Exploring the critical factors of the successful implementation of Six Sigma approach: a case study of Ducab, UAE

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Abstract

Many researchers have identified a number of critical factors for successful Six Sigma implementation within specific companies. However, there is very little agreement on formulating an optimal set of comprehensive list of factors that would be fully capable of theoretically exploring the success of Six Sigma implementation. Therefore, in order to address this specific concern, it is necessary to develop a theoretical framework that accounts for how and why these critical factors guarantee successful Six Sigma implementation. In this context, the Business Process Change (BPC) management theoretical framework was found to be useful as a foundation in explaining the success of Six Sigma implementation in the Dubai Cable Company. This is because Six Sigma implementation involves changing the business processes of companies.

Through an embedded single case study, data based on open-ended questions was collected from seven top and middle level managers in the Dubai Cable Company (Ducab). The questions explored the way that the Six Sigma approach has been successfully implemented within the case company. Interviews were analysed inductively and compared with the constructs mentioned in the BPC management framework.

As a result of data analysis and discussion of the key findings, a theoretical framework was developed in order to be applied for investigating the successful adoption of Six Sigma in the UAE manufacturing sector. Moreover, the research findings identified specific entities which together form each of the five key constructs of change environment within an organisation that lead to successful Six Sigma implementation. These are; Strategic Initiatives, Cultural Readiness, Learning Capacity, Information Technology Leveragability and Knowledge Sharing Capability, and Network Relationship Balancing.

This study has the usual limitations associated with a single case study. In addition, the proposed theoretical framework broadly identifies the entities of the key constructs of change organisational environment. However, complex concepts such as cultural readiness and learning capacity require a multi-level analysis of the data necessary to gain a deep understanding of these specific constructs of change environment in the context of Six Sigma implementation.

The proposed framework provides guidance to companies within the UAE that intend to implement the Six Sigma approach as part of their quality improvement initiatives. In addition, this study recommends organising a national campaign to introduce the Six Sigma approach to local manufacturers in the UAE.

Table of contents

List of Table

List of Figures

Dedication

I dedicate my work to my wife who alone shoulders the responsibility for our family and sacrifices her best days so that I can complete this work

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1 Chapter 1: Research Introduction

This chapter introduces and clarifies the purpose of this research. Several issues are addressed, namely, the importance of this research topic, problem, overall aim and related objectives. Moreover, a background of the case company is provided. The chapter then concludes by providing an overview of the structure of this thesis. The first area to be addressed concerns the importance of this research followed by related research problems for consideration.

1.1 The Importance of this Research

Due to globalisation and open markets, competition in business around the world has intensified and complications in the economic environment have increased (Haikonen et al. 2004). These writers have outlined some key characteristics of successful companies, for example; reliability, timeliness, accuracy and perceived value of their products or services. Consequently, the necessity to use powerful tools to increase market share and ease the economic complications has intensified.

One of the most important approaches to achieve this is improving the quality of products and services. Quality improvement has been considered as a vital tool to be used to strengthen competitive edge (Kaye and Anderson, 1999; Kuei and Madu, 2000; Eckes, 2001). Furthermore, consideration of the national excellence awards as a sign of good organisations has increased the importance of quality improvement (Kwok and Tummala, 1998).

Amongst other quality improvement tools and philosophies, the Six Sigma approach is an essential practice and discipline to improve quality (Peter and Lawrence, 2002). The goal of Six Sigma is to make an organisation more effective and efficient (Eckes, 2003). Therefore, reduction in product defects, good return on investment, achievement of excellence awards, cost cutting and customer satisfaction are some of the beneficial outcomes of the Six Sigma approach. Consequently, globally large numbers of organisations have pursued this approach (McAdam and Lafferty, 2004; Klefsjö et al. 2001). Examples of such companies include amongst others Motorola, General Electric, AlliedSignal and 3M.

In addition, as most of the previous quality improvement tools and philosophies (Appendix 1) have been characterised by setbacks, the importance of innovating a new approach such as Six Sigma has increased (Kwok and Tummala, 1998; Shaw and Dale, 1987 cited Kwok and Tummala, 1998; Folaron et al. 2003). There are many elements that have led to this position. However, a vital debate amongst quality improvement scholars about the novelty and necessity of Six Sigma has occurred (Klefsjö et al. 2001). Therefore, the need to initiate a new quality improvement approach needs to be explored. The credibility of the reasons for the failure of the previous quality improvement tools should be outlined. The distinguishing features of this new approach will be compared with previous approaches in the literature review of this thesis.

1.2 Research Problem and Motivation

In spite of the intensive attention that has been paid to quality improvement by the UAE government, the problem of sub-standard local products persists. Lack of product quality as a consequence has led to widespread customer dissatisfaction. The researcher has personally experienced this problem in his previous post working for the Department of Standardisation and Specification. This department received a large number of complaints from its customers. In addition, the results of an earlier study conducted by the researcher in the foodstuffs industry sector further highlighted poor product quality. Although some companies in the UAE have followed some traditional quality improvement approaches, the level of quality has not improved sufficiently to resolve this problem.

Poor quality is not a unique phenomenon restricted to the UAE or indeed the Gulf region. Substandard quality is a global problem. The results of several studies conducted in the USA have highlighted a similar situation. Nevertheless, the situation there is not as bad as it is in the UAE. This is attributed to the differences in development in the two countries. One of these studies (Harry, 1998) indicates that most of the American companies work near four sigma which means that for every million products, there are at least 6,210 defective parts or units. This means that the loss to these companies and to the national economy is 0.006 per million produced parts. This loss is represented by the cost of rework, repair, scrap and returned items. Moreover, a more recent study (McAdam and Lafferty, 2004) has claimed that a good organisation usually operates at four sigma for the majority of its main business processes. Thus, this result suggests that even in one of the most developed countries in the world, quality improvements need to be made. In comparison, the view would be worse in a developing country like the UAE which has begun its movement towards quality improvement more recently.

