the status of Australian manufacturing SMEs regarding implementing advanced quality management practices.

3.4 Survey

Aboelmaged (2010) showed that, in the field of quality management, the survey has been used occasionally by researchers to statistically validate their hypothesis (Kumar & Antony 2008). However, the main purpose of the survey in this study was to identify the status of quality management practices in the manufacturing sector of Australia and to make this research nationally representative.

3.4.1 Questionnaire Design

The literature review helped to identify other studies on Six Sigma applications globally (Antony, Kumar & Labib 2008; Antony, Kumar & Madu 2005; Kumar
2007; Kumar & Antony 2008, 2009; Kumar, Antony & Douglas 2009; Kumar, Antony & Tiwari 2011; Timans et al. 2012; Wessel & Burcher 2004). As a result, contact was established with a researcher in the UK who had studied Six Sigma implementation in UK manufacturing SMEs. A pre-tested questionnaire, launched in UK, was redesigned to address the Australian environment.

Modifications for the Australian questionnaire included replacing UK geographical locations with Australian states and substituting British pounds (£) with Australian dollars (A$). The inclusion of two new sections related to Six Sigma and Lean practices (Part II and Part III, respectively) could be considered major insertions to the original survey format. Further, three new critical success factors (CSFs) in Part IV were included. Similarly, in Part V, four new benefits and two critical issues were added. All the above-mentioned changes were done with the complete consent of the UK collaborator. The rest of the questionnaire remained an exact replica of the questionnaire used in the UK. It is important to highlight that, while adapting the UK questionnaire, the intention was to make it brief while still covering all the research areas.

As this study aimed to investigate the adoption of Six Sigma by Australian manufacturing SMEs, the questionnaire comprised a broad overview (see Appendix II), ranging from probing open-ended questions to scale-defined questions. The questionnaire consisted of five parts:
• Part I, Questions 1 to 16, was designed to obtain background information about the organisation.

• Part II was an extension of Question 16 and discussed Six Sigma methodology exclusively.

• Part III focused specifically on Lean manufacturing.

• Part IV was designed to determine the degree of importance and the implementation level for the factors that are considered to be crucial while implementing quality management initiatives [QI], in an organisation, using a five-point Likert scale.

• Part V enquired about the benefits that the organisation had experienced following the implementation of the QI program in their business process/es, and included a number of other probing questions.

3.4.2 Recruitment of the Organisations

As SMEs constitute the bulk of organisations in any economy, it is difficult to select SMEs without setting a specific criterion. For this purpose, the following criteria were followed:

• All organisations should be ISO 9001 certified.

• All organisations should belong to the manufacturing sector.

• All organisations should be SMEs based on the definition of the ABS.

As mentioned in the previous chapter, ISO 9000 is one of the most commonly implemented quality management standards in the world (BSI 2011), including in
Australia. The implementation requirements, the auditing mechanisms and the third-party certification process of the ISO 9000 standards provide some sort of assurance that the level of quality management in all ISO certified organisations is similar.

Six Sigma is an advanced quality management technique and the intention of the study was to identify the trend of SMEs in relation to adopting the Six Sigma methodology. Therefore, the selection of ISO 9000 certified organisations was intended to ensure that all participating organisations had the same minimum level of understanding about quality management practices.

The manufacturing sector has been experiencing a tough business environment since the GFC. As Six Sigma is known for enhancing profit margins and performances in all processes, the objective was to study the process of adopting and implementing quality initiatives as a way of easing the effects of globalisation in the post-GFC situation for manufacturing SMEs. While the inclusion of the service industry would have expanded the scope of the study, it was not desirable in the current set of resource-deficient circumstances.

The database of the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) was used to short-list organisations. JAS-ANZ provided a list of all the ISO certified organisations within the entire manufacturing sector. The database is not up to date and, thus, a large number of questionnaires were returned as many organisations had closed down or their addresses had been
changed, which resulted in about 95 ‘wrong addresses’ out of a total of 2,485 organisations. This database provided the list of all manufacturing organisations that are ISO certified but failed to segregate large organisations from SMEs based on the number of employees as defined by the ABS: ‘Small businesses are businesses employing fewer than 20 workers, and medium-sized enterprises are those comprising between 20 and less than 200 employees’ (ABS 2001, p. 1). To fulfil the criteria of SMEs, a question in Part I was included that asked the number of employees, which helped in separating SMEs from large organisations.

3.4.3 Administration of the Survey

After obtaining ethics approval, the redesigned questionnaires were sent via postal mail, accompanied by a self-addressed return envelope to ensure the maximum number of returned questionnaires, along with a covering letter on the letterhead of Deakin University (see Appendix III). The covering letter elaborated the aims and objectives of the study as well as the expected outcome. It provided contact details of the principal supervisor and the university ethics committee so that, if a respondent had any concerns about the study, he or she could contact the ethics committee directly. The covering letter was addressed to managing directors, operations directors, quality managers and production managers.

The respondents were given three weeks to return the completed questionnaire. Although more time should have been given, the Christmas holidays would have arrived within four weeks of the first mail-out; therefore, only three weeks were
available. The decision was made with the assumption that managers would try to clear their desks before the Christmas holidays.

3.4.4 Follow-up Contact

Follow-up was carried out by sending reminders after the Christmas holidays and eight weeks were given to the respondents, to ensure a timely and higher rate of return of the questionnaire. However, the responses were quite discouraging as only 115 out of 2,485 questionnaires were returned and, out of them, only 92 responses represented SMEs. Hence, an overall response rate of just three per cent was achieved.

3.4.5 Survey Data Analysis

SPSS 20.0 software was used for analysis purposes. A descriptive analysis was undertaken to gather the general information. The findings of the questionnaire analysis are discussed in the next chapter. The data analysis also helped to develop further questions to design the interviews used in the next step.

The survey helped to identify Six Sigma practising SMEs. To identify the motivation behind Six Sigma adoption, and the involvement of various factors experienced during the implementation of Six Sigma in Australian manufacturing SMEs, a detailed revisit to Six Sigma practising SMEs was required. The case study method is appropriate for exploring concealed facts (Yin 2009). Sohal, Simon and Lu (1996) confirmed the validity of case study research in providing extensive and in-depth information into the quality management practices of the
organisation under focus. Therefore, the case study method was found to be appropriate for conducting an in-depth exploratory study (Yin 2009).

### 3.5 Case Study

According to Baxter and Jack (2008, p. 544), ‘case study is an approach to research that facilitates exploration of a phenomenon within its context using a variety of data sources’. Yin (2009, p. 8) provided three conditions that guide the researcher’s design selection: (i) the type of research question asked, (ii) the extent of control over actual behavioural events, and (iii) the degree of focus on contemporary as opposed to historical events (see Table 3.1).

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Forms of Research Questions</th>
<th>Requires Control of Behavioural Events?</th>
<th>Focuses on Contemporary Events?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment</td>
<td>How, Why?</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Survey</td>
<td>Who, What, Where, How many, How much?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Archival Analysis</td>
<td>Who, What, Where, How many, How much?</td>
<td>No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>History</td>
<td>How, Why?</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Case Study</td>
<td>How, Why?</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: Adapted from “Case study research: Design and Method” by Yin (2003, 2009)

Punch (1998, p. 150) states that the aim of the case study is to understand the case in depth, and in its natural setting, recognising its complexity and its context. Further, the case study has a general focus, targeting to understand the entirety of the case. Therefore, he claimed, the case study is more a strategy than a method.
Rodney (2010) emphasised that the case study method is significant when issues are difficult to extract from their context.

Yin (2009, p. 8) explained that the case study method is suitable when: (a) ‘how’ or ‘why’ questions are posted, (b) the investigator has little control over events, and (c) the focus is on a contemporary phenomenon within a real life context. Punch (1998) explains that the case may be an individual, a role, a small group, an organisation, a community or a nation. In addition, a decision, policy, process, incident or event, and many more other possibilities, could form the basis for the case.

Yin (2009) categorised five settings in which a case study is most applicable: (i) the investigation is of a current phenomenon; (ii) Unclear evidence of the limits between phenomenon and context; (iii) there are more variables than data points; (iv) there are multiple sources of evidence; and (v) existing theories can be used to direct the data collection and analysis. This study fulfils most of these criteria. Accordingly, the case study was selected for this research because ‘it is the preferred method when attempting to answer ‘how’ and ‘why’ research questions about contemporary events over which the researcher has no control’ (Yin 2009, p. 9).

As the results from the survey highlight the existence of Six Sigma implementing manufacturing SMEs, this encourages the researcher to explore the facts in detail and establish an in-depth case study for other organisations to use as a benchmark.
This was one of the objectives of the study, to identify the steps implemented by the top management of SMEs in the adoption of the Six Sigma methodology.

Further, the literature suggests that a qualitative methodology is the chosen way to research the quality management area (Aboelmaged 2010; Sohal, Simon & Lu 1996). Aboelmaged (2010) found that from 1992 to 2008, 417 research articles on Six Sigma were published in refereed journals. Around 55.4 per cent (231 articles) used the case study method for their research compared to only 7.7 per cent (32 articles) that used the survey methodology. The case study method was thus selected to obtain detailed, in-depth, rich data on the phenomenon of Six Sigma (Yin 2003, 2009).

The case study method is flexible and broad, and easy to understand (NIST 2006). It highlights the importance of humanistic behaviours, elaborates objectives, explores project dynamics and investigates particular phenomena (Guba & Lincoln 1994; NIST 2006). The advantage to gather multiple types of information results the case study method suitable to explore ideas and theoretical construction of the program or project dynamics (NIST 2006). However, Nist (2006) described some disadvantages related to the case study method, such as that it is anecdotal, it is very hard to draw definite cause-effect conclusions, it is difficult to generalise from a single case and biases are possible in data collection and interpretation (Guba & Lincoln 1994).
3.5.1 Case Study Design

A research design is ‘the logic that links the data to be collected (and the conclusion to be drawn) to the initial questions of study’ (Yin 2009, p. 24). Further, Yin (2009, p. 26) explains that a research design, informally, is a logical plan from ‘here’ to ‘there’, where ‘here’ is the research question and ‘there’ is the conclusion. Yin (2003, 2009) proposes five components of a study plan: (i) the question; (ii) the proposition (if any); (iii) the unit(s) of analysis; (iv) the logic linking data to its proposition; and (v) the criteria for interpreting the findings. All these components will be discussed in the following subsections.

Yin (2009, p. 46) also presents four types of case study designs (see Figure 3.2):

1. single-case design with single unit of analysis
2. single-case design with multiple units of analysis
3. multiple-case design with single unit of analysis
4. multiple-case design with multiple units of analysis.

Figure 3.2: Case Study Designs (Yin 2009)
The survey helped to identify four Six Sigma practising SMEs. Out of these four, only one Six Sigma implementing SME agreed to participate in the next phase of study. Therefore, this study follows Model 2, that is, the single case study with multiple units of analysis. Hence, this one SME is represented as one case, with various multiple units of analysis. The units of analysis were:

- Six Sigma adoption
- Six Sigma implementation process and barriers
- Operational performance improvement.

Considering the exploratory nature of the research questions, as mentioned earlier, and the lack of previous research (Nonthaleerak & Hendry 2008), this study is primarily exploratory in nature. As this study is exploratory in nature, a proposition is not mandatory (Yin 2003, 2009).

### 3.6 Data Collection Process

The primary data were collected through interviews with the Six Sigma Black Belt. In addition to this, archives were accessed to obtain factual data. This helped in comparing the performances of the operations before Six Sigma adoption with those after its implementation. Before discussing the various data collection methods, it is appropriate to discuss the case selection process.
3.6.1 Case Selection

Qualitative researchers use purposeful and judgemental sampling techniques in the selection of case studies, in contrast to the systematic sampling techniques used in quantitative studies (Patton 1990). Therefore, the case was selected based on the following criteria:

- The preliminary survey helped to short-list the organisations. This organisation is an SME according to the definition of the ABS.
- This organisation had implemented Six Sigma and, at the time of the interview, was running this program successfully.

3.6.2 Interviews

Yin (2003, 2009) describes interviews that are open ended and conversational in nature but follow a certain line of questioning derived from case study protocol and the interview guide. In this study, the main interview was carried out with the Six Sigma Black Belt.

The systematic approach of establishing the protocols for open-ended questions for semi-structured interviews shows the objectivity of the exploratory nature of the study. The structured method of data collection is through semi-structured interviews that helped the researcher to understand the methodology and its sequential steps.
Yin (2009) described the strengths of interviews and explained that, since the interviewees provide their personal opinions on the topic, the researcher is able to remain focused and allow the facts to emerge. The semi-structured interview also partially prepares the respondents for the areas of discussion; therefore, they are informed of what will be discussed during the interview. Further, the semi-structured interview allows for personal anecdotes and stories to emerge, which in the majority of cases provide a richer answer or insight into a topic area than a simple quantitative questionnaire (Yin 2009).

In contrast to the strengths of interviews, Yin (2009) also highlighted a few weaknesses, such as interviewees, in general, have a high degree of freedom in their responses and, in many cases, the interviewees drift from the topic. Moreover, the interviewer requires a great deal of practice and needs to be vigilant to cover the entire range of area in a specified time.

A semi-structured method of interviewing was used in order to explore facts. This gave the interviewer the flexibility to explore the experiences of the SMEs. The semi-structured method was undertaken in a casual manner by encouraging the interviewee to share more information. As the interviewee was a qualified quality practitioner, a detailed interview plan was constructed. The interview took place at his office location for approximately 120 minutes. After receiving consent, the interview was recorded and notes were taken throughout the interview. The interviewee was requested, prior to the interview, to provide a copy of his
professional curriculum vitae and copies of any additional documents he wished to disclose that may elaborate on his opinion on the topics to be discussed.

### 3.6.3 Archives

On request, the interviewee presented various archives comprising job sheets, working papers, copies of annual reviews and various plans and charts. These archives represented both pre-Six Sigma and post-Six Sigma periods. They helped the understanding of the level of performance improvement achieved after implementing Six Sigma. However, due to confidentiality, the interviewee did not provide any hard copies of any records nor did he agree to share any evidence. Therefore, the reference was only for the benefit of the interviewer.

### 3.7 Triangulation

Triangulation is a process through which qualitative researchers verify and validate their studies (Guion 2002; Guion, Diehl & McDonald 2011). Guion (2002) and Guion, Diehl and McDonald (2011) describe validity, in qualitative studies, as the findings that should be true and certain. Yin (2009) considers triangulation as principle number one in the data collection process.

Patton (2002) describes four types of triangulations:

1. data triangulation
2. investigator triangulation
3. theory triangulation
4. methodological triangulation.

However, Guion (2002) and Guion, Diehl and McDonald (2011) add environmental triangulation to the above list.

Different sources of information are used in data triangulation to increase the validity of the information, while investigator triangulation involves various investigators in the analysis process. When single set data are interpreted by different professionals using a single theory and they all obtain the same result, theory triangulation is said to have occurred. Methodological triangulation is the use of various qualitative and quantitative methods to study a specific issue; when data analysis yields the same result, validity occurs. Similarly, in environmental triangulation, the same process is run under different environmental conditions. If the results remain the same in every environmental setting, environmental triangulation is said to have occurred.

The current study is verified with both data triangulation and method triangulations for validity.

3.7.1 Data Triangulation

Data triangulation involves the use of various data collection methods, and if the conclusions drawn from these methods are similar, data triangulation occurs. Yin (2009) emphasised the importance of data triangulation in executing credible research. Multiple sources used for data collection converging to the same fact are
essential (Neuman 2003; Yin 2009). Multiple data collection methods help to develop converging lines of inquiry, which results in more accurate, verified and convincing conclusions and findings.

For this study, semi-structured interviews with open-ended questions, and operational documents and archives were the methods used to collect data. The interviewee presented various operational documents and records to highlight the improvements achieved after implementing Six Sigma applications. Data collected through these sources converged towards the same fact and, therefore, ensured validity of the findings (see Figure 3.3).

![Data Triangulation (Patton, 2002) Collated by Author](image)

**Figure 3.3: Data Triangulation (Patton, 2002) Collated by Author**

### 3.7.2 Methodological Triangulation

To ensure the validity of the methods used for this study, a systematic approach was followed (see Figure 3.4). An extensive literature review highlighted the gap; the rate of adopting the Six Sigma methodology by manufacturing SMEs is
negligible, and this is supported by the findings of the survey conducted among Australian manufacturing SMEs. Further, one of the conclusions drawn from the case study verifies that the rate of adopting Six Sigma in SMEs is very low.

Figure 3.4: Methodological Triangulation (Patton, 2002) Collated by Author

3.8 Role of the Researcher

The role of the researcher is always very important in qualitative research. Exploration of the hidden facts through various methods is critical. Most of the time, personal biases play a role in this process; hence, results can portray untrue and uncertain facts. Yin (2009) also emphasised avoiding biases. He viewed that this ‘disease of biases’ is quite common in qualitative research and steps to avoid or at least reduce chances for potential biases are essential. Therefore, to ensure that researcher bias did not distort the findings of the study, various strategies were employed, such as:

1. extensive review of the literature
2. multiple data collection methods to triangulate data
3. sharing findings of the interview with the interviewee for verification purposes.

3.9 Experience of the Researcher

According to Creswell (1994), qualitative research is interpretive in nature; thus, the biases, values and judgement of the researcher must be explicitly stated in the research report. Therefore, it is essential to mention that the researcher is a quality management professional and has experience in providing consultancy to organisations. Based on his own experience, the researcher had the perception that SMEs are resource deficient and the majority of them cannot adopt the Six Sigma methodology, perhaps due to an absence of leadership skills. Nonetheless, the researcher took special care while conducting the research to avoid such biases affecting the findings of the study. The measures taken by the researcher are:

1. verification of data by presenting the results of the research to interviewees for authentication
2. use of existing literature to determine whether the literature supported or did not support the findings of the research.

3.10 Summary

This chapter presented the complete research process. A discussion of various research philosophies helped to understand the basic concept of the research paradigm. This led to a description of the different research approaches, which
was followed by an elaboration of the research strategies. Finally, the research methods were discussed.