Another study (Bergquist and Ramsing, 1999) evaluated the impact of traditional quality practices (including the National Quality Awards) on the financial results of North American companies. This study compared the financial results of companies that have won at least one National Quality Award with those of non-awarded companies. The key findings indicate that while the perception of quality is improved in companies that have won the awards, there is no real impact on financial results. Similarly, the results of a study (Zaramdini, on line) that observed International Organization for Standardisation (ISO) certified companies in the UAE indicate that the perceived benefits related to quality of procedures come first. However, the real impact on the bottom line and cost reduction comes last.

By contrast, since the Six Sigma approach has a significant influence on the bottom line, American companies such as Motorola, General Electric, AlliedSignal and 3M have implemented this approach to improve their profits. In practice, profits have increased as a result of this application. In contrast, as a result of the shortage of information about the companies that have adopted Six Sigma in the UAE and for the purpose of this research, the researcher conducted a pilot survey in 2005 and updated it in 2008. The participants in this survey included all the consultants registered in the Standardisation and Specification Authority in the UAE and who worked in quality improvement activities as well as the organisations that were concerned about quality in the UAE (Appendix 2). These participants were asked about their knowledge of Six Sigma companies in the UAE. The result of this survey was surprising in that nearly all of the UAE companies in the entire manufacturing sector had not adopted the Six Sigma approach. The one exception was the Dubai Cable Company (Ducab).

In order to examine the accuracy of this result, an exploratory survey was conducted and a descriptive questionnaire designed. This questionnaire included two closed questions (appendix 3). A letter forwarded to the companies' general managers was attached to this questionnaire. This letter urged these managers to complete the questionnaire and assured data confidentiality (appendix 4). According to the Ministry of Finance and Industry (2009), there were 4,219 companies within the UAE manufacturing sector that represent the research population. According to Curwin and Slater (2002), 300 respondents is a suitable sample for this population. The researcher added 200 respondents in order to avoid invalid questionnaires and unknown addresses. Therefore, a total of 500 respondents were chosen in a systematic random way. These companies were given one month to complete the questionnaires. As a follow-up action, they were called to encourage them to complete the questionnaire. However, the response was very poor. Therefore, the time period was extended by two more months. In addition, the questionnaires were electronically distributed. In spite of all the efforts, the response rate did not improve. Only six companies responded. Out of six responses, five questionnaires were found to be valid and one invalid. This disappointing outcome enhanced the previous survey result.

This result means that it is increasingly necessary for UAE companies to adopt Six Sigma. This is because the Six Sigma approach, as explained earlier, is one of the best tools for improving product quality and the bottom line. Also, this finding highlights Ducab as a unique case that should be investigated. The aim of this study is to investigate how this company has successfully implemented Six Sigma. This enquiry entails looking into the business environment of this company in order to interpret the success of such an application. The findings from such an investigation could therefore serve as a guide to other similar companies in the UAE considering the adoption of this tool. This study thus entails theoretically interpreting the success of the application according to the critical success factors required for such an implementation. However, prior to considering this more fully, it is necessary to provide a background to the selected case company.

1.3 Research context

The United Arab Emirates is well known for its rapidly expanding economy (Shihab, on line; Elhiraika and Hamed, on line; Al sayeg, 2004). This has been attributed to large oil revenues, fresh ideas and economic project initiatives. Since its founding in 1971, the UAE economy has predominantly depended upon oil revenues (Yousef, 2007), with oil providing the main source for foreign exchange earnings and government revenues (Al Sadik, on line). Thus, the economy has been built on open-market policies (Al Sadik, on line; Elhiraika and Hamed, on line; Al Sayeg, 2004). Huge oil revenues and open-market policies have contributed to a massive consumptive economy (Shihab, on line). Furthermore, the UAE economy depends heavily on expatriate workers (Shihab, on line) who represent more than 90 per cent of the private sector workforce (Fasano and Goyal, 2004; Wilkins, 2001). This is due to the limitation, in terms of quality and quantity, of the national workforce (Al Sadik, on line). Nevertheless, these expatriates possess different skills and qualifications (Ghanem, on line).

As the UAE economy is based predominantly on oil which is often at risk of fluctuating value, the government has begun to consider ways in which it can diversify its income streams. Amongst other initiatives, industrialisation has been strongly suggested as an alternative income resource (Elhiraika and Hamed, on line; Yousef, 2007). This includes both oil and non-oil based industries. The former is manufacturing associated with oil and gas such as refineries, fertilizer plants, petrochemicals, natural gas liquefaction and aluminium smelters (Ghanem, on line; Yousef, 2007). The latter includes a mixture of light and heavy industries such as aluminium, iron, steel, cement, food processing, construction materials, mineral water and soft drinks and many other light industries (Yousef, 2007). The diversification of other non-oil based production activities has already resulted in favourable outcomes. In 2003, non-oil industries contributed 17 per cent (Ministry of Planning, 2003 cited Yousef, 2007) to the total UAE gross-domestic product (GDP). More recently, it has been considered that these industries have made the second largest contribution to national economic development (Ministry of Finance and Industry, 2009).

Official numbers have shown that non-oil based industries are growing consistently. In 2008, there were more than 4,219 related firms. Total investment was over seventy-seven billion Dirhams which equal approximately ten billion Pounds Sterling. In addition, these industries recruit more than 317,841 workers (Ministry of Finance and Industry, 2009). According to the same information source, in comparison with the numbers in 2004, the number of firms had increased by 39 percent, whilst investment had increased by 22.3 per cent and the workforce increased by 37.4 per cent. Amongst other activities that are part of non-oil based industries, equipment and machinery activity was one of the fastest growing in 2009. Ducab has been classified as one of the firms that operate within the non-oil based sector.

Dubai Cable, more commonly known as ‘Ducab’ has been producing power cables in the UAE since 1979. Ducab is operating with a total investment of forty million Dirhams which is the equivalent of half a million Pounds Sterling (Ministry of Finance and Industry, 2009). In 2005 a new factory was opened in Abu Dhabi. The company is jointly owned (50% each) by the governments of Dubai and Abu Dhabi. The company occupies 590,000 square metres of land in Jebel Ali in Dubai, and nearly 200,020 square metres in Mussafah in Abu Dhabi (Ducab, http://www.ducab.com/).