As this research methodology is exploratory in nature, it follows a phenomenological philosophy with the case study as a research strategy. Interviews and a questionnaire were used to collect data. The next two chapters discuss the findings from the survey (Chapter 4) and the case study analysis (Chapter 5) respectively.
Chapter 4: Survey Analysis

4.1 Introduction

As described in Chapter 3, the purpose of the survey was to assess the status of quality management practices in the context of Australian manufacturing SMEs. This chapter discusses the findings of the survey conducted to obtain an overview of the status of quality management initiatives taken by manufacturing SMEs in Australia. Further, the results gathered through the survey were analysed in parallel to the findings from the UK study. Hence, the survey findings have also contributed to understanding the present industrial scenario. In addition, the survey findings helped in the designing of the next phase of the study through the formulation of interview questions for the case study.

Figure 4.1 explains the sequence of events in relation to the data collection and data analysis.

![Figure 4.1: Data Collection and Analysis, Collated by the Author](image-url)
4.2 Data Analysis

As mentioned in the previous chapter, this survey replicated the study conducted in the UK, with slight modifications to suit Australian SMEs and to address the purpose of the current study. Therefore, the majority of the results are compared with the findings from the UK study. These findings were then used to design the interview questions as well as to short-list the Six Sigma practising SMEs in the Australian manufacturing sector for the case study. The details of the findings from the survey are discussed next.

4.2.1 Demographic Information of Small and Medium Enterprise Population

The questionnaires were sent to 2,485 organisations, of which only 115 organisations responded. Out of the 115 organisations, 23 were categorised as large based on the ABS definition. Thus, only a three per cent response rate was achieved as only 92 questionnaires were completed that represented SMEs according to the definition of the ABS. In a further classification of the 92 organisations, 25 firms were found to be small, while 67 organisations fulfilled the criteria of medium enterprises (see Table 4.1).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per cent</th>
<th>Valid Per cent</th>
<th>Cumulative Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–20</td>
<td>25</td>
<td>27.2</td>
<td>27.2</td>
<td>27.2</td>
</tr>
<tr>
<td>21–199</td>
<td>67</td>
<td>72.8</td>
<td>72.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>
Of the responding firms, 68 were local, three organisations were joint ventures and 21 companies were subsidiaries of multinational firms (see Table 4.2). It is important to understand the significance of this classification. As the data shows that the number of local firms (Approx. 74%) is far more than any other types of organisations, would ensure that the conclusions drawn from the survey truly represents the indigenous Australian manufacturing SMEs.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Firms</td>
<td>68</td>
<td>73.9</td>
<td>73.9</td>
<td>73.9</td>
</tr>
<tr>
<td>Joint Ventures</td>
<td>3</td>
<td>3.3</td>
<td>3.3</td>
<td>77.2</td>
</tr>
<tr>
<td>Subsidiary of Multinational</td>
<td>21</td>
<td>22.8</td>
<td>22.8</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.3 shows that these SMEs were spread all across Australia and represented diversified industrial sectors (see Table 4.4).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW</td>
<td>21</td>
<td>22.8</td>
<td>22.8</td>
<td>22.8</td>
</tr>
<tr>
<td>QLD</td>
<td>7</td>
<td>7.6</td>
<td>7.6</td>
<td>30.4</td>
</tr>
<tr>
<td>SA</td>
<td>14</td>
<td>15.2</td>
<td>15.2</td>
<td>45.7</td>
</tr>
<tr>
<td>TAS</td>
<td>1</td>
<td>1.1</td>
<td>1.1</td>
<td>46.7</td>
</tr>
<tr>
<td>VIC</td>
<td>34</td>
<td>37.0</td>
<td>37.0</td>
<td>83.7</td>
</tr>
<tr>
<td>WA</td>
<td>5</td>
<td>5.4</td>
<td>5.4</td>
<td>89.1</td>
</tr>
<tr>
<td>Multiple states</td>
<td>10</td>
<td>10.9</td>
<td>10.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>100.0</td>
<td>100.0</td>
<td>22.8</td>
</tr>
</tbody>
</table>

Among all the represented sectors, SMEs belonging to mechanical sector (Approx. 28.3%) have participated more followed by the construction industry (Approx. 11%) as compared to the rest, see Figure 4.4.
### Table 4.4: Industrial Sector

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerospace</td>
<td>2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Automotive</td>
<td>8</td>
<td>8.7</td>
<td>8.7</td>
<td>10.9</td>
</tr>
<tr>
<td>Food</td>
<td>9</td>
<td>9.8</td>
<td>9.8</td>
<td>20.7</td>
</tr>
<tr>
<td>Textiles</td>
<td>1</td>
<td>1.1</td>
<td>1.1</td>
<td>21.7</td>
</tr>
<tr>
<td>Chemical</td>
<td>3</td>
<td>3.3</td>
<td>3.3</td>
<td>25.0</td>
</tr>
<tr>
<td>Utilities</td>
<td>5</td>
<td>5.4</td>
<td>5.4</td>
<td>30.4</td>
</tr>
<tr>
<td>Telecommunications</td>
<td>1</td>
<td>1.1</td>
<td>1.1</td>
<td>31.5</td>
</tr>
<tr>
<td>Mechanical</td>
<td>26</td>
<td>28.3</td>
<td>28.3</td>
<td>59.8</td>
</tr>
<tr>
<td>Pharmaceutical &amp; Health Care</td>
<td>7</td>
<td>7.6</td>
<td>7.6</td>
<td>67.4</td>
</tr>
<tr>
<td>Plastic Industry</td>
<td>1</td>
<td>1.1</td>
<td>1.1</td>
<td>68.5</td>
</tr>
<tr>
<td>Electronics &amp; Discrete Semiconductors</td>
<td>5</td>
<td>5.4</td>
<td>5.4</td>
<td>73.9</td>
</tr>
<tr>
<td>Electrical Industry</td>
<td>2</td>
<td>2.2</td>
<td>2.2</td>
<td>76.1</td>
</tr>
<tr>
<td>Construction Industry</td>
<td>10</td>
<td>10.9</td>
<td>10.9</td>
<td>87.0</td>
</tr>
<tr>
<td>Miscellaneous Industries</td>
<td>8</td>
<td>8.7</td>
<td>8.7</td>
<td>95.7</td>
</tr>
<tr>
<td>Mining Industry</td>
<td>4</td>
<td>4.2</td>
<td>4.2</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

### 4.2.2 Status of Quality Management Implementation

The findings showed that the majority of the enterprises had a financial turnover of $1–10 million (see Table 4.5). Further, around 90% of the SMEs have the annual financial turnover up to $50 million. These results point towards the need to implement the advanced quality management methodologies such as Six Sigma, that could result in enhancing the profit margins, as explained in the literature extensively (Kumar et al. 2008; Lee, Wong & Yeung 2011).

### Table 4.5: Annual Financial Turnover

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 1 million</td>
<td>6</td>
<td>6.5</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td>1–10 million</td>
<td>40</td>
<td>43.5</td>
<td>43.5</td>
<td>50.0</td>
</tr>
<tr>
<td>10–20 million</td>
<td>20</td>
<td>21.7</td>
<td>21.7</td>
<td>71.7</td>
</tr>
<tr>
<td>20–30 million</td>
<td>10</td>
<td>10.9</td>
<td>10.9</td>
<td>82.6</td>
</tr>
<tr>
<td>30–50 million</td>
<td>7</td>
<td>7.6</td>
<td>7.6</td>
<td>90.2</td>
</tr>
<tr>
<td>Over 50 million</td>
<td>9</td>
<td>9.8</td>
<td>9.8</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>
Further, the findings revealed that top management was significantly involved in quality matters, as more than half of the respondents were a CEO/director/general manager (GM), departmental head or quality manager. SMEs are becoming quality conscious and are appointing designated qualified quality managers to look after matters related to quality as depicted in the results that showed quality managers listed as the second most common position in the respondent category list (see Table 4.6).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEO/Director/GM</td>
<td>53</td>
<td>57.6</td>
<td>57.6</td>
<td>57.6</td>
</tr>
<tr>
<td>Departmental Head</td>
<td>11</td>
<td>12.0</td>
<td>12.0</td>
<td>69.6</td>
</tr>
<tr>
<td>Quality Manager</td>
<td>16</td>
<td>17.4</td>
<td>17.4</td>
<td>87.0</td>
</tr>
<tr>
<td>Others</td>
<td>12</td>
<td>13.0</td>
<td>13.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>100.0</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6: Current Position of the Respondents

Table 4.7 shows that more than half of the SMEs had problem-solving teams to conduct review meetings, either once a week or only when the problem occurred in the business processes.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Few Times/Week</td>
<td>6</td>
<td>6.5</td>
<td>11.3</td>
<td>11.3</td>
</tr>
<tr>
<td>Once a Week</td>
<td>12</td>
<td>13.0</td>
<td>22.6</td>
<td>34.0</td>
</tr>
<tr>
<td>Once/2 Weeks</td>
<td>6</td>
<td>6.5</td>
<td>11.3</td>
<td>45.3</td>
</tr>
<tr>
<td>Problem Occurs</td>
<td>19</td>
<td>20.7</td>
<td>35.8</td>
<td>81.1</td>
</tr>
<tr>
<td>Others</td>
<td>10</td>
<td>10.9</td>
<td>18.9</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>53</td>
<td>57.6</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Missing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Applicable</td>
<td>39</td>
<td>42.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>100.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.7: Review Meetings
Analysis of the data on the existence of a quality department highlights that 19 SMEs did not have a quality department (see Table 4.8). Further details show that 12 out of the 25 small firms (see Table 4.9) and seven out of the 67 medium enterprises did not have a quality department (see Table 4.10). When compared with the findings in the UK SMEs, almost similar results were observed in small firms, whereas the situation in medium organisations in Australia is much more encouraging in comparison with medium-sized companies in the UK. Due to the limited number of staff in small firms, usually a person performs multiple tasks (Kumar & Antony 2008; Thomas & Webb 2003; Yusof & Aspinwall 2000), whereas in medium-sized enterprises the organisational structures are much clearer (Kumar & Antony 2008).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>19</td>
<td>20.7</td>
<td>20.7</td>
<td>20.7</td>
</tr>
<tr>
<td>Yes</td>
<td>73</td>
<td>79.3</td>
<td>79.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>92</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>12</td>
<td>48.0</td>
<td>48.0</td>
<td>48.0</td>
</tr>
<tr>
<td>Yes</td>
<td>13</td>
<td>52.0</td>
<td>52.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>7</td>
<td>10.4</td>
<td>10.4</td>
<td>10.4</td>
</tr>
<tr>
<td>Yes</td>
<td>60</td>
<td>89.6</td>
<td>89.6</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>67</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
According to the results, it is indeed surprising that approximately 21% of the SMEs had no quality department. One assumption could be that the level of education regarding quality is much high and everyone in these SMEs is involved in quality related affairs for their own tasks. If this is the case then future research should be designed to explore the facts regarding best practices and should be highlighted through case studies that how they achieved such level of quality competencies in their employees. Contrary to the above, the other alarming aspect could be that due to any reason, these SMEs are not serious about quality management or quality related activities. What are the reasons that impediments an SME to have a quality department, is a point to further investigate and should be explored in futures studies.

According to the survey results, out of 92 organisations only four were running the Six Sigma program, 15 had tried TQM, 33 had tried Lean, and 78 were involved in ISO standards (see Table 4.11). Surprisingly, the data were collected from the organisations that were all ISO 9001 certified. Hence, it was expected that all 92 organisations would mention the implementation of the ISO 9001 standard. However, 14 organisations did not respond to the question. Therefore, the findings, in Table 4.11, acknowledge the response of the organisations. As in the UK, ISO standards are the methodology of choice in Australia, followed by Lean, but the trend towards implementing Six Sigma is very weak. This highlights the need to explore the reasons for not implementing Six Sigma at the SME level. In contrast to the UK situation, it is encouraging to see that the SME sector in
Australia is more progressive in adopting advanced quality management methodologies such as Lean.

<table>
<thead>
<tr>
<th>Implemented quality initiatives in your organisation:</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO Standards</td>
<td>78</td>
<td>84.78</td>
</tr>
<tr>
<td>Lean</td>
<td>33</td>
<td>35.87</td>
</tr>
<tr>
<td>TQM</td>
<td>15</td>
<td>16.30</td>
</tr>
<tr>
<td>Kaizen</td>
<td>6</td>
<td>6.52</td>
</tr>
<tr>
<td>Six Sigma</td>
<td>4</td>
<td>4.35</td>
</tr>
<tr>
<td>TOC</td>
<td>4</td>
<td>4.35</td>
</tr>
<tr>
<td>BPR</td>
<td>2</td>
<td>2.17</td>
</tr>
<tr>
<td>Iip</td>
<td>1</td>
<td>1.09</td>
</tr>
</tbody>
</table>

Further, as almost all organisations have implemented ISO standards prior to adopting any advanced quality management methodology, this verifies that ISO standards facilitate a basic understanding of quality management, and encourage firms to follow a path of continual improvement and implement advanced quality management methodologies (Kumar & Antony 2008). Pfeifer, Reissiger and Canales (2004) also highlighted the significance of ISO standards in supporting organisations in implementing advanced quality management methodologies such as Six Sigma.

### 4.2.3 Company Strategic Objectives

In order to determine the significant factors that defined the company’s strategic objectives, the respondents were asked to pick three main factors from the list of six that they thought were important. Frequency analysis shows that 76 organisations out of 92 chose ‘quality’ as part of their strategic objectives followed by ‘profitability’ (70) and then ‘innovation’ (38), which is the last in the
top three among a number of various factors that defined the company’s strategic objectives (Table 4.12).

Table 4.12: Select Top Three Critical Factors that Define Company's Strategic Objectives

<table>
<thead>
<tr>
<th>Select top three critical factors that define company’s strategic objectives:</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>76</td>
<td>82.61</td>
</tr>
<tr>
<td>Profitability</td>
<td>70</td>
<td>76.09</td>
</tr>
<tr>
<td>Innovation</td>
<td>38</td>
<td>41.30</td>
</tr>
<tr>
<td>Flexibility</td>
<td>32</td>
<td>34.78</td>
</tr>
<tr>
<td>Cost</td>
<td>28</td>
<td>30.43</td>
</tr>
<tr>
<td>Market Share</td>
<td>27</td>
<td>29.35</td>
</tr>
</tbody>
</table>

These results are different from what was found in the UK, where respondents selected ‘profitability’, ‘quality’ and ‘cost’ respectively, as being the most critical factors that defined the company’s strategic objectives. Although the commonality of ‘quality’ and ‘profitability’ in both countries exists, giving ‘quality’ preference over ‘profitability’ and considering ‘innovation’ more important than ‘cost’ highlights the quality consciousness and progressiveness of the Australian manufacturing sector. However, in spite of all these results, the problem remains that, overall, Australian manufacturing SMEs follow the global trend and are somewhat hesitant to adopt advanced quality management methodologies.

4.2.4 Customer-Focused Measures

Customer focus is the number one quality management principle (ISO 2000a), and without its inclusion, quality management discussion is incomplete. Accordingly,
respondents were asked to highlight avenues used by them to focus on customers and to capture their feedback. They were given a list of options from which to select and they had the option to include any other method that was not mentioned in the provided list.

The results show that 89 per cent of the organisations measured customer satisfaction. The remaining 11 per cent of the respondent organisations did not measure customer satisfaction, which raises questions regarding the validity of the quality management systems implemented in these organisations. Of the 89 per cent of organisations that measured customer satisfaction, the majority (65.2 per cent) used ‘customer complaints’, followed by ‘survey’ (51.1 per cent) and ‘delivery time’ (40.2 per cent), as a means of measuring customer satisfaction (see Table 4.13).

<table>
<thead>
<tr>
<th>How does your company measure customer satisfaction?</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Complaints</td>
<td>60</td>
<td>65.2</td>
</tr>
<tr>
<td>Survey</td>
<td>47</td>
<td>51.1</td>
</tr>
<tr>
<td>Delivery Time</td>
<td>37</td>
<td>40.2</td>
</tr>
<tr>
<td>Repeat Business</td>
<td>30</td>
<td>32.6</td>
</tr>
<tr>
<td>Sales Data</td>
<td>26</td>
<td>28.3</td>
</tr>
<tr>
<td>Others</td>
<td>10</td>
<td>10.9</td>
</tr>
</tbody>
</table>

These results are similar to the findings in the UK. They indicate that most of the organisations relied on ‘customer complaints’ as a way to receive feedback. ‘Customer complaint’ is a reactive approach and usually it is initiated by customers. It means that the communication channel is established only when
there is an error in the transaction between the two parties. In contrast, the ‘survey’ is always proactive in nature and helps organisations to keep in touch with their customers, and seeks their assistance, suggestions and support for better quality products. This can lead to the creation of customer loyalty to the product and, ultimately, to the organisation.

Further, to evaluate the intention of SMEs regarding focusing on their customers, the SMEs were asked to highlight the three most important criteria from a list of seven that helped them to win customer loyalty. They rated ‘manufacturing quality’ (81.5 per cent) most highly, followed equally by ‘product reliability’ and ‘on-time delivery time’ (50 per cent) (see Table 4.14).

<table>
<thead>
<tr>
<th>Select top three important criteria that helped to win customer loyalty:</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing Quality</td>
<td>75</td>
<td>81.5</td>
</tr>
<tr>
<td>Product Reliability</td>
<td>46</td>
<td>50.0</td>
</tr>
<tr>
<td>On-Time Delivery</td>
<td>46</td>
<td>50.0</td>
</tr>
<tr>
<td>Delivery Lead Time</td>
<td>37</td>
<td>40.2</td>
</tr>
<tr>
<td>Price</td>
<td>36</td>
<td>39.1</td>
</tr>
<tr>
<td>Wide Product Range</td>
<td>15</td>
<td>16.3</td>
</tr>
<tr>
<td>Others</td>
<td>13</td>
<td>14.1</td>
</tr>
</tbody>
</table>

**4.2.5 Methods of Knowledge Transfer**

Similarly to the UK results, it was found that Australian SMEs relied heavily on in-house ‘training’ programs on QI methods, tools and techniques. This is a cost-effective way of imparting knowledge transfer within organisations. ‘Self-education’ is rated as the second most adopted way of knowledge transfer (see
Table 4.15). While self-education is proactive, it is often unplanned and can sometimes result in creating conceptual confusion with respect to various quality initiatives. The area of knowledge transfer is quite contemporary (Howard 2005) and more research is required on the various knowledge transfer techniques.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training in company</td>
<td>75</td>
<td>81.52</td>
</tr>
<tr>
<td>Self-education</td>
<td>34</td>
<td>36.96</td>
</tr>
<tr>
<td>Consultant</td>
<td>25</td>
<td>27.17</td>
</tr>
<tr>
<td>Conferences</td>
<td>19</td>
<td>20.65</td>
</tr>
<tr>
<td>Internet</td>
<td>12</td>
<td>13.04</td>
</tr>
<tr>
<td>Books/Research articles</td>
<td>12</td>
<td>13.04</td>
</tr>
<tr>
<td>Other</td>
<td>11</td>
<td>11.96</td>
</tr>
</tbody>
</table>

The industrial cluster development methodology introduced by UNIDO works on the same principles of achieving synergetic results through knowledge and resource sharing among participating SMEs.