This company has a workforce of more than five hundred employees (Ministry of Finance and Industry, 2009), three hundred of whom work in the Dubai factory, while two hundred are based in the Abu Dhabi factory (Ducab records, 2006). This workforce has been deployed in five major functions, namely, manufacturing, technical affairs, sales, commercial and administration. Each function is headed by a senior manager and is divided into several sub-functions. These sub-functions are headed by junior managers. The entire company is headed by a managing director (Appendix 5).

Today, Ducab produces over 65,000 cubic copper tonnes of low and medium voltage cables. Ducab is renowned for producing high quality products. The company has won several quality awards such as the Dubai quality award and has gained ISO 9001-2000 certification. Ducab has also attained British Approvals Service for Cables (BASEC) (Radhakrishna, 2002). Quality improvement is a non-stop journey in this company as a result of senior management vision and commitment to continuous improvement.

As the aim of the Six Sigma approach is to improve quality to the point where there are only 3.4 defects per million opportunities, this drive fits in well with Ducab's strategy in pursuing continuous quality for customers (Baker, 2002). Moreover, a competitive business environment within Dubai has led the company to reduce its operating costs and increase its profit margins. In addition, the impact of globalisation has motivated the company to initiate Six Sigma (Six Sigma coordinator in this company, 2006).

1.3.1 Six Sigma approach implementation in Ducab

Ducab has conducted Six Sigma schemes since 2000 (Baker, 2002). A careful study of Ducab's goals and culture preceded this initiative. The company selected Motorola University as the third party to conduct this implementation. The role of this party was to provide Ducab with the knowledge about Six Sigma and to guide it in its new journey that drives towards quality improvement.

The Six Sigma approach has been implemented in two phases. The first phase was the training programme provided for the 'black belts' by Motorola University. Improvement projects were conducted during this phase. There were five projects spread throughout the business process (Baker, 2002; Appendix 6).

Consequently, the positive outcomes from these projects encouraged Ducab to begin the second phase. This phase was conducted in two parts (Baker, 2002). The first part included controlling and maintaining the level of improvement obtained from the first five projects. The second part involved further training for employees selected to work on fresh projects. As a result of this endeavour, the number of these projects increased from five to twenty-eight (Appendix 7). Table 1 shows the profit of major Six Sigma projects during the period from 2001-2008.

Year	Project	Financial Gain
2001	Identification and optimization of bottlenecks in LV/MV power cables	AED 30M in 2003
	Reduce rework and scrap	AED 500K in 2002
2003	Building wire bottleneck optimization - 1	AED 4M in 2003
	Reduce raw material to minimum	AED 600K per year
	Manufacture XL-LSF right-first-time	AED 400K per year
2004	Reduce over usage of MV material	AED 42K on 240 sq mm per year
	Increase building wire output - 2	
2005	Reduce raw material to minimum	AED 592K per Year
2006	Conductor weight control in stranding lines	AED 4M in 2008
2007	Core assembly operation on stranding line Mc-502	
	Cost saving in PVC manufacture by introduction of new plasticizer	AED 2.7M per Year
	Cost saving in PVC manufacture by introduction of new CaCO3 supplier	AED 0.6M per Year
2008	Cost reduction of PVC heat shrink caps	
	Maximize PVC output on machine 3001	AED 2.0M per Year
	Dispatch drums packaging cost reduction using Lamiflex	

Table 1: The profit of major Six Sigma projects in Ducab during 2001-2008

Moreover, Table 2 shows an improvement in the profit per employee in the period of time between 1993 and 2008.

1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
146	134	177	257	204	199	164	192	194	181	198	217	241	285	476	442

Table 2: The profit per employee in the Ducab

As a result of this growth Ducab survived the financial recession although it dramatically hit Dubai. Moreover, in the second quarter of 2009, Ducab's sales showed a 30% improvement over the first 3 months of the year. In addition, Ducab launched an office in Qatar as a response to the rising demands for cables in the Qatari market. This growth indicates the success of the Six Sigma approach in Ducab. However, there are other indicators that could add weight to this conclusion.

1.3.2 Indicators of successful Six Sigma approach implementation in Ducab

One of these indicators which could be used to judge the success of the implementation is the impressive results of Six Sigma projects in contrast to other improvement projects conducted in Ducab. Generally, analysis has revealed that the value of the benefits to the business has more than repaid the cost of training, equipment and employees' time (Baker, 2002; Six Sigma coordinator in this company, 2006).

Moreover, these projects have not been dedicated to one single business process activity. Rather, Ducab has spread these quality improvement projects throughout the company, whereby more departments and employees have been involved in the implementation than in previous quality improvement projects. In addition, senior management's enthusiasm to continue exploiting Six Sigma in order to improve practices and processes is a clear indicator of success.

Because of these success indicators characterising the successful implementation in Ducab, the Six Sigma approach has been selected for this investigation.

1.4 Research Aim and Objectives

The research aim and objectives have been determined in order to find a solution for this research problem. They are the following:

1.4.1 Research Aim

The aim of this research is to develop a means for investigating the readiness of the organisational environment of companies within the UAE manufacturing sector for a potential successful implementation of the Six Sigma approach. This development is based on the experience of Ducab in the approach's successful implementation. This is because it is the only company that has adopted Six Sigma in the entire UAE manufacturing sector.

1.4.2 Research Objectives

The following proposed objectives should be fulfilled in order to achieve the above aim:

1. To critically review the literature relating to the Six Sigma approach in order to establish a theoretical foundation underpinning this research.
2. To explore the business environment of the case company via interviews with key employees in order to find out the critical factors that have contributed to the success of the implementation.
3. To develop a theoretical framework to explain how and why these critical factors have affected the success of the implementation in the case company.
4. Proposing the resultant theoretical framework to be a guide for potential implementations of Six Sigma in the manufacturing sector in the UAE.
5. Suggesting some recommendations according to the research results. These recommendations could enrich Ducab's experience and could be useful for other

companies within the manufacturing sector in the UAE that intend to implement Six Sigma.

1.5 Research structure

This chapter has introduced the research area, the case-study company and the overall research aim and related objectives. The remainder of this thesis comprises four chapters. The following chapter is a critical review of the literature concerning quality improvement philosophies and tools. A key feature of this chapter will be to consider the critical factors required to successfully implement Six Sigma. An additional feature will be to discuss the means of investigating the success of this implementation in order to elaborate the theoretical background to underpin the developed theoretical framework. The third chapter addresses the research methodology of this study. It is here that the case for an inductive research approach is made, underpinned by an interpretive research philosophy. Following on from this, case-study research methods will be discussed followed by the use of transcript matrices in the analysis of the interview transcripts. The fourth chapter provides an analysis of the case-study findings, associated discussion and research reflections. In light of the findings, the final chapter will conclude by recommending good practice for companies planning to implement Six Sigma and ways in which further research can contribute to the literature.

2 Chapter 2: Literature Review

Sunders, et al (2003) contended that the critical literature review forms the foundation on which research is built. Its main purpose is to help to develop a good understanding and insight into relevant previous research and the trends that have emerged. The precise purpose of the literature review depends upon the approach which the researcher intends to use in his/ her research. For some research projects the researcher uses the literature to help him/her to identify theories and ideas that he/she will test using data. This is known as a deductive approach in which the researcher develops a theoretical or conceptual framework, which he/she subsequently tests using data. For other research projects the researcher will be planning to explore the data and to develop theories from them that the researcher will subsequently relate to the literature. This is known as an inductive approach. These issues and others will be discussed in the next chapter. Meanwhile, since this researcher explores participants' thoughts regarding how and why the critical factors have affected the success of the implementation in the case company in order to develop a theoretical framework that is underpinned by the literature, this researcher intends to use the inductive approach to conduct this research.

Accordingly, this chapter answers two main questions that have emerged from the last chapter. The first and second sections discuss why this research is looking into Six Sigma as an alternative approach to improve quality. Thus, the first section elaborates on Six Sigma definition, rationale and techniques whilst the second section extensively compares Six Sigma approach to other quality improvement tools, approaches and philosophies. The aim of this comparison is to show the similarities and differences between these approaches and Six Sigma. The third section the discussion answers what are the critical factors of a successful implementation of Six Sigma and are these factors appropriate to be considered as a means to investigate the success in the case company. Prior to this discussion, the definition of quality will be discussed in the following paragraphs.

According to the reviewed literature, there is a wide variety of quality definitions. A comprehensive study that has dealt with many quality gurus and scholars' definitions (Reeves and Bednar 1994) indicates that these definitions are multiple and often muddled and have been described as a wide variety of phenomena. Amongst others, this study has quoted various definitions of quality, such as: *"value (Abbott, 1955; Feigenbaum, 1951), conformance to specifications (Gilmore, 1974; Levitt, 1972), conformance to requirements*

(Crosby, 1979), fitness for use (Juran, 1974, 1988), loss avoidance (Taguchi, cited in Ross, 1989), and meeting and/or exceeding customers' expectations (Gronroos, 1983; Parasuraman, Zeithaml and Berry, 1985)" (Reeves and Bednar, 1994, p.419) .

This study has attributed these multiple and muddled definitions to the constant change in demands of business over a period of time. A result of another study (Yong and Wilkinson 2002) has enhanced the view that these multiple and varied definitions are muddled, demonstrating that they depend on the circumstances. A more recent study (Ivanovic and Majstorovic 2006), has emphasised this result. However, it has considered that quality is a multi-dimensional value, where its dimensions vary from one organisation to another. In this researcher's opinion, there is no contradiction between these justifications because the circumstances could be the business environment of organisations including the strategies that fulfil its demands.

Despite the variety of definitions, there is consensus amongst the reviewed studies (Jacques, 1996; Kuei and Madu, 2003; Reeves and Bednar, 1994; Yong and Wilkinson, 2002; Ivanovic' and Majstorovic', 2006). As mentioned earlier, they have considered quality to be excellence, value, conformance to specifications or meeting and/or exceeding customers' expectations. The following is a brief elaboration of these definitions.

According to the Oxford Dictionary, quality as excellence originates from the Greek word, '*arête*' which refers to 'superiority' or 'being the best'. According to this definition, quality may vary from one circumstance to another and could be used to describe objects or subjects as excellent. For human beings, for instance, quality could be used to describe the way they can be morally, intellectually, physically, or practically capable.

Quality can also be defined on a value basis. This definition reflects a relationship between cost and price. Therefore, quality is linked to customer conditions. This reflects a clear relationship between quality and circumstances. Moreover, quality is conformance of specifications. This is a manufacturing-based definition that means any deviation from specifications during any stages of production is a reduction in quality.

Nowadays, the most accepted definition is meeting and/or exceeding customers' expectations. This definition has been proposed by most of the quality gurus like Crosby, Feigenbaum, Juran and Deming. Since the previous definition is based on a manufacturer's point of view, this one is a customer-based definition. In this context, quality is a level of satisfaction that could be perceived by customers each and every time they use a product or service. This satisfaction is related to fulfilling customers' requirements and meeting and/or exceeding their expectations. Thus, this definition emphasises the impact of market changes on quality levels through monitoring customers' requirements and expectations.

From the previous discussion it could be concluded that a single best definition of quality does not exist. This is because the definitions in use describe different aspects of quality in different circumstances (Reeves and Bednar, 1994). Moreover, there is a difference in describing the quality of a product or a service. This is attributed mainly to the way that quality can be measured. Usually, product quality has measurable characteristics such as statistical, engineering or numerical. On the other hand, quality of service often has emotional characteristics such as feelings, sense of worth or satisfaction (Jacques, 1996; Komashie et al. 2007). In this respect, Rust, R. and Oliver, R. (1994) claim that service quality is by nature a subjective concept, which means that understanding how the customer thinks about service quality is essential to effective management. As a result of the aforementioned discussion, this researcher agrees with the customer-based definition. Thus, he defines quality as the set of characteristics and features that distinguish a product or service that satisfy customers through fulfilling their needs and meeting or exceeding their expectations.