4.2.6 Reasons for Not Implementing Six Sigma in SMEs

In order to assess the SMEs’ perception of Six Sigma, they were explicitly asked the reasons for not implementing Six Sigma. The question was exploratory and the responses were descriptive in nature. However, the responses were then categorised and simple descriptive analysis was carried out, as shown in Table 4.16.

Most of the Australian SMEs highlighted their concerns over the existing ‘conceptual confusion’ and its potential ‘relevance’ to them and included
statements such as ‘No statistical benefit at this stage, organisation not mature enough’. The other reason highlighted by the SMEs was ‘lack of knowledge’ and a state of ‘unawareness’ towards Six Sigma, and they expressed concerns such as ‘Not enough information known about Six Sigma’ and ‘Never heard of it’. ‘Lack of resources’ was categorised as another reason for not implementing Six Sigma, as illustrated in Figure 4.2.

Figure 4.2: Reasons Why Australian Manufacturing SMEs are Reluctant to Implement Six Sigma Methodology

A summary of the results is shown in Table 4.16.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Frequency</th>
<th>Per Cent</th>
<th>Valid Per Cent</th>
<th>Cumulative Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Valid</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conceptual Confusion &amp; Irrelevance</td>
<td>26</td>
<td>28.26</td>
<td>42.62</td>
<td>42.62</td>
</tr>
<tr>
<td>Lack of Knowledge &amp; Unawareness</td>
<td>19</td>
<td>20.65</td>
<td>31.15</td>
<td>73.77</td>
</tr>
<tr>
<td>Lack of resources</td>
<td>9</td>
<td>9.78</td>
<td>14.75</td>
<td>88.52</td>
</tr>
<tr>
<td>Others</td>
<td>7</td>
<td>7.61</td>
<td>11.48</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>61</td>
<td>66.30</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td><strong>Missing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Applicable</td>
<td>31</td>
<td>33.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>92</td>
<td>100.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
However, the literature cites the most common reasons for not implementing advanced quality management methodologies such as Six Sigma in the UK as ‘availability of resources’, ‘absence of top management commitment’ and ‘status quo’ regarding ISO standards (Antony, Kumar & Labib 2008; Antony, Kumar & Madu 2005; Kumar & Antony 2008; Kumar, Antony & Douglas 2009). Therefore, this study has further contributed to the identification of the inhibitory factors related to Six Sigma implementation, especially from the perspective of Australian manufacturing SMEs.

### 4.2.7 Critical Success Factors for Implementation

CSFs are very important for the viability of any business, as failure to address CSFs could result in the failure of the business. To evaluate the understanding of CSFs to the organisation and its implementation status in the firm, the respondents were asked to rate the importance to them of CSF on a five-point Likert scale, with 1 referring to ‘not important’ and 5 as ‘very important’. To assess the implementation status of the CSFs, 1 corresponds to ‘not implemented’ and 5 to ‘fully implemented’.

The results show that ‘leadership’, ‘communication’, and ‘education and training’ are rated the top three CSFs on a five-point Likert scale respectively. However, when their implementation levels are assessed, the results indicate a gap between the importance given to the CSFs and their actual implementation level in the organisation. To assess the statistical significance of the difference between the mean values of importance and the practice, a t-test was performed. The result
shows that the gap between the mean values of importance and practice is statistically significant. This highlights the situation of SMEs in implementing important CSFs in their organisations. This indicates that, even though the respondents acknowledged the importance of CSFs for any quality initiative, in practice, there is a gap. There could be many reasons for this gap, but the smaller the gap is the more efficient the firm would be (see Table 4.17).

<table>
<thead>
<tr>
<th>Critical Success Factors</th>
<th>Importance (MEAN)</th>
<th>Practice (MEAN)</th>
<th>GAP</th>
<th>Sig.* Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>4.64</td>
<td>3.87</td>
<td>0.77</td>
<td>.000</td>
</tr>
<tr>
<td>Organisational Infrastructure</td>
<td>4.20</td>
<td>3.63</td>
<td>0.57</td>
<td>.000</td>
</tr>
<tr>
<td>Cultural Change</td>
<td>4.10</td>
<td>3.28</td>
<td>0.82</td>
<td>.000</td>
</tr>
<tr>
<td>Education and Training</td>
<td>4.27</td>
<td>3.50</td>
<td>0.77</td>
<td>.000</td>
</tr>
<tr>
<td>Fact Based Decision Making</td>
<td>4.26</td>
<td>3.53</td>
<td>0.73</td>
<td>.000</td>
</tr>
<tr>
<td>Linking Quality Improvement (QI Initiative to Customers)</td>
<td>4.16</td>
<td>3.34</td>
<td>0.82</td>
<td>.000</td>
</tr>
<tr>
<td>Linking QI Initiative to Business Strategy</td>
<td>4.02</td>
<td>3.32</td>
<td>0.7</td>
<td>.000</td>
</tr>
<tr>
<td>Linking QI Initiative to Employees</td>
<td>4.24</td>
<td>3.44</td>
<td>0.8</td>
<td>.000</td>
</tr>
<tr>
<td>Linking QI Initiative to Suppliers</td>
<td>3.98</td>
<td>2.98</td>
<td>1</td>
<td>.000</td>
</tr>
<tr>
<td>Communication</td>
<td>4.44</td>
<td>3.68</td>
<td>0.76</td>
<td>.000</td>
</tr>
<tr>
<td>Project Management Skills</td>
<td>4.07</td>
<td>3.20</td>
<td>0.87</td>
<td>.000</td>
</tr>
<tr>
<td>Project Prioritisation and Selection</td>
<td>3.97</td>
<td>3.26</td>
<td>0.71</td>
<td>.000</td>
</tr>
<tr>
<td>Usage of Innovative Techniques and IT Systems</td>
<td>3.77</td>
<td>3.23</td>
<td>0.54</td>
<td>.000</td>
</tr>
<tr>
<td>Networking with Government and Academia</td>
<td>2.96</td>
<td>2.60</td>
<td>0.36</td>
<td>.006</td>
</tr>
</tbody>
</table>

Note: ‘Test performed at 5 per cent significance level

Recently, Suresh et al. (2012, p. 240) highlighted the importance of leadership in the context of Six Sigma and pointed out that the literature is almost silent: ‘there is almost a complete absence to explain how and what leadership characteristics are needed for successful implementation of Six Sigma initiatives’. Therefore, more research is needed to explain the role of leadership required for the successful implementation of Six Sigma initiatives.
4.2.8 Benefits of Implementation of Quality Improvement Programs

To assess the effect of implementing quality management programs, the respondents were given a list of various benefits. This list of benefits was extracted from the literature (Aboelmaged 2010; Andersson, Eriksson & Torstensson 2006; Antony 2002; Bendell 2006; Kwak & Anbari 2006). The respondents were asked to rate various benefits on a five-point Likert scale. The scale was defined in such a way that the 1 represents ‘negative improvement’; 2 is ‘no benefits’; 3 is ‘some benefits’; 4 is ‘significant benefits’; and 5 corresponds to ‘crucial’. The respondents were also offered the option of stating they were not currently using any particular measure, which was represented by ‘0’ in the data, as shown in Table 4.18.
Table 4.18: Benefits (Complete Data Summary)

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Statistics</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not Used (0)</td>
<td>Negative Benefits (1)</td>
</tr>
<tr>
<td>Reduction of Scrap Rate</td>
<td>Frequency</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>21.74</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>22.99</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>22.99</td>
</tr>
<tr>
<td>Reduction of Cycle Time</td>
<td>Frequency</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>26.09</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>27.91</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>27.91</td>
</tr>
<tr>
<td>Reduction of Delivery Time</td>
<td>Frequency</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>9.78</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>10.47</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>10.47</td>
</tr>
<tr>
<td>Reduction of Defects</td>
<td>Frequency</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>4.35</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>4.71</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>4.71</td>
</tr>
<tr>
<td>Reduced Work in Progress</td>
<td>Frequency</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>16.30</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>17.44</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>17.44</td>
</tr>
<tr>
<td>Increase in Productivity</td>
<td>Frequency</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>7.61</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>8.14</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>8.14</td>
</tr>
<tr>
<td>Benefits</td>
<td>Statistics</td>
<td>Parameters</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td><strong>Reduction of Production Costs</strong></td>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td></td>
</tr>
<tr>
<td><strong>Increase in Profitability</strong></td>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td></td>
</tr>
<tr>
<td><strong>Improved Sales</strong></td>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td></td>
</tr>
<tr>
<td><strong>Increase in Customer Retention/Loyalty &amp; Satisfaction</strong></td>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td></td>
</tr>
<tr>
<td><strong>Increase in Employee Satisfaction and Level of Commitment</strong></td>
<td>Frequency</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td></td>
</tr>
</tbody>
</table>
Simple descriptive analysis suggested that, overall, the respondents were confused about the benefits achieved or perhaps the organisations were not achieving the full benefits after taking QI initiatives. The maximum mean value attained was 3.85 for the benefit ‘reduction of defects’ followed by ‘increase in profitability’ and ‘increase in productivity’ respectively. The details of the mean values along with standard deviation statistics are mentioned in Table 4.19. Table 4.19 highlights that the higher values of standard deviation point towards dispersion in the responses. Apart from the list of benefits provided to the respondents, they had the opportunity to mention benefits of their choice. Increased customer base, improved discipline, structured problem solving and improved chances for business expansion were a few improvement aspects reported by the respondents.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>N</th>
<th>MEAN</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction of Scrap Rate</td>
<td>87</td>
<td>2.77</td>
<td>1.682</td>
</tr>
<tr>
<td>Reduction of Cycle Time</td>
<td>86</td>
<td>2.60</td>
<td>1.784</td>
</tr>
<tr>
<td>Reduction of Delivery Time</td>
<td>86</td>
<td>3.38</td>
<td>1.399</td>
</tr>
<tr>
<td>Reduction of Defects</td>
<td>85</td>
<td>3.85</td>
<td>1.190</td>
</tr>
<tr>
<td>Reduced Work in Progress</td>
<td>86</td>
<td>2.76</td>
<td>1.533</td>
</tr>
<tr>
<td>Increase in Productivity</td>
<td>86</td>
<td>3.58</td>
<td>1.288</td>
</tr>
<tr>
<td>Reduction of Production Costs</td>
<td>86</td>
<td>3.42</td>
<td>1.269</td>
</tr>
<tr>
<td>Increase in Profitability</td>
<td>86</td>
<td>3.66</td>
<td>1.154</td>
</tr>
<tr>
<td>Improved Sales</td>
<td>84</td>
<td>3.26</td>
<td>1.110</td>
</tr>
<tr>
<td>Increase in Customer Retention/Loyalty &amp; Satisfaction</td>
<td>86</td>
<td>3.45</td>
<td>1.280</td>
</tr>
<tr>
<td>Increase in Employee Satisfaction and Level of Commitment</td>
<td>85</td>
<td>3.42</td>
<td>1.138</td>
</tr>
</tbody>
</table>

### 4.2.9 Impeding Factors in Implementation of Quality Improvement Initiatives in Small and Medium Enterprises

Respondents were asked to rate the top five critical issues they faced while implementing QI initiatives. They were asked to select at least five critical issues
out of 13 and rate them according to the level of criticality, ranging from the lowest level of criticality to the highest level of most critical. Table 4.20 shows the complete picture of the responses. Due to the diverse nature of the responses, it was difficult to conclude which factor was considered the most critical impeding factor. To calculate the responses holistically, all the responses were assigned priority numbers. The most critical factor was multiplied by five, the next by four, then three, two and finally the least by one, as shown in Table 4.21. After multiplying with the assigned numbers, the mean was calculated and the factor with the greatest mean value was rated as the top impeding factor.

The analysis found that most respondents rated ‘availability of resources’ as the topmost impeding factor followed by ‘lack of knowledge’ and then ‘lack of top management commitment’. The analysis showed ‘lack of training’ was the fourth and ‘poor employee participation’, ‘internal resistance’ and ‘ineffective communication’ were rated fifth among various impeding factors. This result partially corresponds to that of the findings in the UK in that lack of resources was identified in both surveys as one of the most important inhibitory factors for SMEs. However, this survey’s findings contradict the findings of the UK study that ‘lack of top management commitment’ was not rated in the top five (Kumar & Antony 2008), as had been previously determined by other researchers (Antony, Kumar & Labib 2008; Antony, Kumar & Madu 2005; Kumar 2007). Further, Kumar and Antony (2008) did not declare any reason for the impeding factor of ‘lack of top management commitment’ not being rated among the top five.
<table>
<thead>
<tr>
<th>Critical Issues</th>
<th>Statistics</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Response</td>
<td>Most Critical (1)</td>
</tr>
<tr>
<td>Lack of Top Management Commitment</td>
<td>Frequency</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>59.78</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>65.48</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>65.48</td>
</tr>
<tr>
<td>Lack of Knowledge</td>
<td>Frequency</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>48.91</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>53.57</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>53.57</td>
</tr>
<tr>
<td>Poor Supplier Involvement</td>
<td>Frequency</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>69.57</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>76.19</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>76.19</td>
</tr>
<tr>
<td>Poor Employee Participation</td>
<td>Frequency</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>58.70</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>64.29</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>64.29</td>
</tr>
<tr>
<td>Poor Delegation of Authority</td>
<td>Frequency</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>61.96</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
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</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>67.86</td>
</tr>
<tr>
<td>Lack of Training</td>
<td>Frequency</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>43.48</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
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</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>47.62</td>
</tr>
<tr>
<td>Inadequate Process Control Techniques</td>
<td>Frequency</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>59.78</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>65.48</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>65.48</td>
</tr>
<tr>
<td>Critical Issues</td>
<td>Statistics</td>
<td>Parameters</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td></td>
<td>Response</td>
<td>Most Critical (1)</td>
</tr>
<tr>
<td>Availability of Resources</td>
<td>Frequency</td>
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<tr>
<td></td>
<td>Per Cent</td>
<td>36.96</td>
</tr>
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<td>Valid Per Cent</td>
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</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>40.48</td>
</tr>
<tr>
<td>Changing Business Focus</td>
<td>Frequency</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>64.13</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
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</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>70.24</td>
</tr>
<tr>
<td>Internal Resistance</td>
<td>Frequency</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>51.09</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
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</tr>
<tr>
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<td>55.95</td>
</tr>
<tr>
<td>Poor Project Selection</td>
<td>Frequency</td>
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</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>82.61</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
<td>90.48</td>
</tr>
<tr>
<td></td>
<td>Cumulative Per Cent</td>
<td>90.48</td>
</tr>
<tr>
<td>Lack of Performance Measurement &amp; QMS</td>
<td>Frequency</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>66.30</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
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<td></td>
<td>Cumulative Per Cent</td>
<td>72.62</td>
</tr>
<tr>
<td>Ineffective Communication</td>
<td>Frequency</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Per Cent</td>
<td>47.83</td>
</tr>
<tr>
<td></td>
<td>Valid Per Cent</td>
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</tr>
<tr>
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<td>Cumulative Per Cent</td>
<td>52.38</td>
</tr>
</tbody>
</table>
Table 4.21: Final Summary of the Impeding Factors in Implementation of QI Initiatives in SMEs

<table>
<thead>
<tr>
<th>Critical Issues</th>
<th>Multiplying Critical Rating Index with Assigned Weights</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Most Critical 1 X 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 X 4</td>
<td>3 X 3</td>
</tr>
<tr>
<td>Availability of Resources</td>
<td>85</td>
<td>40</td>
</tr>
<tr>
<td>Lack of Knowledge</td>
<td>70</td>
<td>68</td>
</tr>
<tr>
<td>Lack of Top Management Commitment</td>
<td>105</td>
<td>4</td>
</tr>
<tr>
<td>Lack of Training</td>
<td>25</td>
<td>44</td>
</tr>
<tr>
<td>Poor Employee Participation</td>
<td>25</td>
<td>32</td>
</tr>
<tr>
<td>Internal Resistance</td>
<td>25</td>
<td>24</td>
</tr>
<tr>
<td>Ineffective Communication</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Inadequate Process Control Techniques</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Changing Business Focus</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td>Poor Delegation of Authority</td>
<td>10</td>
<td>24</td>
</tr>
<tr>
<td>Poor Supplier Involvement</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Lack of Performance Measurement &amp; QMS</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Poor Project Selection</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

These results further contribute and suggest that before formulating the strategy to implement any quality improvement initiative in Australian manufacturing SMEs, these identified impediments should be properly addressed by the decision making authority.

4.2.10 Status of Six Sigma Implementing SMEs

The questionnaire results identified only four SMEs that were currently practising Six Sigma methodology. Out of these four firms, three firms had over $50 million of annual financial turnover; and three of the organisations had implemented ISO standards. Although these SMEs claimed that they were Six Sigma practising
organisations, the results point out that, out of four, three of them are working on less than three sigma and only one firm is operating on four–five sigma. These SMEs were not following the Six Sigma classical implementation team hierarchy and two of the companies had no Champions. The results show that one of the organisations was running its entire Six Sigma program on Green Belts only, without the existence of any member from the senior hierarchy of the Six Sigma belt system, that is, Champions, Master Black Belts and Black Belts.

To measure the performance of their processes, out of seven metrics, cost of poor quality, defect rate and process capability are commonly used by all SMEs. These SMEs were experienced practitioners, as all of them had completed at least five Six Sigma projects, while two of them reported having completed more than 20. Two of the SMEs mentioned that they had gained financial benefits after successful execution of Six Sigma projects that ranged from $250,000 to $1 million per annum.