The variation and variety of quality definitions has occurred simultaneously over a period of time in conjunction with the evolution of the tools, approaches and philosophies of quality improvement (Reeves and Bednar, 1994; Yong and Wilkinson, 2002). The development and application of quality improvement tools has a long history, stretching as far back as the period of Egyptian Pharaohs and Greek philosophers (Reeves and Bednar, 1994; Elshennawy, 2004). However, it is only very recently (i.e. since the beginning of the twentieth century), that significant developments in quality improvement tools, approaches and philosophies have been noted (Kaye and Anderson,1999). Furthermore, Garvin (1988 cited Kuei and Madu, 2003), Bounds et al. (1994 cited Kaye and Anderson, 1999), Yong and Wilkinson (2002) and Raho and Mears (1997) have categorised four phases or eras of the quality improvement movement. These phases are inspection, statistical quality control (SQC), quality assurance (QA) and strategic quality management (SQM) such as total quality management (TQM) and business process re-engineering (BPR). The first three phases are called 'traditional' because they were initiated in the early stages of quality improvement. Such phases are related to the older definitions of quality, which include considerations such as ‘excellence’, ‘value’, and ‘conformance to specifications’ (Reeves and Bednar, 1994; Yong and Wilkinson, 2002). In contrast, because the quality improvement in the fourth phase has strategic features, it is termed the strategic quality management phase. This is because the end of the quality assurance era witnessed intensification of the role of management in quality improvement activities that are related to goals and objectives of an organisation. Moreover, quality was important for an organisation’s reputation. However, it was not a competitive means to an end (Kwok and Tummala, 1998; Kaye and Anderson, 1999). Thus, these authors have maintained that the dominant phases today are a result of developments from previous phases of quality improvement, which were deemed to be lacking in some respect. Therefore, this has led to the initiative of modern quality improvement tools, approaches and philosophies.

This chapter now proceeds in the first section to look into the definition, rationale and techniques of the Six Sigma approach. This is in order to compare, in the next section, Six Sigma with other quality improvement tools, approaches and philosophies that could support this research choice of investigating the adoption of the Six Sigma approach.

2.1 Section 1: the Six Sigma approach
(Definition, rationale and techniques)

As a corollary of change, the critique of one form of quality improvement has led to the development of newer movements that better address the gaps identified in the former (Ivanovic and Majstorovic 2006; Yong and Wilkinson 2002). Accordingly, the development of the Six Sigma approach has been attributed to the drawbacks of the previous quality improvement tools, approaches and philosophies as well as to the change in the levels of thinking that has eventually occurred within various domains (Smith 2001). Therefore, the Six Sigma approach is, as has been mentioned in the first chapter, a well-disciplined and structured approach to improve quality (Goh and Xie, 2004; Schroeder et al. 2008; Sekhar and Mahanti, 2006; Byrne, 2003). It aims to satisfy customers as well as shareholders (Motwani et al. 2004; Eckes, 2001; Harry, 1998; Raisinghani et al. 2005; Ehie and Sheu, 2005; Black and Revere, 2006). The Six Sigma approach combines good quality that satisfies customers and a good return on investment that satisfies shareholders (Savolainen and Haikonen, 2007).

The Six Sigma approach is distinguished by a unique rationale that has been built upon the principles of zero defects and statistical quality control (Behara et al. 1995; de Mast, 2004; Folaron et al. 2003; McAdam and Evans, 2004; Brewer and Bagranoff, 2004; Komashie et al. 2007). In addition, it has two strengths, namely, scientific methodology to improve the quality of processes and products as well as the 'belts system' structure. These issues and others are discussed further in this section. First, it begins with a demonstration and discussion of a number of definitions of the Six Sigma approach that tackle it from different perspectives. Second, the rationale of this approach will be explained. Following this, Six Sigma techniques will be clarified. This discussion will show the way that the Six Sigma approach differs from other modern quality improvement tools, approaches and philosophies, especially that of total quality management (TQM). This is because TQM was the dominant theoretical and empirical paradigm for quality management and included many of the elements advocated by leading quality thinkers such as Deming, Juran, and Crosby (Schroeder et al. 2008). This comparison is the issue of the next section.

2.1.1 Defining the Six Sigma approach

There are various definitions of the Six Sigma approach within the literature that have been reviewed. These definitions have been articulated in different ways. This could be attributed to Raisinghani et al. (2005) Caulcut (2001) who have attested to the difficulty of defining this term in one simple sentence. This is because, as Raisinghani et al. (2005) have explained, Six Sigma encompasses the methodology of problem-solving and focuses on optimisation and culture change. In addition, Schroeder et al. (2008) and Schonberger (2005) have attributed this situation to the variety of practitioner perspectives. Antony and Bañuelas (2002) have emphasised that Six Sigma has different interpretations and definitions for different people. Moreover, Klefsjö et al. (2001) have agreed with these authors and contended that the content of the Six Sigma approach varies from company to company, consultant to consultant, and from author to author. Therefore, Schroeder et al. (2008) have claimed that there is not a single shared definition. Thus, there are a number of Six Sigma definitions that have been built on special points of view such as that of Motorola and General Electric. These special definitions match the objectives of these companies (Sitnikov, 2002; Caulcut, 2001; Klefsjö et al. 2001; Henderson and Evans, 2000).

In order to identify a definition that works with this research, a wide variety of definitions have been reviewed. According to the way that they have been articulated, these definitions could be classified into three categories. The first category includes the definitions that have been developed from the technical perspective (McAdam and Lafferty, 2004). Within this category there are two groups of definitions. One includes the definitions that have been constructed on the techniques of applying Six Sigma. The second group within this category includes the definitions that have been constructed upon the statistical way of calculating Six Sigma. The second category includes the definitions that have been built on business perspectives. The third category includes the definitions that incorporate the perspectives of the first two categories. This classification agrees with Antony and Bañuelas's (2002) claim that Six Sigma can be defined in both statistical and business forms. This could be attributed to the features of the Six Sigma approach that combine statistical tools and business strategies to achieve the objective of quality improvement.

Looking into some of the definitions of the first group within the first category it could be claimed that Six Sigma has been defined according to the techniques of applying it. For example, Kendall and Fulenwider (2000) have defined Six Sigma as a process, and one popular approach identifies eight phases, namely, recognise, define, measure, analyse, improve, control, standardise and integrate. Another definition that has been suggested by Harry and Schroeder (2000, cited Caulcut, 2001) outlines Six Sigma as a disciplined method of using extremely rigorous data collection and statistical analysis to pinpoint sources of errors and ways of eliminating them. Similarly, Snee, (2004 cited Antony et al. 2005) has defined Six Sigma as a well-established approach that seeks to identify and eliminate defects, mistakes or failures in business processes or systems by focusing on those process performance characteristics that are of critical importance to customers.

In a more specific way, Six Sigma has also been defined in statistical terms since its roots are deep in statistics. Therefore, the entire definitions that have been reviewed in this regard have focused upon the statistical principle of calculating Six Sigma. In this context, McAdam and Lafferty (2004) and Goh and Xie (2004) have clarified that the term ‘sigma’ is a Greek alphabet letter used to describe variability and is applied as a statistical process technology measure in organisations. Moreover, a sigma quality level, as Breyfogle and Forrest (1999 cited McAdam and Lafferty, 2004) have stated, offers an indicator of how often defects are likely to occur in the process considered where sigma levels and corresponding defect levels are as derived from the standard probability curve for an organisational process. Furthermore, at Motorola, Six Sigma has been and still is defined as a quality improvement program with the goal of reducing the number of defects to as low as 3.4 parts per million opportunities. Six Sigma uses the normal distribution and strong relationships between product nonconformities, or defects, and product yield, reliability, cycle time, inventory, and schedule (Tadikamala, 1994, cited Henderson and Evans, 2000; Brewer and Bagranoff,2004; Russell and Taylor, 2003, cited Camgoz-Akdag, 2007; Pandey, 2007; Savolainen and Haikonen, 2007). Similarly, Kumar and Gupta (1993, cited Motwani et al. 2004) have defined the Six Sigma philosophy as a quality-focused program that requires process design that can accept twice the normal variation of (+, -) 3 sigma in a process, even if the process mean shifts by as much as (+, -) 1.5 sigma. In addition, Six Sigma is defined as the spread about the mean that includes 99.74% of the population (Caulcut, 2001). Thus the goal of organisations adopting Six Sigma is to continually improve their processes until they achieve this level of process capability and the quality ensures that a maximum of 3.4 parts per million are defective in each step of the process.

These are some examples of the definitions in this group of the first category. Other definitions that have been suggested by Bañuelas and Antony (2002), Behara et al. (1995), McAdam and Lafferty (2004), Antony and Bañuelas (2002) and Klefsjö et al. (2001) are similar to these definitions. In conclusion, all reviewed definitions of the second group of this category focus on the statistical rationale and the way of calculating Six Sigma in order to achieve near to the goal of perfection.

Six Sigma definitions in the second category have been articulated from the business perspective. These definitions focus on the way that Six Sigma improves business performance. This could be achieved, as Zairi (1999, cited McAdam and Lafferty, 2004) states, by coupling the ever-increasing integration of quality and business strategy. In this regard, Caulcut (2001) has stated that an alternative definition, which was used in Motorola, offers a rather different perspective. According to this perspective, Six Sigma is a business philosophy of driving behaviour by making an organisation's values explicit in its compensation system and a business strategy of cost cutting and boosting customer satisfaction. In addition, McAdam and Evans (2004) have agreed with the definition that has been suggested by Antony and Banuelas (2001, cited Antony and Bañuelas, 2002) and have defined Six Sigma in business terms as a business improvement strategy used to improve profitability, to drive out waste, to reduce quality costs and improve the effectiveness and efficiency of all operations that meet or even exceed customers' needs and expectations. Moreover, Motwani et al. (2004) have defined the Six Sigma quality system as the collective plans, activities, and events designed to ensure that products, processes, and services will satisfy customer needs. It is a customer-focused approach to business that provides an overall framework for quality management. Similarly, Haikonen et al. (2004 cited Savolainen and Haikonen, 2007) have defined Six Sigma as a process improvement methodology that aims to increase business performance through a solid and accurate business focus. In conclusion, these definitions that have been built upon business perspectives consist of two main parts, namely, the aim of applying Six Sigma to improve business performance and customers' satisfaction and the means exploited to achieve this aim.

In the third category of Six Sigma definition, authors have combined the technical and business perspectives to define Six Sigma more holistically. Caulcut (2001) defines Six Sigma as an information-driven methodology for reducing waste, increasing customer satisfaction and improving processes, with a focus on financially measurable results. Moreover, Brewer and Bagranoff (2004) have defined Six Sigma as a customer-driven, fact-based set of process improvement tools that enables managers to define, measure, analyse, improve upon, and control problems. In addition, Linderman et al. (2003) define Six Sigma as an organised and systematic method for strategic process improvement and new product and service development that relies on statistical methods and scientific method to make dramatic reductions in customer-defined defect rates. Similarly, Harry (1998) has defined Six Sigma as a strategy that measures the degree to which any business process deviates from its goal. The average product, regardless of how simple or complex, has a quality performance value. The best products however, are valued at Six Sigma, a level of excellence in performance that is truly world class.

The aforementioned demonstration of the various Six Sigma definitions indicates that there are some similarities and differences between these definitions. Mainly, these definitions are composed of three parts: the essence of Six Sigma, the aims of Six Sigma and the means of achieving these aims. In order to discuss these similarities, Table 3 has been designed according to the contents and perspectives characterising the varying definitions of Six Sigma.