For the purpose of the current study, we identified a manufacturing SME that had been practising Six Sigma for the previous six years and was not receiving any assistance from any consultant. This had resulted in further reducing consultancy costs, which can be a significant cost contributor. The next phase of this research consists of an in-depth case study to explore how this SME had implemented the Six Sigma methodology, and what the motivation was behind this successful endeavour. Details related to the case study analysis are discussed in Chapter 5.
4.2.11 Status of Lean Implementing Small and Medium Enterprises

The analysis shows that 33 (35.87 per cent) of SMEs were practising Lean, which is encouraging especially when compared with the findings of the UK study that only 17 (26 per cent) of firms were doing so. The majority of the SMEs were local firms with few representing joint ventures. These organisations were spread all over Australia and belonged to a wide manufacturing sector. Most of them had established quality departments and all of them, except one, measured the satisfaction level of their customers. Three out of four Six Sigma exercising SMEs were also using Lean to control their internal wastes. The majority of the Lean practising SMEs received formal training, and they thought that their internal organisational cultures supported Lean. These organisations identified ‘producing defects’ as the top-most waste, followed by ‘poor inventory management’ and ‘un-necessary waiting periods’ (see Table 4.22).

Table 4.22: Top Three Wastes Important for the Company

<table>
<thead>
<tr>
<th>Measure Type</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producing Defects</td>
<td>28</td>
<td>84.8</td>
</tr>
<tr>
<td>Inventory</td>
<td>18</td>
<td>54.5</td>
</tr>
<tr>
<td>Waiting</td>
<td>16</td>
<td>48.5</td>
</tr>
<tr>
<td>Over production</td>
<td>15</td>
<td>45.5</td>
</tr>
<tr>
<td>Over processing</td>
<td>9</td>
<td>27.3</td>
</tr>
<tr>
<td>Motion</td>
<td>6</td>
<td>18.2</td>
</tr>
<tr>
<td>Transport</td>
<td>4</td>
<td>12.1</td>
</tr>
</tbody>
</table>

These SMEs highlighted various benefits after embracing Lean, such as ‘financial savings’, ‘reduced lead time’, ‘reduced inventory’, ‘increased process understanding’, ‘better understanding of customer needs’, ‘less process waste and less rework’ (see Table 4.23).
<table>
<thead>
<tr>
<th>Measure Type</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Savings</td>
<td>29</td>
<td>87.9</td>
</tr>
<tr>
<td>Reduced Inventory</td>
<td>28</td>
<td>84.8</td>
</tr>
<tr>
<td>Less Process Waste</td>
<td>28</td>
<td>84.8</td>
</tr>
<tr>
<td>Increased Product Understanding</td>
<td>27</td>
<td>81.8</td>
</tr>
<tr>
<td>Reduced Lead Time</td>
<td>25</td>
<td>75.8</td>
</tr>
<tr>
<td>Less Rework</td>
<td>24</td>
<td>72.7</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
<td>12.1</td>
</tr>
</tbody>
</table>

When asked if they had ever tried to merge Lean with Six Sigma, only two out of 33 SMEs answered affirmatively. Only three SMEs thought that Lean should be implemented first and then Six Sigma, whereas three SMEs suggested that both should be implemented simultaneously. However, the majority of the responding organisations did not answer the question, which could be because the respondents were confused regarding the proper implementation sequence of Lean and Six Sigma practices or they lacked strategic quality planning.

4.3 Comparing Six Sigma (Large Organisations Versus Small and Medium Enterprises)

As mentioned in Chapter 3, the data exclusive to SMEs in Australia were unavailable; therefore, a question was introduced in the questionnaire designed for Australia, asking the number of employees working in the organisation. As a result, in addition to four SMEs, five large organisations had responded affirmatively to having implemented the Six Sigma methodology. Although the scope of the current study is confined to SMEs, it is timely to compare the status of the quality management practices of SMEs and those of large Australian manufacturing organisations. It is important to note that the term ‘organisation’ when used in the following sections represents both SMEs and large companies.
4.3.1 General Information of Six Sigma Practising Organisations

Out of nine Six Sigma practising organisations, seven were subsidiaries of multinational groups and the remaining two organisations were local firms. These organisations were spread nationally over Australia. One organisation was operating in multiple states whereas two were in Victoria, three belonged to New South Wales and the remaining were in Tasmania. These organisations represented diverse industrial sectors: three were from the pharmaceutical sector, two belonged to the mechanical sector, another two belonged to the mining sector and one each belonged to the automotive and defence industries.

Apart from one organisation, all of them had an annual financial turnover of over $50 million. Almost all the respondents were either quality managers or Six Sigma certified professionals with experience of up to 10 years. One organisation did not have a quality department.

All organisations measured customer satisfaction, and details of the method used are shown in Table 4.24. A customer complaint was the most frequent method used to measure customer satisfaction, although the respondents in this question were given the choice of selecting as many options as they thought were relevant to their organisation.
Table 4.24: How Does the Company Measure Customer Satisfaction?

<table>
<thead>
<tr>
<th>Measure Type</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Complaints</td>
<td>6</td>
<td>66.7</td>
</tr>
<tr>
<td>Surveys</td>
<td>5</td>
<td>55.6</td>
</tr>
<tr>
<td>Delivery Times</td>
<td>4</td>
<td>44.4</td>
</tr>
<tr>
<td>Sales Data</td>
<td>2</td>
<td>22.2</td>
</tr>
<tr>
<td>Repeat Business</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>33.9</td>
</tr>
</tbody>
</table>

Data analysis shows that all nine organisations used ‘training’ as the most favourable way of knowledge transfer with respect to QI methods. Details of the remaining methods are given in Table 4.25. As with the previous question, the respondents had the option of selecting the maximum number of possibilities applicable to them.

Table 4.25: How Does the Company Impart Knowledge on Quality Improvement Methods?

<table>
<thead>
<tr>
<th>Measure Type</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training in Company</td>
<td>9</td>
<td>100.0</td>
</tr>
<tr>
<td>Books/Research Articles</td>
<td>4</td>
<td>44.4</td>
</tr>
<tr>
<td>Conferences</td>
<td>3</td>
<td>33.3</td>
</tr>
<tr>
<td>Consultants</td>
<td>3</td>
<td>33.3</td>
</tr>
<tr>
<td>Internet</td>
<td>3</td>
<td>33.3</td>
</tr>
<tr>
<td>Self-Education</td>
<td>3</td>
<td>33.3</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
<td>44.4</td>
</tr>
</tbody>
</table>

Respondents rated the top three critical factors that defined the company’s strategic objectives, starting from ‘quality’ and ‘profitability’ at the top, followed by ‘cost’.
Similarly, these organisations considered ‘manufacturing quality’ topmost, followed by ‘on-time delivery’ and then ‘product reliability’ as the top three most important criteria for win customer loyalty (see Table 4.26).

<table>
<thead>
<tr>
<th>Measure Type</th>
<th>Frequency</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing Quality</td>
<td>7</td>
<td>77.8</td>
</tr>
<tr>
<td>On-Time Delivery</td>
<td>6</td>
<td>66.7</td>
</tr>
<tr>
<td>Product Reliability</td>
<td>5</td>
<td>55.5</td>
</tr>
<tr>
<td>Price</td>
<td>3</td>
<td>33.3</td>
</tr>
<tr>
<td>Wide Product Range</td>
<td>2</td>
<td>22.2</td>
</tr>
<tr>
<td>Delivery Time</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
<td>11.1</td>
</tr>
</tbody>
</table>

Out of nine Six Sigma practising organisations, three did not disclose the duration of the Six Sigma implementation. Among the remaining organisations, two had been practising Six Sigma for previous ten years, another two for the previous six years, one for the previous nine years and one for five years. Apart from Six Sigma, four out of five organisations had the experience of implementing TQM, while all of them were involved in running Lean programs.

Five organisations did not consider ISO 9000 the foundation for implementing Six Sigma; however, one said ‘yes’ and the remaining three were not sure about it. These findings are somewhat contrary to what has been extensively recommended in the literature, that ISO 9000 could be the first step complementing Six Sigma implementation (Pfeifer, Reissiger & Canales 2004; Wessel & Burcher 2004).
4.3.2 Six Sigma Practices

The data show a high level of variability in the practices of Six Sigma in organisations. The focus of the current study was to analyse Six Sigma implementation practices—in general, and comparing the practices of SMEs to that of large organisations.

When asked about measuring the average sigma level, only five organisations were doing so. Three of these were SMEs. Further, in extension to the previous question, when asked about disclosing the average sigma level of their core processes, three of them disclosed having fewer than three sigma and another three claimed to operate at three–four sigma levels. The remaining two respondents did not know about the level and one did not respond to the question. When analysed, it was found that all four SMEs were, in fact, calculating their average sigma levels for the core processes. Hence, this represents the serious attitude of the SMEs towards Six Sigma practices. Further, as discussed in the literature review chapter, setting performance metrics is essential for self-monitoring and assessing continuous improvement of the processes (Linderman et al. 2003; Pyzdek 2001). Accordingly, the situation in the large organisations was quite alarming. In addition to the average sigma level, the data show that the organisations frequently used ‘defect rate’ as the top performance measurement, followed by ‘cost of poor quality’, ‘first time yield’, ‘process capability’ and ‘number of complaints’.
The large organisations had well-developed Six Sigma implementation teams, but the number varied. However, in the SMEs, the reliance was more on Green Belts, although, out of four SMEs, two had Champions and three claimed to have the services of Master Black Belts and Black Belts.

When asked about the number of completed Six Sigma projects, four out of nine respondents had completed more than 20 projects, two between 10 and 20 projects, another two between five and 10 projects, and only one claimed to have completed between one and five projects.

Financial gain is considered one of the core determinants in evaluating the performance of Six Sigma implementation (Antony 2002; Yang et al. 2007). Three out of the nine organisations claimed to have gained financial benefits after the successful implementation of Six Sigma of more than one million per annum. One organisation registered financial benefits of between half a million and one million, while another three had so far harvested between $250,000 and $500,000 per year. Two of the respondents were not aware of the savings. Of the four SMEs, one recorded financial benefits of more than one million per year, another registered gains of between half a million and one million per year and the other two earned between $250,000 and $500,000 per annum. Hence, again this proves that Six Sigma has benefited SMEs.

The Six Sigma practising organisations highlighted various reasons for the failure of Six Sigma projects, including ‘time constraints’, ‘missing critical process’,
leadership’, ‘change in customer requirement’ and ‘commitment of the sponsor or process owner’.

4.3.3 Lean Practices

The data show that all Six Sigma practising organisations had also implemented Lean. Except for one organisation, they had all arranged formal training in Lean manufacturing. Except for one, all organisations affirmed the support of the organisational culture for Lean manufacturing. They reported various benefits harvested from Lean, ‘financial savings’ being the topmost, followed by ‘reduced inventory’ and ‘increased product understanding’. When asked about the top three wastes that the organisations produced, respondents replied by rating ‘defect production’ at the top, followed by ‘inventory’ and then ‘waiting’.

When asked about merging Lean with Six Sigma, seven out of nine answered affirmatively, while the remaining two had negative responses. Further, on the question of combining the two methodologies, respondents shared their observations and experiences by using phrases such as ‘a lot of tools complement each other’; ‘more pragmatic approach to maximise effectiveness’; and ‘works better’. When asked about the sequence of implementing both methodologies, five out of nine believed that both the methodologies should be implemented simultaneously; however, two recommended Lean be the first and then Six Sigma, one did not know, another organisation did not respond.
4.3.4 Critical Success Factors

Out of 14 CSFs, Six Sigma practising organisations rated the following top five in descending sequence as ‘leadership’, ‘education and training’, ‘communication’, ‘cultural change’ and ‘fact-based decision making’ (see Table 4.27).

<table>
<thead>
<tr>
<th>Critical Success Factors</th>
<th>Importance (MEAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>4.68</td>
</tr>
<tr>
<td>Education and Training</td>
<td>4.34</td>
</tr>
<tr>
<td>Communication</td>
<td>4.34</td>
</tr>
<tr>
<td>Cultural Change</td>
<td>4.28</td>
</tr>
<tr>
<td>Fact-based decision making</td>
<td>4.28</td>
</tr>
</tbody>
</table>

When the implementation level of CSFs was analysed, as shown in Table 4.28, the sequence turned out to be ‘leadership’ at the top followed by ‘linking quality initiative to customers’, ‘linking quality initiative to business strategy’ and ‘linking quality initiative to employees’, which shared the second spot, and then came ‘cultural change’ and ‘fact-based decision making’. The analysis shows that ‘leadership’ is the most important factor for the successful implementation of Six Sigma.

<table>
<thead>
<tr>
<th>Critical Success Factors</th>
<th>Implementation (MEAN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>4.11</td>
</tr>
<tr>
<td>Linking Quality Improvement (QI) Initiative to Customers</td>
<td>3.56</td>
</tr>
<tr>
<td>Linking QI Initiative to Business Strategy</td>
<td>3.56</td>
</tr>
<tr>
<td>Linking QI Initiative to Employees</td>
<td>3.56</td>
</tr>
<tr>
<td>Cultural Change</td>
<td>3.50</td>
</tr>
<tr>
<td>Fact based decision making</td>
<td>3.50</td>
</tr>
</tbody>
</table>
4.3.5 Benefits of Six Sigma Implementation

When asked about the benefits achieved as a result of Six Sigma implementation, the organisations responded by declaring ‘reduction of defects’ as the topmost followed by ‘reduction of production cost’ and then ‘increase in productivity’. Table 4.29 summarises the details of the responses. These results are almost in coherence with the findings of the overall survey results that comprise only SMEs reporting benefits as a result of implementing QI programs.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>N</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction of Scrap Rate</td>
<td>9</td>
<td>3</td>
<td>5</td>
<td>3.78</td>
<td>0.833</td>
</tr>
<tr>
<td>Reduction of Cycle Time</td>
<td>9</td>
<td>0</td>
<td>5</td>
<td>3.78</td>
<td>1.563</td>
</tr>
<tr>
<td>Reduction of Delivery Time</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>4.00</td>
<td>0.756</td>
</tr>
<tr>
<td>Reduction of Defects</td>
<td>8</td>
<td>4</td>
<td>5</td>
<td>4.38</td>
<td>0.518</td>
</tr>
<tr>
<td>Reduced Work in Progress</td>
<td>9</td>
<td>0</td>
<td>5</td>
<td>3.44</td>
<td>1.424</td>
</tr>
<tr>
<td>Increase in Productivity</td>
<td>9</td>
<td>3</td>
<td>5</td>
<td>4.22</td>
<td>0.667</td>
</tr>
<tr>
<td>Reduction of Production Costs</td>
<td>9</td>
<td>3</td>
<td>5</td>
<td>4.33</td>
<td>0.707</td>
</tr>
<tr>
<td>Increase in Profitability</td>
<td>9</td>
<td>3</td>
<td>5</td>
<td>4.11</td>
<td>0.601</td>
</tr>
<tr>
<td>Improved Sales</td>
<td>8</td>
<td>0</td>
<td>5</td>
<td>2.87</td>
<td>1.458</td>
</tr>
<tr>
<td>Increase in Customer Retention/Loyalty &amp; Satisfaction</td>
<td>8</td>
<td>0</td>
<td>4</td>
<td>3.25</td>
<td>1.389</td>
</tr>
<tr>
<td>Increase in Employee Satisfaction &amp; Level of Commitment</td>
<td>8</td>
<td>3</td>
<td>5</td>
<td>3.62</td>
<td>0.916</td>
</tr>
</tbody>
</table>

The comparison was carried out between the large Six Sigma practising organisations and the SMEs implementing Six Sigma. Table 4.30 summarises the details of the results. From the results, it is evident that SMEs are not lagging behind large organisations in achieving benefits due to Six Sigma application.
However, the point of concern is that SMEs who had not implemented Six Sigma were reporting almost the same benefits as those of the organisations using Six Sigma applications. This aspect requires further investigation and more in-depth data are required to differentiate clearly the magnitude of the benefits acquired by the organisations, with or without Six Sigma applications.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>Small &amp; Medium Enterprises</th>
<th>Large Organisations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Min</td>
</tr>
<tr>
<td>Reduction of Scrap Rate</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Reduction of Cycle Time</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Reduction of Delivery Time</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Reduction of Defects</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Reduced Work in Progress</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Increase in Productivity</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Reduction of Production Costs</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Increase in Profitability</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Improved Sales</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Increase in Customer</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Retention/Loyalty &amp; Satisfaction</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

4.4 Summary

This chapter discussed the findings from the survey conducted among Australian manufacturing organisations already certified with ISO 9001 standards. The results of this survey were analysed based on the findings from a similar study.
held in the UK. That the survey resulted from an international collaboration helped to sustain the viability and validity of the area under study.

This survey helped to understand the reasons why Australian manufacturing SMEs are reluctant to adopt Six Sigma applications, as has been shown in Figure 4.2. It was found that ‘conceptual confusion’ and state of ‘unawareness’ are two of the main reasons behind the lack of seriousness regarding Six Sigma implementation. Similarly, among various CSFs, ‘leadership’ was identified as the most important factor. Figure 4.3 highlights the salient features through further exploring the CSFs required. ‘Lack of resources’ was acknowledged as the most significant impeding factor for any QI initiative. This study also verified the performance improvement indicators as a result of implementing QI initiatives against the literature (see Figure 4.3).
These survey findings also enabled comparison between the practices of Six Sigma by large organisations and those of SMEs. This comparison assisted the conclusion that the applications of Six Sigma are the same for SMEs as they are for large organisations.

Further, to understand the processes of adoption, implementation and possible performance improvements as a result of Six Sigma endeavours, the second phase of the study was designed. A manufacturing SME involved in running a Six Sigma program was approached and an in-depth case study was conducted to understand how it had become successful in running the program. The findings are presented in the next chapter.
Chapter 5: Case Study Analysis

5.1 Introduction

This chapter introduces the second phase of the study: a case study of an Australian manufacturing SME that had implemented Six Sigma and had sustained it for the previous six years. The main objective of this chapter is to explore the fundamentals that motivated this SME to adopt Six Sigma applications. In addition, this chapter will analyse the factors involved in successful implementation of Six Sigma and the magnitude of the resulting subsequent performance enhancement. An SME-specific framework is developed to explain the various stages of Six Sigma application, using the information from the case study. It is important to highlight that the information presented in Figure 4.3 represents Australian manufacturing SMEs only.

The contribution of this chapter is twofold. First, it presents the exemplary achievement of an Australian manufacturing SME for others to use as a benchmark, and secondly, it helps us to understand the various dynamics involved in the implementation. The findings from the survey analysis (Chapter 4) and case study analysis then lead to critical discussions that result in establishing the final framework for Australian manufacturing SMEs (Chapter 6).

5.2 Research Questions

The following two research questions (RQ) were addressed to respond to the objectives of the current study:
RQ 1: What was the motivation of the top management to adopt Six Sigma and what was the mechanism involved in the adoption of Six Sigma?