Details / Authors	**Perspective**	**Essence**	**Aims**	**Means**
Kendall and Fulenwider (2000)	Technical (techniques)	Process and popular approach	Applying Six Sigma	Exploiting eight phases of the scientific method
Harry and Schroeder (2000, cited Caulcut, 2001)	Technical (techniques)	Disciplined method	Applying Six Sigma	Exploiting the analysis of the scientific method
Snee, (2004, cited Antony et al. 2005)	Technical (techniques)	Well-established approach	Applying Six Sigma	Exploiting the define phase of the scientific method
de Koning and de Mast (2006)	Technical (techniques)	Well-established approach	Applying Six Sigma	Exploiting the define phase of the scientific method
McAdam and Lafferty (2004)	Technical (statistics)	Statistical measures	3.4 defects per million	Statistical process technology measure
Goh and Xie (2004)	Technical (statistics)	Statistical measures	3.4 defects per million	Statistical process technology measure
Breyfogle and Forrest (1999, cited McAdam and Lafferty, 2004)	Technical (statistics)	Statistical measures	3.4 defects per million	Statistical process technology measure
Tadikamala (1994, cited Henderson and Evans, 2000)	Technical (statistics)	Statistical measures and quality improvement program	3.4 defects per million	Statistical process technology measure
Russell and Taylor (2003 cited Camgoz-Akdag, 2007)	Technical (statistics)	Statistical measures and quality improvement program	3.4 defects per million	Statistical process technology measure
Kumar and Gupta (1993 cited Motwani et al. 2004)	Technical (statistics)	Statistical measures, philosophy and quality-focused program	3.4 defects per million	Process design and statistical process technology measure

Table 3: Comparison of various Six Sigma definitions according to its perspective, essence and content (continued)

Details / Authors	Perspective	Essence	Aims	Means
Klefsjö, Wiklund, et al. (2001)	Technical (statistics)	Statistical method	3.4 defects per million	Statistical process technology measure
Breyfogle and Forrest (1999 cited McAdam and Lafferty, 2004)	Technical (statistics)	Statistical measure	3.4 defects per million	Statistical process technology measure
Brewer and Bagranoff (2004)	Technical (statistics)	Set of processes improvement tools	3.4 defects per million	Statistical process technology measure
Antony and Bañuelas (2002), Bañuelas and Antony (2002) and McAdam and Lafferty (2004)	Business	Business improvement strategy	Improve profitability, drive out waste and reduce quality costs	Improve effectiveness and efficiency of operations to meet or exceed customers' needs and expectations
Motwani, Kumar, et al. (2004)	Business	Quality system and approach	Ensure that products, processes and services satisfy customer needs	Designing collective plans, activities and events
Caulcut (2001)	Business	Business philosophy	Cost cutting and boosting customer satisfaction	Driving behaviour by making an organisation's values explicit in its compensation system and business strategy
Haikonen et al. 2004 cited Savolainen and Haikonen, 2007)	Business	Process improvement methodology	Increase business performance	A solid and accurate business focus
Caulcut (2001)	Combination of both perspectives	Information-driven methodology	Reducing waste and increasing customers' satisfaction	Improving processes and focusing on financially measured results
Linderman, Schroeder, et al (2003)	Combination of both perspectives	Organised and systematic method	Strategic process improvement and new product and service development	Relying on statistical methods and the scientific method to make dramatic reductions in customer-defined defect rates
Savolainen and Haikonen (2007)	Combination of both perspectives	Method	Achieving continuous process improvement	Focussing on eliminating variation
Harry (1998)	Combination of both perspectives	Strategy	A level of excellence in performance that is truly world-class	Measuring the degree to which any business process deviates from its goals

Table 3: Comparison of various Six Sigma definitions according to its perspective, essence and contents

Table 3 indicates that there is a disagreement regarding the essence of Six Sigma. While some authors (Antony, 2004; Bañuelas and Antony, 2002; Antony and Bañuelas, 2002; Harry, 1998; McAdam and Evans, 2004) have considered it as a strategy, others (Haikonen et al. 2004; de Koning and de Mast, 2006; Caulcut, 2001) have considered it as a methodology. In addition, others (Harry and Schroeder 2000 cited Caulcut, 2001; Klefsjö et al. 2001; Linderman et al. 2003) have considered it as a method whilst others (Snee, 2004 cited Antony et al. 2005; Motwani et al. 2004; Kendall and Fulenwider, 2000; Savolainen and Haikonen, 2007) have considered it as an approach.

Moreover, some authors (Breyfogle et al. 2001; Goh and Xie, 2004; McAdam and Lafferty, 2004; Brewer and Bagranoff, 2004) have considered it as a measure and a tool. By contrast, some (Tadikamala 1994, cited Henderson and Evans, 2000; Kumar and Gupta 1993, cited Motwani et al. 2004; Russell and Taylor 2003, cited Camgoz-Akdag, 2007) have considered it as quality program whilst others (Kumar and Gupta, 1993 cited Motwani et al. 2004; Caulcut, 2001) have considered it as a philosophy and others, (Motwani et al. 2004) have considered it as a system.

This disagreement could be acceptable because, as Caulcut (2001) has suggested, different definitions focus on different important aspects of Six Sigma. In addition, Six Sigma, as was mentioned earlier, has different interpretations and definitions for different people. According to McAdam and Lafferty's (2004) elaboration, Six Sigma could be a normal statistical measure within a larger quality improvement methodology to assist the identification of defects, or a broad strategic methodology that depends on firm management theory and practice involving a wide range of measures. Therefore, Six Sigma could be considered as any one of the aforementioned essences. However, this researcher agrees with writers such as Snee (2004 cited Antony et al. 2005) Motwani et al. (2004) Kendall and Fulenwider (2000) Savolainen and Haikonen (2007) who have considered it as an approach. This is because the word '*approach*' means, according to the Longman Dictionary, a method of doing something or dealing with a problem. So, since Six Sigma is a way to improve quality of products and services and eliminate defects, it is, in this researcher's opinion, an approach. This approach depends on the general principles of quality improvement philosophy that have been suggested by quality gurus such as Shewart, Deming, Crosby and Taguchi (Nachtsheim and Jones, 2003).