RQ 2: What are the significant CSFs required for the implementation of Six Sigma in SMEs? What is their effect on Six Sigma?

5.2.1 Supporting Questions

To address the above-mentioned main research questions, semi-structured, open-ended extended questions were designed and categorised into three sections: strategic; functional and operational; and reflective.

1. Strategic

   a. What was the motivation to implement Six Sigma?

   b. How did you identify the need to adopt Six Sigma methodology in your organisation?

   c. Why did you select Six Sigma methodology from amongst other quality management methodologies?

   d. What factors did you consider before implementing Six Sigma?

   e. What strategy did you adopt to implement Six Sigma?

   f. Did you get any external assistance for implementing Six Sigma?

   g. Before initiating the Six Sigma program, what measures were taken to prepare organisation as well as the employees?

   h. How long was the transition period before launching the Six Sigma program?
2. *Functional and Operational*

a. How advantageous is the Six Sigma methodology for organisation, internal working culture and operations?

b. Did you notice any disadvantages of this methodology?

c. What were, and are, the barriers faced during its implementation?

d. What types of processes were focused initially for Six Sigma and why? How? Who selected the projects?

e. What is the overall process for conducting and implementing Six Sigma projects?

f. What is the normal size of the execution team?

g. How much performance is enhanced after implementing Six Sigma?

h. How many hours of training are required, before launching and during implementation of Six Sigma?

3. *Reflective*

a. What lessons were learned that you consider are important for others to follow?

b. What is the overall feedback of employees after implementing Six Sigma?

c. What are the benefits that the organisation considers are due to Six Sigma?
5.3 Discussion of the Interview Findings

Due to confidentiality, the name of the SME cannot be disclosed and, therefore, the organisation was coded as XYZ. Moreover SME XYZ agreed to allow an interview with the Quality Manager only, and access to other employees was not permitted.

5.3.1 General Information

The interviewee is a quality manager at organisation XYZ, and has had additional responsibilities of process improvement coordination for the previous six years. He is a certified Master Black Belt and therefore had competent authority to highlight the Six Sigma endeavour at organisation XYZ.

Organisation XYZ is a subsidiary of a multinational set-up. It was established in 1964 and is one of the many subsidiaries operating in Australia. Each subsidiary is completely autonomous in every aspect of decision making and operations. The organisation under focus is situated in the state of New South Wales, Australia. This organisation is involved in heavy mechanical works and manufactures pipes ranging from six to 20 inches. It is important to mention that the organisation follows the basic business philosophy of safety and customer first. This organisation is unique from the rest of its sister organisations due to its strong affiliation with advanced quality management initiatives such as TQM, Six Sigma and Lean. However, the main focus during the interview was on Six Sigma execution.
Table 5.1 presents a summary of the key characteristics of organisation XYZ. According to the definition of SMEs (Australian Bureau of Statistics 2001), this organisation is a medium-sized organisation with 75 full-time permanent employees along with 15 casuals. This organisation has an annual financial turnover of over AU$50 million. At the time of the study, the organisation had completed 15–20 Six Sigma projects with the estimated financial benefits of more than one million dollars annually.

Table 5.1: Company Factual Data

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company label</td>
<td>XYZ</td>
</tr>
<tr>
<td>Type of organisation</td>
<td>Subsidiary of multi-national</td>
</tr>
<tr>
<td>Business</td>
<td>Pipe manufacturing</td>
</tr>
<tr>
<td>No. of employees</td>
<td>Full time: 75</td>
</tr>
<tr>
<td></td>
<td>Part time: 15</td>
</tr>
<tr>
<td>Six Sigma experience</td>
<td>Six years</td>
</tr>
<tr>
<td>Annual financial turnover</td>
<td>Over 50 million</td>
</tr>
<tr>
<td>Six Sigma technical support team</td>
<td>Yes</td>
</tr>
<tr>
<td>Ongoing Six Sigma projects</td>
<td>Yes</td>
</tr>
<tr>
<td>Six Sigma Training</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 5.1 also highlights the existence of a Six Sigma technical support team comprising two Six Sigma Champions, a Master Black Belt and a Black Belt, and two Green Belts to support and execute Six Sigma projects. In addition, Table 5.1 highlights that organisation XYZ is currently involved in various Six Sigma projects, and the training related to Six Sigma is an ongoing aspect of the organisation. Hence, this organisation presents a classical example of the transformation of a typical manufacturing culture to a competitive, quality-
conscious culture (Antony 2004; Motwani, Kumar & Antony 2004; Schroeder et al. 2008).

Even though the quality voyage is still ongoing, it took the company a few years to actually see and enjoy the fruits of quality management. The paradigm shift in the thoughts of the employees at the shop floor can be considered one of the actual outcomes of the entire quality journey. This case study highlights the importance of employee empowerment, to establish confidence and self-trust. The findings of the case study also present an excellent example of the leadership required to initiate and maintain any endeavour. Moreover, the study identified various CSFs and shared many insights on the effectiveness of the Six Sigma methodology. The interviewee also had valuable suggestions for all managers that had already implemented Six Sigma as well as for those who had the intention to do so in their organisations, especially within the SME sector.

5.3.2 Six Sigma Adoption

The journey towards Six Sigma adoption began with the vision of one of the organisation’s production managers, whose role was to introduce various quality initiatives in the operational processes. Some of these initiatives from the manager’s perspective were in-house training on QI methodologies, awareness sessions related to process improvement techniques and even using consultancy services from third-party professional organisations. The credit goes to the visionary capabilities and leadership skills of the management team that resulted in the initiation of the transformation of the mindset of the employees—from the
traditional style of working to the high quality, efficient way of completing tasks. Hence, the tiresome and slow process of cultural transformation began in 2005. Although various quality management methodologies and techniques were well known to the organisation in 2005 and almost all the leading methodologies of the time, such as Kaizen, Theory of Constraints (TOC) and TQM, had been tried, due to a lack of proper vision and strategic planning, no significant results had been achieved. In addition to other quality management methodologies, this organisation had ISO 9001 certification before 2005. After the implementation of Six Sigma, the organisation successfully integrated the two methodologies of ISO 9001 and Six Sigma. However, it was noted that, later on, with the change in management, other methodologies, such as Lean, were also tried but the integration was not considered very successful, as expressed by the interviewee:

And the next manager introduced the Lean process so it became Lean and Six Sigma trying to work side by side and unfortunately the amalgamation, with the way it was introduced, it wasn’t very cohesive.

It was also noted that the organisation had launched the TQM program before 2005 but it had never been understood properly nor had it been thoroughly structured; therefore, it simply vanished. When comparing TQM with Six Sigma, the interviewee acknowledged that, although there are lot of commonalities in the basic philosophies, TQM may have failed due to poor implementation strategy or perhaps due to the lack of proper ‘drivers’ behind it. This was highlighted by the interviewee in the following words: ‘I’ve never been shown or taught the whole TQM process but a lot of people felt that it came and went’. He further
mentioned, ‘I don’t know if it was implemented very well or what the drivers were behind it’.

In 2005, a new operations manager joined the organisation with a clear vision for process improvement. He started by introducing the very basic problem-solving package known as Kepner-Tregoe (KT) to initiate a QI blitz in the organisation. The interviewee considered that moment the turning point and reflected that:

that was the very first time we’d actually started with looking at inputs to a process rather being output and inspection based … Prior to that [2005] we would just manufacture. Anything that was outside of specification would go to reworks or scrapped and anything inside specification would go to the customer and that was how we operated.

These interviewee words provide a glimpse of the working style at the time. The shift in the mindset from fire fighting, reactive mode to proactive and preventive is considered a foundation for fundamental change in the culture of the traditional way of running operations.

As mentioned earlier, organisation XYZ had already tried almost all quality management initiatives without harvesting any significant outcomes. However, the introduction of KT contributed through small but very basic changes, such as to the format for conducting meetings, introducing root cause analysis to any defect produced, as overviewed by the interviewee:

KT introduced a meeting format that gave us focus on the defects, focus on the big issues and keeping it fairly brief for a shift changeover.
The short-term objective of KT was to instigate cultural transformation, while the long-term goal was to prepare the organisation to launch the Six Sigma program. Hence, the efforts of the manager were described by the interviewee as ‘he really pushed the Six Sigma movement then’. After the success of KT, the same manager then asked for two volunteers from the shop floor to take on the role of Six Sigma Green Belt and the interviewee was the only one to step forward. The interviewee volunteered for the job to gain insight into the process and to reduce the stress related to his role. The other volunteer was selected from the ranks of middle management.

Management selected a volunteer from the shop floor with the objective of first having him trained and then making him responsible for running the Six Sigma quality blitz in the main production operations and manufacturing processes of the organisation. After the volunteers were hand-picked, they were given a complete plan, starting from the Green Belt role to acquiring a Black Belt position and finally becoming a Master Black Belt. Hence, their professional development goals were made clear to them. For an unskilled shop-floor worker, such a career plan held a great deal of motivation for career development in itself.

The management initiated a number of activities for increasing the volunteers’ awareness of Six Sigma, such as visits to other Six Sigma practising organisations, establishing contact with Six Sigma practitioners from other organisations and formal Six Sigma training sessions. The manager who initiated this quality movement was later promoted, but the new manager who took his
place followed the path of his predecessor. The new manager arranged a formal four-week, extensive Six Sigma training session for the two already selected volunteers, which resulted in the formal adoption of the Six Sigma quality initiative by the organisation.

5.3.3 Six Sigma Implementation

The Six Sigma implementation process at organisation XYZ began after selecting volunteers, one worker and one from middle management. After completing the initial awareness and training sessions, the challenge was to kick-start the first project. The expectation was that the training process they had undergone would make them competent enough to run the Six Sigma program successfully.

As a shop-floor worker, the interviewee’s strength lay in his knowledge of the process, which was well capitalised by the manager. The manager was well aware of this strength and said to him, ‘We want you to keep going because you understand that process. We want you to keep going in this vein with no preconceived thought about anything else.’ Hence, the direction from the manager was straightforward, asking the interviewee to focus only on understanding the Six Sigma concept and demanding his full concentration on working out how to improve operational processes.

When first launching the Six Sigma program, they faced extreme difficulties in its implementation. In the beginning, the implementation of Six Sigma was planned according to the classical instructions. The progress was too slow and was facing
resistance from the workforce, especially at the time of project handover. The element of ownership was missing at the workers’ level. They were not ready to accept this new Six Sigma blitz and commented that Six Sigma was another fad and the movement would die automatically. The interviewee highlighted the views of the workers thus:

We’ve seen this before, we won’t participate, we won’t be constructive, we’ll just let it blow over, it’ll go away, it’s another TQM type initiative that’s going to last six or 12 weeks and then it’ll be gone and we’ll be left alone.

The employees considered Six Sigma a ‘waste of time’ or ‘more work’. Most of the time, they refused to collect data or to conduct audits and argued that it was just more work being added and demanded from them. These employees’ views of such initiatives are reflected by the interviewee: ‘I don’t like what you’ve done, I don’t understand what you’re doing or why you’re doing it, you’re just giving me more work’. This situation of lack of ownership by the workers demanded a revisit to the whole Six Sigma implementation strategy. Accordingly, the interviewee at the time changed his strategy, as explained below:

With that, I took a step back after watching it unfold with a few employees and I thought with the projects that I’ve put in I probably haven’t done the Six Sigma process in its purest form but I’ve managed to get all the projects in and working and people working to the projects.

The interviewee then analysed the whole situation thoroughly and realised the root cause. Having been a colleague on the shop floor, he knew how shop-floor workers thought and communicated their feelings. This helped him to develop a
well-thought-out implementation strategy to address the resistance. The interviewee recalled the situation in the following words:

When I looked at it I thought it’s mainly because these guys don’t understand the process, they’re not data driven, they’re caught in the culture of I’m just here to push buttons and go home.

Therefore, a change in implementation strategy was required. To build their trust, the Six Sigma team had to do all the measurements, data collection and audit themselves. An education program for the workforce was designed and launched with the clear message that ‘if they didn’t want to be involved they wouldn’t get in the way’; they would be either ‘be supportive’ or ‘step to the side’. The education program was designed in a way to deal with the day-to-day problems faced during the manufacturing stage and its rectification, using measurements and control measures as required by the Six Sigma methodology. This approach resulted in the shop-floor workers becoming involved and witnessing the difference in the way they did work previously.

When the workers realised that, due to the activity of the Six Sigma implementation team, there was significant reduction in setting-up time, they commented that it was a ‘fluke’. Even when further progress in the same process was achieved, the workers responded with ‘twice in a row, two flukes’. To create more interest, the interviewee asked the shop-floor workers to:

imagine if we get this right and you don’t have to touch it again? It started to get them thinking about what does that mean for you? It means no more reworks, no more impact guns, no more taking it apart and
putting it back together, no more swinging on spanners and hurting your back, reducing injuries, shoulder injuries.

By that time, the workers had started to become involved in the process. Then, more improvement was noticed and, gradually, they reached the point at which no more set-up time was required for that particular product. At that moment, the workers started taking interest, attending meetings, presenting ideas and collecting data. Therefore, a great deal of exemplary work was done to attract their attention. Now, these workers are contributing positively, thinking how they could further improve cycle times or how they could reduce reworks and rejects. As they were collecting data in numerical measurement terms, the information became fact based and not based on judgements. In this way, everybody understood what they were presenting or what they were trying to do, and so they received the support of everyone in the chain.

5.3.4 Contributory Factors

5.3.4.1 Top Management Commitment

The efforts to create ownership for this ‘new way of doing things’ required the total support of the top management and a well-thought-out strategy for launching the Six Sigma program in organisation XYZ. These efforts received a boost when the main person selected to look after Six Sigma was drawn from the workforce. This strategic decision of the top management can be considered the main reason for the successful running of the entire Six Sigma program.
The interviewee acknowledged the backing of the top management in making Six Sigma implementation successful. With the full support from the management, this indigenous quality catalyst became the main driver of the entire quality campaign in the organisation. The interviewee described the top management support thus:

\[
\text{We need you to drive it. If we can’t see it, we’re not going to be offended if you drive it or if you challenge us on it but we need you to drive it.}
\]

Therefore, the message from the top was clear and straightforward, demanding practical steps from the Six Sigma implementation team. It further highlighted the commitment and assurance from the top management to roll out the Six Sigma project at any cost. Further, the interviewee described the authority given to him from the top management to initiate Six Sigma methodology as ‘policing the process’:

\[
\text{They said our support looks like you telling us and everybody when we are not complying with processes and you holding us accountable to that and that’s OK and that was their support because they said if you don’t know it, you don’t know, if we don’t know that something should be happening in a certain way or that this process isn’t being followed, we need you to pick us up.}
\]

As described earlier, the interviewee enjoyed such thorough backing from the top management to instigate Six Sigma projects that he was even allocated the authorisation to question his superiors. This authority and autonomy to execute Six Sigma projects was well communicated throughout the organisation, so he
was able to put his ideas into practice, which made possible the successful implementation of Six Sigma.

5.3.4.2 Communication

The interviewee declared ‘communication’ to be an important factor that played a critical role in successfully implementing Six Sigma. The interviewee had no problems in communicating with other employees, due to his similar working background, and they helped him to win their support in gathering data and discussing things about the processes. Having no prior formal qualifications, university degree or an engineering background, when discussing problem-solving techniques and quality-related issues with his fellow workers, communication was easy and the tasks were executed accordingly. The interviewee broke all communication barriers to include everyone in the process. He had a clear mandate to push the project at any cost. Directions were quite clear to everyone to either cooperate or to step aside and not to obstruct the execution of the Six Sigma project. When the results started to appear, people began listening, participating and executing various tasks.

5.3.4.3 Education and Training

To win the support of fellow workers, more attention was given to the training and education areas. Training was given on a one-to-one basis, and all the statistical tools and sophisticated statistical language were made understandable by the interviewee. This training and education program has been given a permanent place and now, with the support of the government, is an ongoing
feature in the organisation. In collaboration with the government, organisation XYZ introduced an advanced course named ‘Competitive Manufacturing Qualifications’ for the shop-floor employees. As a result, qualified employees are awarded professional completion certificates.

5.3.4.4 Six Sigma Implementation Team

The Six Sigma implementation team is one of the unique features of the Six Sigma methodology (Andersson, Eriksson & Torstensson 2006; Kumar et al. 2008). Organisation XYZ had followed the classical Six Sigma implementation team hierarchy, with slight modifications to the roles. In contrast to the classical Six Sigma principle of having a designated Black Belt devoting 100 per cent of his or her time to Six Sigma projects, the team here is more flexible in executing their tasks. Sometimes, the team members work under the umbrella of Six Sigma and sometimes as members of operations. They follow the main management system of ISO 9001 and the activities of Six Sigma are aligned accordingly, that is, under the umbrella of ISO 9001 requirements. Therefore, their Six Sigma roles are defined under the requirements of ISO 9001 standards. Such an arrangement is not common in large organisations, and Schroeder et al. (2008) highlight the existence of ‘parallel structures’ responsible for improving the organisation. Lawler III (2008, p. 132) defines parallel structures as ‘extra creations that operate outside of, and do not directly alter, an organisation’s normal way of operating’.
5.3.4.5 Impeding Factors Influencing Six Sigma Implementation

The interviewee identified various impeding factors in effectively implementing Six Sigma. The interviewee considered ‘resistance to change’ the most significant impeding factor, followed by the ‘inability of workers to understand the language’.

The biggest issues faced during the implementation of QI initiatives, as highlighted by the interviewee, included lack of top management commitment, lack of knowledge of the Six Sigma methodology, lack of training of employees related to the Six Sigma methodology and lack of performance measurements. It is important to point out that the interviewer selected the above-mentioned issues from a list extracted from the literature (Kumar 2007; Kumar & Antony 2008; Kumar, Antony & Tiwari 2011), and these issues could vary from one organisation to another.

5.3.4.6 Critical Success Factors Highlighted by the Interviewee

A list of CSFs required for the successful implementation of quality management initiatives such as Six Sigma was provided to the interviewee. The list contained 14 CSFs extracted from the literature (Kumar 2007; Timans et al. 2012) and the interviewee was asked to first rate them on the basis of his perception as to whether the CSF was important, and then rate the same on the basis of its actual implementation in the organisation.
The interviewee considered leadership, cultural change, fact-based decision making, linking QI initiatives to customers, business strategy, employees and suppliers as the most important CSFs. He claimed that they had implemented these factors in the organisation in their true spirit. CSFs such as education and training, project prioritisation and selection, and networking with government and academia were declared ‘important’ factors and were effectively implemented in the organisation.

The interviewee, when asked to rate the status of implementation on a five-point Likert scale, where 1 represented ‘not implemented’ and 5 is ‘fully implemented’, responded ‘neutral’ to organisational infrastructure, communication, and usage of innovative techniques and information technology. Further, he did not consider project management skills important and, therefore, their implementation level was quite superficial.

5.3.5 Performance Improvement

After employees fully owned the Six Sigma methodology, the processes became more efficient with a very low rate of defects generated and higher profits for the organisation. Moreover, the workers became more confident about the operations and the work executed by them. There has thus been a paradigm shift in the way the employees see things happen, as highlighted by the interviewee.

The management team and the supervisory teams and staff people have a lot of faith so we don’t need to go out there and watch these guys. They get the product out, a lot of the time the smaller crews overachieve above what we’re aiming for targets.
In addition to focusing on the outputs of the operational processes, now the organisation has also started to give more attention to the inputs that have resulted in establishing a very strong planning activity. The recent execution of a very successful megaproject is an example of strong planning, involvement of all levels of employees and systematic use of the Six Sigma methodology. Right from the beginning, management made the decision to run the megaproject as if it were a Six Sigma project. Tasks were allocated and a great deal of data gathering, analysis and discussions took place. Everyone was involved and shared their observations and input, which led to establishing measurement systems that then, guided the establishment of processes to measure operational variations. The communication flow was designed so that everyone was connected to the network, regardless of their level of contributing the information. It was the observation of a crane driver that identified ‘a critical input to the process’, which resulted in changing the entire outcome of the project. The whole project was very significant in terms of self-confidence and was described by the interviewee thus:

It gave the guys out here on the floor a taste of the power of observation and data and measurement systems, inputs, controlling inputs, understanding where everything should be and how they influenced the outcome.

Six Sigma also resulted in establishing more reliable processes, standardised procedures and cohesion among all level of employees. It was noted that it took a couple of years to be set in motion, but then employees started to enjoy their work. Problems such as absenteeism decreased and stress levels fell, but the level of commitment remained high. Workers developed a sense of empowerment and
responsibility. Six Sigma changed the nature of relationships in the organisation and an environment of mutual respect with a great deal of cohesive energy was developed. Accordingly, the interviewee described the situation thus: ‘it’s not us against them anymore, we all work together to make it all happen’.

Overall, the interviewee highlighted that there were significant financial and operational gains. The interviewee specified that these gains were due to the reduction in the scrap rate, reduction of cycle time, reduction of delivery time, reduction of defects, reduced work in progress, increase in productivity, reduction of production cost, increase in profitability, structured problem-solving techniques, and increase in employee satisfaction and their level of commitment.

5.3.6 Competitor Analysis

On the question of having competitors and their status with respect to quality management practices, the interviewee revealed that, in Australia, there is only one major competitor who was involved in the same product line. Following the 2008 GFC, that organisation had stopped manufacturing and switched to imports. One of the reasons for their suspension of manufacturing operations was the inability to reduce their rejects and reworks due to either absence or, perhaps, inappropriate implementation of quality management systems. Further, it was highlighted that the competitor organisation had tried Lean but, due to improper strategic planning, the desirable results were not achieved. In contrast, organisation XYZ had implemented Six Sigma and not only withstood the GFC but broke many records, and the employees harvested unprecedentedly huge
bonuses. The interviewee rightfully recognised the importance of quality management and commented, ‘I don’t think we can have a future without a good quality program’. Moreover, about facing the GFC and withstanding it, the interviewee was confident in pointing to ‘cultural change’ as the actual reason behind the success and mentioned, ‘If we didn’t make the changes prior to the GFC, the culture changes, we wouldn’t be here’.

5.3.7 Suggestions to Newcomers

With respect to other organisations planning to adopt Six Sigma methodology, the interviewee suggested that Six Sigma should be integrated with the business objectives and become an integral aspect of the operational processes. A successful Six Sigma program requires a comprehensive training program comprising awareness of the basics by the entire organisational hierarchy and purposeful training on tools and techniques for the value adding chain of the operations. A thorough, successful and completed project handover should be conducted by the implementation team. Extensive focus should be put on the employees directly involved in the execution of the value adding activities. The interviewee expressed his point of view thus:

The people that collect the data, the people that notice the changes, your observers and your data collectors are all on the frontline and they’re the ones that need to be engaged and understand, what they’re doing and why they’re doing it to be a part of that process being successful.

Further, the interviewee suggested establishing some sort of recognition systems for all the participating members involved in Six Sigma projects, with venues in
which to present and share, and to publicise their achievements. He considered education and training a major CSF, which contributed to stimulating the cultural change in the organisation. The interviewee expressed his thoughts thus: ‘Education and training to underpin it, I would say would be the large factors and they’ll have success and to make sure everything is translated or discussed in a language that the people understand’. Nevertheless, it is important to highlight that education and training are largely dependent on the transformation of difficult, statistical terminology into easy-to-understand language.

5.4 Case Study Conclusions

This section presented and discussed the findings from the interview. These findings are further analysed and compared against the main research framework of the current study.

5.4.1 Strategic Findings

The most interesting part in the current case study was the selection of the first team from the shop floor. To establish a sustainable, embedded Six Sigma methodology, attention was given to developing and relying on their in-house human resources. Apart from the initial training, all the activities related to Six Sigma implementation were undertaken entirely by the team under the supervision of the Master Black Belt. The success would not have been possible without the management’s full support and the training and subsequent confidence of the team.
Enormous process variations and a traditional style of working forced the operations manager to search for solutions. Being a Master Black Belt, he was an expert in the Six Sigma methodology, and had the experience to implement it. He knew that Six Sigma was the answer to the process variations and had the potential to instigate cultural transformation from the traditional way of working to a robust, quality-conscious workforce.

In summary, the reduction in process variation was the main motivation behind the Six Sigma endeavour, which was then complemented by the personal vision and professional expertise of the operations manager. His leadership qualities and belief in factors such as the employees’ involvement, their empowerment and effective communication led to the transformation of the organisational culture.

5.4.2 Functional and Operational Findings

The functional and operational aspects of the successful Six Sigma implementation were dependent on addressing the cultural issues of the organisation. The need to establish examples of improvement and the journey towards quantifying and measuring each activity represented a clear distinction from various other traditional quality management techniques. Another significant improvement witnessed was the paradigm shift in the thought processes of employees, from a fire fighting, reactive mode to a proactive, preventive approach. In contrast to traditional ways of thinking, Six Sigma made it clear to every employee they should spend more time on inputs and doing things right,
that is, being efficient and effective, the first time. In addition to the above-mentioned advantages, a significant contribution of the Six Sigma practice was the creation of a culture based on mutual respect and support. The decrease in absenteeism was a bonus. Hence, the improvements contributed towards financial gains.

It was noted that the main impediments to implementing Six Sigma were lack of understanding towards Six Sigma terminologies and tools, resistance to change, lack of confidence, lack of trust from management, improper training, poor internal communication, and the fear of new technologies and becoming redundant. The majority of the workforce did not have professional qualifications and, therefore, the launch of any new program could result in the creation of various types of fears, such as the fear of losing one’s job and the fear of inability to understand new knowledge. However, it was found that these worries could be overcome by establishing effective communication through the implementation team being composed of workers from the same shop floor.

It was noted that, in contrast to the traditional focus on financial benefits at the beginning of the process, organisation XYZ selected simpler and easier to manage processes. The team worked on the processes, collected data, established measuring criteria, set controls against the criteria and then incorporated change. As the team was once part of the workforce, they were well acquainted with the operations. Such exemplary contributions attracted the attention of the fellow employees and thus the process of learning started.
In a medium-sized organisation, having a dedicated Six Sigma execution team is difficult to manage due to the shortage of human resources. Therefore, the whole team structure was based on role playing. The key members become part of many teams at the same time, executing their regular responsibilities related to operations whenever required. Usually, the team formations were based on the multi-disciplinary backgrounds of their members, depending on the need of the speciality.

Sustainability of the system was ensured through regular training programs. These training programs were mostly on site, based on open communication. The environment during training sessions encouraged everyone to interact and participate fearlessly, and ask as many questions as they liked.

The most significant impeding factor highlighted by the interviewee was the language and acronyms of the Six Sigma methodology. For a shop-floor worker, the hard-core statistics were confusing, and therefore, a great deal of effort was required to make them understand the basics. In the beginning, a simpler strategy was adopted and the interviewee expressed it thus:

We don’t show numbers, we just use graphs to demonstrate it. At this point in the graph we had this issue and they can relate to that. If I show them a whole series of numbers they switch off because to do that I’ve got to say we have a tolerance and these are outside the tolerance and these are within one standard deviation, I don’t go down that path.
Hence, a great deal of time was consumed by training and education, which sometimes also resulted in a lack of attention from the employees.

DMAIC is considered one of the basic implementation strategies in the literature (Andersson, Eriksson & Torstensson 2006; Evans & Lindsay 2011; Kumar et al. 2008; Linderman et al. 2003; Moosa & Sajid 2010; Thomas, A & Barton 2006). Nonetheless, it should be noted that there is no fixed rule to follow DMAIC and many organisations have developed their own customised implementation strategies, such as Samsung did (Yang et al. 2007). However, organisation XYZ followed DMAIC as an implementation strategy, but recommended customising DMAIC for SMEs.

5.4.3 Reflective Findings

The employees felt more satisfied with their jobs after implementing Six Sigma practices. The interviewee acknowledged that the overall confidence levels rose tremendously. Communication became objective and clearer. A culture of mutual respect and understanding was established.

In addition to financial gains, the organisation successfully narrowed the process variations. An efficient cultural transformation and the successes during GFC were considered a result of the Six Sigma endeavour.

Making Six Sigma part of the business and the operational objectives is the key to success and is recommended to any new SME that plans to implement the Six Sigma methodology. Practical reality demands the running of extensive awareness
sessions in the beginning followed by basic training programs for everyone. These programs should focus on all those employees who are directly involved in the operations, run the processes, collect process data and observe variation in the process. The supporting material should be developed in an understandable format and language without any technical jargon. The workers must know the rationale for performing every activity on the shop floor. Further, setting a sound recognition system is highly recommended. Establishing various means to publicise achievements and share experiences should be given a high priority.

5.4.4 Findings Incorporated into the Research Framework

The main research framework comprised three main steps: Six Sigma adoption, Six Sigma implementation and performance improvement (see Figure 1.1). The findings of the case study, when incorporated into the research framework, resulted in certain modifications. Details of the findings according to the basic research framework are shown in Figure 5.1 and are discussed in the following sections.
5.4.4.1 Six Sigma Adoption

It is important to identify the motivation behind the organisation, in general, and in SMEs, in particular, for adopting the Six Sigma methodology. The literature suggests various impetuses towards Six Sigma adoption and, among them, the most attractive and well reported is the unprecedented financial gain, as reported by companies such as Motorola, GE and Allied Signal (O’Donnell-Young & Pilotto 2006; Pyzdek 2001). Further, Braunscheidel et al. (2011) analysed the whole process of Six Sigma adoption using institutional isomorphic theory and concluded that coercive and mimetic pressures are the main factors behind Six Sigma adoption. However, this seems not to be the case for organisation XYZ;
here, normative pressure was found to be the only motivation behind Six Sigma adoption and financial gains were not the ultimate objective of this campaign.

5.4.4.2 Six Sigma Implementation

It is important to highlight that the normative mechanism influenced the Six Sigma implementation phase when the operations manager who had the expertise of Six Sigma was the major driver executing its implementation successfully. Later on, when the initiating manager left the organisation, the newly trained implementation team took the lead and executed all the projects in organisation XYZ. Therefore, the normative mechanism also played its part during the implementation of Six Sigma.

The implementation phase of Six Sigma comprised a number of elements, such as the strategy adopted, CSFs, implementation team, tools and techniques, creating knowledge awareness, its transfer and training. These elements are discussed next.

5.4.4.2.1 Implementation Strategy

The strategy adopted by the manager was based on using in-house human resources to lead the campaign of Six Sigma implementation. This strategy served many purposes in the long run, including helping to create ownership of the Six Sigma methodology. As the team selected was from the shop floor, they were well aware of the types of processes running in the organisation. Communication with the employees took place easily as everyone already knew the team. Hence, it facilitated the addressing of the cultural issues. It also helped the team to utilise
fully the skills of the human resources available in the organisation for completing the Six Sigma projects.

As for the Six Sigma implementation, organisation XYZ used the conventional DMAIC strategy to initiate the projects. However, later on, it was revealed by the interviewee that there were some concerns about using the DMAIC strategy. Thus, based on his expertise, the interviewee recommended certain modifications to DMAIC to meet the requirements of the organisation implementing Six Sigma.

5.4.4.2.2 Critical Success Factors
As mentioned earlier, the interviewee identified certain important CSFs and rated their importance for the successful implementation of Six Sigma. In his opinion, factors such as leadership, cultural change, linking QI initiatives to customer, business strategy, employees and suppliers are very important for a successful endeavour.

5.4.4.2.3 Implementation Team
The case study revealed that it is quite difficult for an SME to establish a classically designated Six Sigma implementation team exclusively to look after Six Sigma affairs. Therefore, organisation XYZ established a role-based Six Sigma implementation team that executed Six Sigma projects under the umbrella of the ISO 9001 standard. The formation of the team kept on changing according to the requirements of the project. Even the role of the Master Black Belts and the Black Belts were modified according to the work demand.
5.4.4.2.4 Tools and Techniques

As organisation XYZ was well acquainted with various other quality management methodologies, the interviewee acknowledged that they did not follow any specific pattern to use any specific tools and techniques under the banner of Six Sigma. However, the choice of tools or techniques rested with the team and they were quite flexible in their choices. Usually, the team selected a tool or technique from any methodology to serve the purpose. For example, the interviewee highlighted that they were still following the pattern of KT in conducting their meetings and interviewing workers for the purpose of fact finding. He reiterated that ‘the KT training had a big impact in giving me a base and dealing with the people’. Similarly, the interviewee mentioned that his first Six Sigma project started with 5S, a tool of Lean.

5.4.4.2.5 Knowledge Awareness, Transfer and Training

Knowledge awareness, knowledge transfer and training have a significant effect on the implementation of the Six Sigma. The organisation under study focused extensively on these aspects. In the beginning, awareness sessions were arranged regarding the various quality management techniques and, among these, the most significant seemed to be the KT methodology. Similarly, for Six Sigma, the importance of this methodology was highlighted and it was these awareness sessions that motivated the interviewee to become a volunteer to undergo the specialised training on Six Sigma methodology.
Prior to their Six Sigma training, various awareness visits to Six Sigma practising organisations were arranged as well as interaction with professionals to grasp the essence of the Six Sigma methodology. After the awareness campaign, the volunteers were sent to a four-week extensive Six Sigma Black Belt training program. This training gave them the competence to run the Six Sigma projects successfully. However, it would not have been possible without the charting of the strategy for knowledge transfer to the workers.

The knowledge transfer helped to multiply the number of workers who understood Six Sigma. It also facilitated Six Sigma implementation team’s successful execution of the Six Sigma projects. The interviewee encapsulated his thoughts thus:

With the education programs and working with people, it all started to become a lot more cohesive and I think since that time I’m now up to my 19th or 20th Six Sigma project and so far they’ve all been received by the people, all the handovers have occurred.

The knowledge transfer in SMEs is significant as it can reduce the effects of the lack of resources for running the Six Sigma projects. Organisation XYZ recognised the importance of knowledge transfer and training and, hence, they introduced a formal education program of competitive manufacturing qualifications for the workers. This program is run with the support of the government, so it does not put any additional financial burden on the organisation.
5.4.4.3 Performance Improvement

The last important aspect in the research framework is the performance improvement achieved as a result of the Six Sigma application. The interviewee highlighted various performance improvement aspects in the organisation, supporting the claims of Zu et al. (2008). For convenience, these are divided into three main segments: cultural improvement, operational advancements and financial gains.

5.4.4.4 Cultural Improvement

After implementation of Six Sigma, the organisation experienced significant improvements in the culture. The interviewee termed them as soft aspects and ranked them as the most difficult and important to achieve. The development of a culture of cohesiveness, mutual respect, empowerment, commitment and self-confidence among the employees was reported as the most significant outcome of the Six Sigma implementation. The transformation from a conventional operational culture to a robust, fact-based system helped to create more value for the organisation and resulted in strengthening the internal relationships among the employees. This was described by the interviewee thus:

The relationships are very good so the staff-iron worker industrial type relationships have all changed. It’s not us against them anymore. We all work together to try and make it all happen so quality programs and process improvement work if it’s consistent and driven within an organisation have a big impact if it’s all done and engaged the right way.
5.4.4.4.1 Operational Advancement

The implementation of Six Sigma had a direct effect on the operational capabilities of the organisation. Improvements in the processes such as reduction in defects, scrap rate, delivery time and cycle time resulted in an increase in employee satisfaction and their level of commitment. However, the interviewee revealed that the organisation had yet to calculate the overall sigma value for the whole business. Further, he claimed that, currently, the operations were working at fewer than three standard deviations. Considering the time that had elapsed since Six Sigma was first launched, the pace seemed to be slow in addressing quality performance metrics related to sigma levels. Nonetheless, the encouraging aspect is that the organisation is an SME practising Six Sigma, whereas the overall trend to experience Six Sigma implementation by SMEs throughout the world is very weak.

5.4.4.4.2 Financial Gains

After implementing Six Sigma, organisation XYZ reported harvesting more than a million dollars in financial gains annually. Both positive cultural transformation and operational advancements contributed to improving the finances of the organisation. The interviewee reported that the organisation kept a very close eye on cost of quality metrics, which resulted in minimising the failure and production costs. Six Sigma has eradicated the concepts of rework and rejects from the shop floor. Improved sales due to the production of reliable products were another reward of Six Sigma implementation. The financial gains achieved by organisation XYZ complement the findings of the literature (Andersson, Eriksson
5.5 Areas of Improvement

In spite of the successful execution of the Six Sigma projects, there is always a need for improvement. Some points of concern detected by the researcher during the case study analysis include the fact that, since 2005, when the organisation first launched the Six Sigma program, the organisation is still not measuring the overall organisational sigma levels. The interviewee claimed that it was not the organisation’s current objective to measure the sigma level, although, for the core processes, they are operating at fewer than three standard deviations. This is quite a concern because the expectations from a Six Sigma practising organisation are that: (1) it will measure its sigma level; and (2) the sigma level of the core process will be at least greater than three levels of standard deviations.

Secondly, the need to publicise all the achievements in the shape of a quarterly magazine or a newsletter had not been addressed. Although the organisation had an internal free flow of intercommunication, there was no system present for sharing their successes in a proper format. Sharing success stories is important, not only to motivate fellow employees but also to recognise the efforts of the team that has completed a project. Further, as described earlier, the organisation under study is a part of a multinational chain, but there is no channel available to share its experiences with sister organisations.
Thirdly, during discussions, it was noted that, due to the regular change in management structure, the current management is much less focused on Six Sigma projects or QI initiatives and believes in maintaining the status quo. This was deducted from the interviewee’s comment that ‘in general as an organisation does not seem to be supporting Six Sigma as much anymore’. This is indeed alarming and a challenging situation for the Six Sigma implementation team and for the operations because maintaining the status quo means that the element of continual QI is absent, and it further points towards a lack of support from top management. Moreover, a lack of support from top management means that quality initiatives will not form part of the corporate objectives and thus could face limitations in resource allocations. As a result, the consequences for the organisation could be damaging, especially for the motivation of the Six Sigma team and the overall culture of the organisation.

5.6 Summary

The aim of this chapter was to explore the motivation behind the decision to adopt Six Sigma applications and the CSFs involved in its implementation in SMEs. This was only possible with the help of further investigation through conducting interviews. This case study was based on an Australian manufacturing SME involved in Six Sigma applications for the last six years. A brief introduction of the case study highlighted various significant aspects.
The analysis of the case study was conducted using the structure of the fundamental framework of this research (see Figure 1.1). The detailed analysis of the case study suggested that initiating cultural change is the core of quality transformation, and it requires the support and strategic planning of the top management of the SME.
Chapter 6: Discussion and Conclusion

6.1 Introduction

The purpose of this study was to conduct an exploratory investigation into Six Sigma application by Australian manufacturing SMEs. This study exemplified the journey towards Six Sigma adoption by an Australian manufacturing SME for future research purposes. In concluding the study, this chapter aims to address the research questions, and to summarise the major findings in relation to the objectives of the study.

Structurally, this final chapter reconfirms the key findings from which conclusions are drawn and policy implications are formulated for manufacturing SMEs and management practices. Finally, the limitations of this research are highlighted with suggestions to future research on the topic.

6.2 Discussion

The academic literature and professional media are full of success stories illustrating the magnificent past that Six Sigma has enjoyed (General Electric Company 2011; Harry 2012; Harry & Schroeder 2000; Pyzdek 2001). Whether the organisation is Motorola or GE or Allied Signals, almost everyone has claimed significant financial benefits, in the shape of pure profits, or due to internal defect reduction, or as a result of reduction in process variations. Almost every organisation has experienced prosperity and pride due to an increase in their public share values.
To understand the positioning of Six Sigma in the manufacturing sector, a thorough review of the academic as well as professional literature was carried out. The literature review followed the sequence of briefly describing quality management, followed by an exploration of the fundamentals of Six Sigma methodology, leading finally to the facts about manufacturing SMEs in Australia.

The logical starting point for discussion is to highlight the consistency present in the literature regarding Six Sigma applications in manufacturing SMEs throughout the world (Antony, Kumar & Madu 2005; Deshmukh & Chavan 2012; Kaushik et al. 2012; Kumar 2007; Kumar, Antony & Tiwari 2011; Pulakanam & Voges 2010; Wessel & Burcher 2004). The main purpose of this study was to identify the reasons why manufacturing SMEs are reluctant to adopt the Six Sigma methodology. Kumar, Antony and Tiwari (2011, p. 5449) presented a framework for the implementation of Six Sigma in SMEs and claimed it was ‘a roadmap to manage and sustain the change’, but the important question remained regarding what motivates an SME to adopt Six Sigma. Braunscheidel et al. (2011) used institutional theory to determine the motivation behind Six Sigma adoption, but their findings were not exclusive to manufacturing SMEs. Therefore, this study was designed to focus on Australian manufacturing SMEs and explore the necessary components required for the successful implementation of Six Sigma.

The literature review led to formulating a conceptual framework, followed by the designing of an appropriate research methodology for the current study. The conceptual framework comprised three sections: Six Sigma adoption, Six Sigma
implementation and sustainable performance improvement. This initial conceptual framework was modified and extracted from the basic framework presented by Braunscheidel et al. (2011, p. 430) for their study, as shown in Figure 6.1.

![Conceptual Framework Derived from Braunscheidel et al. 2011](image)

**Figure 6.1: Conceptual Framework Derived from Braunscheidel et al. 2011**

The significance of the extracted conceptual framework is that it ensured valid attention was given to the Six Sigma adoption stage. As the fundamental objective of this study was to explore the factors that motivate an SME to embrace Six Sigma applications, due consideration was given to explaining the active dynamics behind the Six Sigma adoption decision. Details are available in the following section.
6.2.1 Six Sigma Adoption

The adoption of Six Sigma is rare in SMEs (Pulakanam & Voges 2010), and therefore, it is a point of concern as to why organisations, in general, and SMEs, in particular, are not adopting the Six Sigma methodology. Although the extensive list of large organisations practising Six Sigma can be found in various publications (O’ Donnell-Young & Pilotto 2006; Pyzdek 2001), reference to SMEs is either absent or their number is negligible (Deshmukh & Chavan 2012; Kaushik et al. 2012; Kumar, Antony & Tiwari 2011). Recent studies in UK manufacturing SMEs identified various reasons behind the lack of Six Sigma implementation but the motivational aspects towards Six Sigma adoption requires more attention (Braunscheidel et al. 2011).

The above-mentioned description related to Six Sigma implementation is vital to understanding the current situation, but the question remains as to what motivates an organisation to make the decision to adopt or to practice Six Sigma. The literature presents various theoretical foundations and rationales for the adoption of various quality management methodologies such as TQM (Anderson, Rungtusanatham & Schroeder 1994) and ISO standards (ISO 2000b) but, for the Six Sigma methodology, very little is discussed as to how the adoption process is initiated (Braunscheidel et al. 2011).

The foundation of the current study is the institutional theory presented by DiMaggio and Powell (1983). The theory involves three isomorphic change mechanisms labelled coercive, mimetic and normative. In the literature,
Braunscheidel et al. (2011) used institutional theory to determine the motivation behind Six Sigma adoption in the USA, regardless of the size of the organisation. It is important to highlight that, out of the seven organisations in their study, only one falls under the category of SME according to the definition criteria of the ABS. Therefore, the judgement regarding coercive and mimetic mechanisms may be only valid for large organisations.

Braunscheidel et al. (2011) determined that, for Six Sigma adoption, only coercive and mimetic mechanisms are involved, while the normative mechanism is active during the Six Sigma implementation phase (see Figure 6.2).

**Framework 1:** Extracted framework from the case study findings by Braunscheidel et al. (2011, p. 441)

**Framework 2:** Final framework of the current study

**Figure 6.2:** Comparison between the Framework of the Previous Study (Framework 1) Conducted by Braunscheidel et al. (2011) and the Framework Extracted from the Current Study (Framework 2)
Contrary to the findings of Braunscheidel et al. (2011), in the current case, the SME under study followed the normative mechanism to instigate change. When asked specifically about the motivation behind the Six Sigma adoption, the interviewee responded thus:

There was one person in the organisation who had the vision, who understood manufacturing and what was needed to actually control the processes and to stabilise and that it wasn’t going to be a quick fix. It was going to be a long-term solution and that we needed to start the journey now.

Therefore, the whole adoption process was started by the manager on site, who was ‘process driven’ with the pre-qualification of Six Sigma Black Belt. It was his visionary and strategic skills that resulted in asking for the volunteers from the shop floor, as described in Chapter 5.

Figure 6.2 highlights that in the Australian manufacturing SME; normative mechanism played a fundamental part in the adoption and implementation of Six Sigma. This finding excluded the involvement of any coercive or mimetic factors as a motivation to adopt Six Sigma practices. Although this finding is based on just one case, it seems to be an important contribution to the current body of knowledge. Hence, the current study strongly suggests that normative isomorphic mechanism is responsible for the successful adoption of Six Sigma practices in Australian manufacturing SMEs.

The findings also indicate that the other isomorphic change mechanisms, that is, coercive and mimetic, are currently absent in the Australian industrial
environment. Now, the question is how to create normative isomorphic change mechanism that is effective for other manufacturing SMEs. There could be many propositions for addressing this issue, such as:

- hire a Six Sigma Black Belt
- arrange training and awareness sessions for the employees
- contact third-party consultants to initiate the process of quality transition.

However, the main problem remains: the scarcity of resources required for the implementation of Six Sigma application, including human; financial and time resources. To address the resource issues in SMEs, a suggestion is presented in the recommendations section of the current chapter.

It is important to highlight that the organisation under focus is part of a giant multinational group that enjoyed the luxury of having ample resources for the start-up; however, in most cases, resources are considered a vital CSF for SMEs. This aspect is significantly highlighted in the literature (Kumar & Antony 2008; Kumar et al. 2012) and is included in the findings of the recent survey carried out among Australian manufacturing SMEs (Khurshid, Kumar & Waddell 2012).

After comparing the findings of Braunscheidel et al. (2011) and those of the current study, it appears that the reason why SMEs are not adopting the Six Sigma application is that there are currently no coercive and mimetic pressures in the Australian manufacturing SME sector. Therefore, the absence of these isomorphic change mechanisms from the SME sector has a great influence on the motivation
to adopt Six Sigma application. Due to a high level of variability in the processes, operations and structures, SMEs are also subject to experiencing variation regarding the decision to adopt Six Sigma methodology.

It was further noted that the SME under focus was involved in a number of quality initiatives prior to embracing Six Sigma, but the outcomes of such endeavours were never very hopeful. Therefore, the employees had the impression that all QI initiatives were only either fads or the flavour of the month. They had the same view of Six Sigma. However, this time, the presence of a strong leader pushed the entire Six Sigma movement in a strategic way. An experienced, qualified Six Sigma practitioners, he had a clear vision and, thus, laid Six Sigma on firm foundations, so that, even after he left, the SME completed many successful projects.

6.2.2 Six Sigma Implementation

After making the decision to practice Six Sigma in the organisation, the question of ‘how’ arises, that is, how can Six Sigma be implemented effectively? As the focus of the current study was to explore the facts related to the successful implementation of Six Sigma in SMEs, the findings from the survey were compared with the findings in the literature. These were then further analysed in light of the data gathered from the SME under focus.

In the literature, the most common reasons for not implementing Six Sigma are unavailability of resources, absence of top management commitment, lack of
knowledge or understanding of the system and desire to maintain the status quo of ISO standards (Antony, Kumar & Labib 2008; Antony, Kumar & Madu 2005; Kumar & Antony 2008; Kumar, Antony & Douglas 2009). In addition, the literature mentions various impediment factors in adopting quality management programs (Antony, Kumar & Labib 2008; Husband & Mandal 1999; Thomas & Webb 2003) such as:

- absence of clarity among various quality management methodologies
- internal existing cultures
- considering ISO 9001 to be sufficient for their needs
- fear of extensive statistics
- perceiving Six Sigma as another ‘fad, fantasy or flavour of the month’.

The survey conducted among Australian manufacturing SMEs highlighted the concern about the existence of conceptual confusion with respect to Six Sigma relevance, lack of in-depth knowledge and unawareness of Six Sigma, which confirms most of the findings from the literature. The findings from the survey are summarised in Figures 4.3 and 6.4. This study highlights the need to develop a new Six Sigma adoption-implementation framework exclusive to SMEs.

When comparing the findings in the UK with those in Australia, it is surprising to find that, even in today’s information age, factors such as conceptual unawareness and lack of knowledge are common areas of concern. However, this state of unawareness could be minimised through building strong communication
channels between various stakeholders of the system. These stakeholders may include various industrial associations, chambers of commerce, educational institutions and the government. These stakeholders together could form a strategic alliance in order to create awareness and establish venues for knowledge sharing and its application.

As the objective of the current study was the implementation of Six Sigma, more importance was given to the findings of the case study than to the findings of the survey. This does not undermine the significance of the findings of the survey; however, the scope of the current study suggests remaining focused on Six Sigma practices. On the one hand, the findings from the case study identify the CSFs for implementing Six Sigma in SMEs: leadership and cultural change, linking quality initiatives to customers, business strategy, employees and suppliers. On the other, they highlight the salient features that impede the successful implementation of Six Sigma in SMEs: lack of top management commitment, lack of knowledge, lack of training, internal resistance and lack of performance measurement and quality management system. These findings are almost congruous with what is available in the literature.

6.2.3 Performance Improvement

The literature highlights various performance improvements as a result of implementing Six Sigma in an organisation but, as the number of Six Sigma practicing SMEs is quite negligible worldwide and in Australia, therefore the case of even one Six Sigma practicing SME is worth mentioning. The findings from
the survey identified performance improvement factors such as improvement in sales, increase in productivity and reduction of scrap rate. However, the case study considered the cultural transformation from the traditional way of doing things to the quality-conscious, confident and efficient workforce being the actual essence of the Six Sigma implementation, in addition to the performance improvement factors found in the survey. Moreover, the culture of ownership flourished in the Six Sigma practising organisation and it resulted in the cultivation of other benefits, including reduction of cycle time, defects, delivery time and production cost. The uniqueness of the current study is that it highlighted and considered the cultural transformation the core improvement aspect, hence showing and guiding other SMEs to focus in depth on these cultural issues. Secondly, the performance and other improvement findings are exclusive to the Australian manufacturing SME, as highlighted in Chapter 5.

6.3 Consequences for Australian SMEs

As the current study highlights the significance of normative factors during the Six Sigma implementation phase, it is recommended that SMEs establish a permanent and sustainable training infrastructure. In addition to the training process, the current study highlighted various important aspects necessary during the implementation phase, such as the implementation strategy, implementation team structure and CSFs.
The topography of Six Sigma implementation was largely dependent on the strategic decision making of the top management. This study drew clear lines for the top management to maintain proper conceptual awareness, vision and, above all, a commitment towards the allocation of resources to instigate quality change in the organisation.

The strong focus on cultural aspects in this study pointed towards transforming the available human resources synergistically for the benefit of the organisation. This study extracted a very clear message of employee empowerment, mutual respect, trust and confidence in employees for other SMEs to follow. Moreover, the current study identified the importance of linking quality initiatives to customers, business strategy, employees and suppliers. These findings are unique and are representative of Australian manufacturing SMEs (see Section 5.4.4).

6.4 Conceptual Transition

The starting research framework based on the literature review helped to establish the foundations for the current study. The survey findings contributed more information to the starting framework. The findings of the survey helped to see the bigger picture of the entire manufacturing SME sector with respect to QI initiatives, while the case study significantly contributed to our understanding of the journey towards quality change through applications of Six Sigma. Figure 6.4 shows the complete conceptual transformation process.
The information gathered from the survey contributed mainly by identifying the issues related to implementation of QI initiatives. As the number of Six Sigma practising SMEs is low, it was significant to capture the perception of SMEs with respect to implementing QI initiatives. The survey also helped our understanding of various CSFs and issues faced during implementing QI initiatives.

After considering the literature, the findings from the survey and the case study, a final framework was extracted (see Figure 6.3). The final framework explains the Six Sigma adoption mechanism, followed by successful implementation, which can lead to sustainable performance improvement in Australian manufacturing SMEs. It is important to mention that the implementation phase of Six Sigma included all the salient features that the literature suggests.

The final framework explains the three processes, which are Six Sigma adoption, Six Sigma implementation and performance improvement achieved as a result of Six Sigma implementation, with respect to Australian manufacturing SMEs. It highlights that a normative isomorphic change mechanism is currently the main factor behind successful Six Sigma adoption and Six Sigma implementation in Australian manufacturing SMEs (see Figure 6.3).

The final framework also sheds light on the Six Sigma implementation stage. All the salient features—implementing strategy, CSFs, overcoming impeding factors, implementation team, the mechanism for knowledge transfer and training infrastructure—are required for successfully implementing Six Sigma in SMEs.
Hence, the process for implementing Six Sigma in SMEs requires almost all the same elements that are required in large organisations. Leadership, cultural change and strategic decision making constitute the CSFs. Resistance to change, difficult Six Sigma language and lack of performance measurements are among the few impeding factors to consider. SMEs require simplicity in forming implementation teams and following the conventional Six Sigma belt system is not mandatory. SMEs are required to take matters related to training and knowledge transfer seriously.

![Final Framework](image)

**Figure 6.3: Final Framework**

After implementing Six Sigma, performance improvement is an unquestionable outcome. The magnitude of the performance improvement significantly varies according to the type and nature of the Six Sigma completed projects. The
literature highlights various performance improvement aspects, such as increase in profitability, improved sales, increased productivity, reduction of variations, reduced defects, reduced scrap rates, reduced delivery times, reduced work in progress, increased customer retention and increased employee satisfaction with enhanced levels of commitment (Aboelmaged 2010; Andersson, Eriksson & Torstensson 2006; Antony 2002; Bendell 2006; Kwak & Anbari 2006). These benefits were verified by the survey and the case study. They were then categorised under two main groups: financial gains and operational excellence. Figure 6.4 summarises the findings of the final framework.
Figure 6.4: Summary of the Transitional Stages of the Research Framework
6.5 Limitations and Recommendations for Future Research

As one of the earliest studies on the topic, with scope for exploring and articulating original knowledge, this study has its limitations.

Firstly, the study concerned the adoption and implementation of Six Sigma methodology; therefore, the entire focus was on identifying Six Sigma practising SMEs. For this reason, a focused survey was completed. To conserve resources, only organisations that were ISO 9001 certified were selected. The survey resulted in identifying just four SMEs practising Six Sigma out of more than 2,000 organisations. On the one hand, this result confirmed the findings of the previous studies and the existing literature but, on the other, it created problems for the progress of the current study. Further, only one SME agreed to participate in the next phase of the study. Therefore, a generalisation of the findings could not be undertaken. However, as no previous study has been conducted on Australian manufacturing SMEs, the findings from the current study can be considered an example for other SMEs to use as a benchmark and, indeed, a first step towards exploring the facts in detail.

Secondly, due to the unavailability of data exclusive to Australian manufacturing SMEs, the survey was sent to all ISO certified organisations, regardless of their size. This resulted in a waste of financial resources and allowed only one reminder to be served to a limited number of organisations. This resulted in a low response rate.
Thirdly, the study focused on SMEs belonging to the manufacturing sector only and the service sector was not discussed.

The reason behind the selection of manufacturing over the service sector was that the study would have expanded if the service sector were included to a point beyond the financial and temporal resource constraints of a master thesis.

The current study highlighted various avenues for conducting further research, which are:

- The concept of Six Sigma is still in need of a theoretical foundation; hence more work is required regarding its applicability in manufacturing SMEs.
- The Manufacturing SME sector is large and complex and it is very difficult to generalise the findings to the entire manufacturing sector. Therefore, it is highly recommended that future endeavours focus on specific industrial types or at least industries belonging to a similar industrial sector.
- The need to investigate the status of industry-academia linkage in relation to quality management education and training is very important. As SMEs are generally resource deficient, academic institutions can meet their needs effectively. Hence, future research could focus on the importance and viability of the industry-academia relationship.
- In-depth effort is required to establish UNIDO’s cluster development methodology in relation to the adoption of advanced quality management techniques by forming various need-based consortia. Cluster development methodology encourages involving other players, such as academic
institutions, industrial and professional associations, chambers of commerce and the government. Thus, following cluster development methodology could result in subsequent stimulation of coercive and mimetic isomorphic change mechanisms. A boost in the adoption of Six Sigma methodology in manufacturing SMEs could follow.

- More research is required to understand the phenomenon of Six Sigma implementation in SMEs.
- At present, Six Sigma lacks any formal governing body to look after the conceptual and professional development of the Six Sigma technique on similar grounds as the ISO. Therefore, a study could be launched to assess the importance and feasibility of establishing such a governing body for the conceptual development of Six Sigma.
- The role of the government to guide and resource allocation for quality management could be evaluated in detail. This would help to build a strong relationship between the government and industry, in general, and the SMEs, in particular. Hence, the more specific needs of SMEs could be understood and addressed by the government.

6.6 Study Conclusions

This study provided an empirical characterisation of an Australian SME implementing Six Sigma practices and identified major CSFs associated with successful Six Sigma implementation. The specific aims were to identify the motivation behind Six Sigma adoption and implementation; the identification of CSFs and the reason why the trend to adopt Six Sigma is weak in SMEs.
The most important conclusion that could be extracted from the current study is the affirmation that Six Sigma can be implemented in manufacturing SMEs. Despite the fact that the SME under focussed, it was part of a multinational setup and can enjoy various benefits and assistance from the parent group. But even then as the number of Six Sigma practising SMEs is currently very low, with the help of strategic planning, the situation could be overturned so that there would not be only normative factors involved in the adoption and implementation of Six Sigma, but coercive and mimetic factors could also be instigated to play their part. This study has laid down the foundations for understanding the mechanism involved in the process of adoption and implementation of one of the world’s finest quality management methodologies—Six Sigma—thus stimulating and instigating the process of more research to understand the methodological dynamics of Six Sigma in reference to SMEs.

Another major benefit arising from this study is that it also presents an example of the successful endeavour of an Australian manufacturing SME involved in executing Six Sigma projects for all Australian manufacturing SMEs to use as a benchmark. As the SMEs belonging to the manufacturing sector of Australia are facing challenges of globalisation and operational costs, their competitiveness could be enhanced through reducing process variations and increasing operational efficiencies by adopting and implementing Six Sigma practices.


Australian Bureau of Statistics 2001, Small Business in Australia, 1321.0, ABS, Canberra, ACT.

Australian Bureau of Statistics 2011, Australian Industry 2009-10, 8155.0, ABS, Canberra, ACT.

Australian Bureau Of Statistics 2012, Australian Industry 2010-11, 8155.0, ABS, Canberra, ACT.

Australia Bureau of Statistics 2012a, Characteristics of Australian Exporters 2010-11, 5368.0.55.006, ABS, Canberra, ACT.


Brue, G 2006, *Six Sigma for small business*, CWL Publishing Enterprises, Madison, WI.


Evans, JR & Lindsay, WM 2011, *Managing for quality and performance excellence*, 8th edn, South-Western, Cengage Learning, Mason, OH.


Guion, LA, Diehl, DC & McDonald, D 2011, *Triangulation: establishing the validity of qualitative studies*, University of Florida, Gainesville, FL.

Gygi, C, DeCarlo, N & Williams, B 2005, *Six Sigma For Dummies*, 1 edn, Wiley, John & Sons, Indianapolis, IN.


Huq, Z 2006, ‘Six-Sigma implementation through competency based perspective (CBP)’, *Journal of Change Management*, vol. 6, no. 3, pp. 277–89.


Khurshid, KK, Waddell, D & Glassop, L 2010, ‘Six Sigma: the answer to quality issues in SMEs’, paper presented at QUALCON 2010, Canberra, ACT.


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Shields, M 2003, *Using employment data to better understand your local economy*, 2.5M1/03nvo4540, Pennsylvania State University, University Park, PA.


Yin, RK 2003, Case study research: design and methods, 3rd edn, SAGE, Thousand Oaks, CA.


## Appendices I: Australian Bureau of Statistics Data

### 1. Business in Australia, by size

<table>
<thead>
<tr>
<th>Number of Employees</th>
<th>Number of businesses in 2011</th>
<th>Employment as in 2011</th>
<th>Value Added as in 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'000</td>
<td>Per cent of total</td>
<td>Per cent of total</td>
</tr>
<tr>
<td>Small</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-19</td>
<td>2046</td>
<td>96</td>
<td>46</td>
</tr>
<tr>
<td>Of which:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1306</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>1-4</td>
<td>509</td>
<td>24</td>
<td>14</td>
</tr>
<tr>
<td>5-19</td>
<td>231</td>
<td>11</td>
<td>20</td>
</tr>
<tr>
<td>Medium</td>
<td>81</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Large</td>
<td>6</td>
<td>0.3</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td>2133</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Data Source: ABS Catalogue No. 8155.0 Published in 2012

### 2. The value of exports and the number of exports with contribution to each industry

#### Value of exports with Contribution to each Industry

<table>
<thead>
<tr>
<th>Size of Exporters</th>
<th>2006-07</th>
<th>2007-08</th>
<th>2008-09</th>
<th>2009-10</th>
<th>2010-11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$m</td>
<td>%</td>
<td>$m</td>
<td>%</td>
<td>$m</td>
</tr>
<tr>
<td>Large</td>
<td>155,839</td>
<td>92.7</td>
<td>168,292</td>
<td>93.1</td>
<td>219,393</td>
</tr>
<tr>
<td>Medium</td>
<td>11,110</td>
<td>6.6</td>
<td>11,363</td>
<td>6.3</td>
<td>10,279</td>
</tr>
<tr>
<td>Small</td>
<td>1,149</td>
<td>0.7</td>
<td>1,201</td>
<td>0.7</td>
<td>1,156</td>
</tr>
<tr>
<td>Total Goods Exporters</td>
<td>168,098</td>
<td>100.0</td>
<td>180,856</td>
<td>100.0</td>
<td>230,829</td>
</tr>
</tbody>
</table>

#### Number of exporters with Contribution to each Industry

<table>
<thead>
<tr>
<th>Size of Exporters</th>
<th>2006-07</th>
<th>2007-08</th>
<th>2008-09</th>
<th>2009-10</th>
<th>2010-11</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
<td>No.</td>
<td>%</td>
<td>No.</td>
</tr>
<tr>
<td>Large</td>
<td>4,375</td>
<td>10.3</td>
<td>4,411</td>
<td>10.2</td>
<td>5,932</td>
</tr>
<tr>
<td>Medium</td>
<td>21,666</td>
<td>50.8</td>
<td>21,670</td>
<td>50.3</td>
<td>20,787</td>
</tr>
<tr>
<td>Small</td>
<td>16,613</td>
<td>38.9</td>
<td>17,017</td>
<td>39.5</td>
<td>16,540</td>
</tr>
<tr>
<td>Total Goods Exporters</td>
<td>42,654</td>
<td>100.0</td>
<td>43,098</td>
<td>100.0</td>
<td>43,259</td>
</tr>
</tbody>
</table>

Data Source: ABS Catalogue No. 5368.0.55.006 Published in 2012
Appendices II: Survey Questionnaire

Quality Improvement Initiatives within Australian Manufacturing Organisations: A Survey

The attached questionnaire is designed to assess the status of quality management initiatives within the Australian manufacturing organisations. I would appreciate if you could help me by responding to the attached questionnaire. There are no right and wrong answers. The questionnaire has five parts and may take about 25 -30 minutes to complete. The survey data will be analysed on a collective basis as per the research objectives established at the beginning of the research. I would be happy to share the results of my study, if you provide me with your contact details - Voluntary (Part VI).

Thank You in advance for your assistance.

Part-I Company Background

This section asks for some background details of yourself and your organisation.

1) Name of organisation (Optional) and start-up year:
2) Type of Organisation
   - Local Firm
   - Joint Venture
   - Subsidiaries of Multi-national
3) What Part of the Country are you located?
   - ACT
   - NSW
   - NT
   - QLD
   - SA
   - TAS
   - VIC
   - WA
4) What is your industrial sector?
   - Aerospace
   - Automotive
   - Food
   - Chemical
   - Telecommunications
   - Mechanical
   - Pharmaceuticals
   - Plastics
   - Electronics & discrete semiconductors
   - Other (please specify):
5) How many employees does your organisation have?
   - Full time employees:
   - Other:
6) What is your organisation’s turnover (AUD)?
   - Less than 1million
   - 1-10 millions
   - 10-20 millions
   - 20-30 millions
   - 30-50 millions
   - over 50 millions
7) What is your current position within the organisation?
   - CEO/ Director/ General Manager
   - Departmental Head
   - Quality manager
   - Other (please specify):
8) How long you have been in this position?
   - Years
9) Do you have a quality department?
   - Yes
   - No
10) Is Quality Management, responsibility of Quality Department?
   - Yes
   - No
11) Does your company measure Customer Satisfaction?
   - Yes
   - No
   - If yes, How does your company measure Customer Satisfaction?
     - Surveys
     - Delivery times
     - Customer Complaints
     - Sales Data
     - Repeat Business
     - Others
12) Are there specific teams in your company for problem solving?
   - Yes
   - No
   - If “Yes”, how often do they meet?
     - Few times/week
     - Once/2 weeks
     - Only when problem occurs
13) Select the top three critical factors that define the company’s strategic objective(s) (Tick up to 3 boxes)
   - Profitability
   - Flexibility
   - Market Share
   - Innovation
   - Others (specify)
14) Select top three important criteria that helped your company win customer loyalty (Tick up to 3 boxes)
   - Manufacturing Quality
   - Price
   - Other (specify)
15) Which quality initiatives have been implemented in your organisation?

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Current</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Six Sigma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TQM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lean</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kaizen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BPR*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOC*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 9001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO 9000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IIP*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* BPR- Business Process Reengineering
* TOC- Theory of Constraints
* IIP- Investors in People
1. Do you think ISO 9000 Standard is foundation for Lean/Six Sigma?
   - Yes
   - No
   - Don’t Know

2. If your organisation is not implementing Six Sigma, please state the reason/s why?

---

**Part-II Six Sigma: If you ticked ‘Yes’ for Six Sigma in question 16 (Part I)**

1. Do you measure your Sigma level?
   - Yes
   - No

2. What is the average sigma capability level of your core processes?
   - Less than 3 sigma
   - 3–4 sigma
   - More than 5 sigma
   - Do not know

3. How many trained Six Sigma personnel does your organisation have?
   - Six Sigma Champions
   - Yellow Belts
   - Green Belts
   - Black Belts
   - Master Black Belts

4. What metrics do you use frequently to measure your process performance?
   - Cost of poor quality
   - Defect rate
   - First time yield
   - Throughput yield
   - Process capability
   - No of complaints
   - Percentage scrap
   - Other (please specify):_________________________

5. How many Six Sigma projects have you completed to date?
   - 1–5
   - 5–10
   - 10–20
   - Above 20
   - In process

6. Can you estimate financial benefits gained (in AUD) after successful implementation of Six Sigma?
   - < 50K/year
   - 50K–100K/year
   - 100K–250K/year
   - > 1m/year
   - Don’t know

7. If any Six Sigma initiative ever failed could you please give reason/s:

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If Part-II is not relevant, continue with Part-IV

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**Part-III: Lean Manufacturing: If you ticked ‘Yes’ for Lean in question 16 (Part IV)**

1. Has your organisation arranged a formal training in Lean manufacturing?
   - Yes
   - No

2. Does the culture of your organisation support Lean manufacturing?
   - Yes
   - No

3. What benefits does your organisation get after implementing Lean manufacturing?
   - Financial Savings
   - Reduced Lead Time
   - Reduced Inventory
   - Increased Process Understanding
   - Better Understanding of Customer Needs
   - All of the above
   - Other:

4. Do you measure these wastes?
   - Over Production
   - Waiting
   - Transport
   - Inventory
   - Over Processing
   - Motion
   - Defects

5. Select top three wastes which are important for your company (Tick up to 3 boxes that you consider important)
   - Over Production
   - Waiting
   - Transport
   - Inventory
   - Over Processing
   - Motion
   - Defects

6. List the tools and techniques you are using frequently for Lean:

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7. Has your organization ever tried to merge Lean with Six Sigma?
   - Yes
   - No
   - Go to a & b
   - Go to 8

   a) If “Yes” please share your observations and experience:

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b) In your opinion, what do you think which implementation pattern should a new SME follow for implementing Lean Six Sigma?

- First Lean then Six Sigma
- First Six Sigma then Lean
- Lean and Six Sigma simultaneously
- Does not matter
- Don't know

1. If ‘No’ to question 7 (Part-III) please mention if there are/is any specific reason(s):  

Pl. Continue with Part-IV

<table>
<thead>
<tr>
<th>Factors</th>
<th>Importance (1 - 5)</th>
<th>Implementation Level (1 - 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Organisational Infrastructure</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Cultural Change</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Education and Training</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Fast-based decision making</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Linking Quality Improvement (QI) Initiative to Customers</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Linking QI Initiative to Business Strategy</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Linking QI Initiative to Employees</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Linking QI Initiative to Suppliers</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Communication</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Project Management Skills</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Project Prioritisation and Selection</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Usage of Innovative techniques and IT systems</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>Networking with Government and Academia</td>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Others (please specify): ____________________

<table>
<thead>
<tr>
<th>Measure Not used in the company</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Part-V Results of implementation of Quality Improvement Program

This section asks about the benefits that your organisation has experienced following the implementation of Quality Improvement program in your business processes. Please tick the appropriate box according to the following code:

1. Negative benefit / improvement
2. No benefit / improvement
3. Some benefit / improvement
4. Significant benefit / improvement
5. Crucial

1. Benefits

- Reduction of scrap rate
- Reduction of cycle time
- Reduction of delivery time
- Reduction of Defects
- Reduced work in progress
- Increase in productivity
- Reduction of production costs
- Increase in profitability
- Improved sales
- Increase in customer retention/loyalty & satisfaction
- Increase in Employee Satisfaction and level of commitment

Others (please specify): ____________________
2. What is the most frequently used performance metrics in the organisation?


3. The benefits listed above are result of:

☐ Six Sigma implementation
☐ Lean implementation
☐ Lean Sigma implementation
☐ Others (Please specify): ____________________________

4. Do you understand the term Cost of Quality?   ☐ Yes   ☐ No

If you have answered “Yes” to question 4, please mention the factors that constitute cost of quality in your company.


5. What have been the Five largest issues you have faced during implementation of quality improvement initiatives?

(Please Rank top Five from the list, with 1 being the most critical issue)

☐ Lack of Top management commitment
☐ Lack of Knowledge
☐ Poor Supplier involvement
☐ Poor Employee Participation
☐ Poor Delegation of authority
☐ Lack of Training
☐ Inadequate process control techniques
☐ Availability of resources
☐ Changing business focus
☐ Internal resistance
☐ Poor project selection
☐ Lack of Performance measurement and quality management system
☐ Ineffective communication

6. Please use this space to tell us more about the successful (and unsuccessful) quality initiatives within your organization


Dear Sir or Madam,

Subject: Study of Six Sigma implementation in Australian Manufacturing Organisations

We would like to invite you to participate in a study on the status of Six Sigma implementation in Australian manufacturing organisations being undertaken by the Deakin University. The research is being conducted as part of a doctoral thesis.

The aim of the project is to study the current quality management practices with specific reference to the adoption of Six Sigma methodology by Australian manufacturing organisations. Among different quality methodologies, Six Sigma is the most focused methodology. Six Sigma has proven its potential to address the issues of large organisations, but there is a need to consider how it could be adopted for Australian manufacturing organisations. The study revolves around the status of Six Sigma implementation in manufacturing organisations followed by determining the inhibitory aspects to implement Six Sigma in this sector. A survey will be undertaken to assess the current quality management status in the sector. At the end of this survey we will compare the findings from Australian manufacturing organisations to the results gathered from the research conducted with UK manufacturing organisations.

We have enclosed a copy of the questions we would like to explore. Could you please take the time to read these questions and respond within two weeks in the reply paid envelop provided. Please note that your participation is entirely voluntary. We assure that the information provided will be used only for academic purposes. The survey will be analysed at Deakin University. All your responses and any information provided by you will be treated as confidential and results will be handled so that no individual’s responses or specific organisations can be identified.

The study has been approved by the Human Ethics Committee of Deakin
University. Please retain this form for your own records and if, during or after the study, you have any questions regarding the research and/or findings, please write or call: Khurram Khurshid, Deakin University, Burwood, Vic 3125, Australia; Phone +61 (431) 056 151; fax +61 (3) 9251 7083; Email: khawajak@deakin.edu.au. If you have any queries or complaints about the way you have been treated, you may contact Secretary Human Research Ethics Committee, Research Services, Deakin University, (221 Burwood Highway, Burwood VIC 3125. Tel (03) 9251 7123 E-mail: research-ethics@deakin.edu.au), please quote project no: 2010-223.

This study would not be possible without your generous support. As a token of appreciation of your co-operation, you may choose to receive a summary of our findings by providing your consent on the survey. Any queries about your participation in this project may be directed to the Principal Researcher, Associate Professor Dianne Waddell (Phone 03 9244 6265 Email dianne.waddell@deakin.edu.au)

Thank you for considering our request.

Yours sincerely