On the other hand, apart from this difference, there is integration with other elements of the definition. The aim and the means in all definitions that tackle Six Sigma are the same, according to the statistical perspective. As has shown in Table 3, the aim is to achieve 3.4 defects per million and the means are to exploit statistical process technology measurement. Moreover, the aim is the same in the definitions that tackle Six Sigma from a techniques perspective, whilst the means are slightly different. However, the entire means are part of the scientific method. In addition, there is no contradiction between the aims and means in the definitions that tackle Six Sigma according to the business perspective and the combination of both technical and business perspectives.. The aims are to reduce quality costs, eliminate waste, satisfy customers and increase profitability. Also, the means improve operational effectiveness and efficiency, design collective plans, activities and events and drive behaviours by making an organisation's values explicit in its compensation system and business strategy.

Bearing in mind a rigorous base definition that has been proposed by Schroeder et al. (2008), this definition has been built on a wide review of a large number of definitions. This is in order to capture the theoretical aspects of Six Sigma from the case study data and literature. They have defined Six Sigma as an organised, parallel-meso structure to reduce variation in organisational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives. Consequently, this researcher suggests his own definition, whereby the Six Sigma approach is an integrated set of strategic initiatives which includes plans, projects, programs and tools that have been built on the principles of quality improvement philosophy. This puts emphasis on solving the root causes of business problems, not only the indicators, through exploiting statistical and scientific methods with direct supervision of specialists and top management leadership. This will effectively and efficiently measure and improve each and every business process to achieve a level of product and service excellence in quality of equal to 3.4 defects per million to satisfy customers and generate significant profit margins.

In order to clarify the aforementioned suggested definition, some issues should be explained. The following part is dedicated to discuss the rationale, concept and features of the Six Sigma approach. In addition, there is an elaboration of the scientific and statistical methods and an explanation of the 'belts system' as a special structure to implement Six Sigma. However, prior to this elaboration, in the next part it is necessary to briefly define some of the terms related to the Six Sigma approach.

2.1.2 Definitions of several related terms

In order to discuss Six Sigma rationale and concepts, several terms should be defined. The following demonstration provides brief definitions of these terms.

2.1.2.1 Sigma

Briefly, as Pande et al. (2002) have defined, *"Sigma is the Greek letter statisticians use to represent the standard deviation of a population. The Sigma, or standard deviation, tells you how much variability there is within a group of items. The more variation there is, the bigger the standard deviation".*

2.1.2.2 Process

Most authors (Bal, 1998; Zairi, 1997; Harrison, 1998; Biazzo, 2000), who have been reviewed, have defined process as a set of activities to convert one or more inputs to an output that will achieve the expectations of internal and/or external customers.

2.1.2.3 Business Process

This term has nearly the same definition as that of process. However, business process is more focused on customer satisfaction, the bottom-line and the costs brought about by poor quality (Luo and Tung, 1999; Blakeslee, 1999; Kettinger and Grover, 1995; Harrison, 1998; Davenport and Short, 1990).

2.1.2.4 Critical To Quality characteristic

Quality characteristics are defined as determining and defining the customer needs and requirements to achieve satisfaction (Antony and Bañuelas, 2002). Following the Six Sigma definition and definitions of these terms, the rationale of the Six Sigma approach is elaborated.

2.1.3 The rationale of the Six Sigma approach

The concept of the Six Sigma approach was developed and concluded by engineers in Motorola Inc. (Harry, 1998). They stated that new products could be produced defect-free from the early stages in production. So, the idea is to measure customer requirements and performance against pre-defined targets during production, rather than after production (Caulcut, 2001).

Furthermore, nowadays business organisations are a web of interrelated processes rather than functional hierarchies (Luo and Tung, 1999). Poor quality and defective products are attributed to the variation of processes (Goh and Xie, 2004). Consequently, the effective implementation of the Six Sigma approach needs a rigorous mapping of existing business processes, agreement about the processes and the kind of outputs that customers expect (Blakeslee, 1999).

2.1.4 The concept of the Six Sigma approach

According to the above demonstration, Harry (1998) has stated that within the Six Sigma approach, there is recognition of a correlation between the number of defective products, wasted operating costs and the level of customer satisfaction. Moreover, the aim of statistical methods is to measure the capability of the process to perform defect-free work. Sigma capability reflects the performance target that applies to a single Critical To Quality (CTQ) characteristic (Bañuelas and Antony, 2002). According to Harry (1998), research has shown that a typical process is likely to deviate from its natural centring situation by approximately 1.5 standard deviations at any given moment in time. Depending on this principle, he has conducted a rational estimation of long-term process capability with only short-term performance knowledge. In addition, he has used a metric unit termed 'defects per opportunity' (DPO). Subsequently, the DPO is scaled to 'defects per million opportunities' (DPMO). Thus, the aim of Six Sigma is to reduce the opportunities of defect occurrence to achieve a higher sigma. Therefore, using the scientific methodology to improve the quality of both processes and products it is essential to achieve optimal results.

2.1.5 The features of the Six Sigma approach

The Six Sigma approach is distinguished by a number of features. It is a highly disciplined and structured approach that is conducted through various steps of scientific method and with statistical measures and tools (Antony, 2004; Klefsjö et al. 2001; Nachtsheim and Jones, 2003; Wiklund and Wiklund, 2002). In addition, it is a top-down approach that should be led by top management (Klefsjö et al. 2001; Wiklund and Wiklund, 2002). Moreover, it is a data-oriented or information-directed approach since decision-making depends on facts rather than intuition (Antony, 2004; Motwani et al. 2004; Goh and Xie, 2004; Klefsjö et al. 2001; Blakeslee, 1999; Brewer and Bagranoff, 2004; Wiklund and Wiklund, 2002).

Furthermore, Six Sigma is a customer-focused approach (Goh and Xie, 2004; Nachtsheim and Jones, 2003; Brewer and Bagranoff, 2004) which has a clear impact on the bottom line (Antony, 2004). It features the democratic environment that allows people across an organisation to discuss process capabilities. This democracy is supported by the existence of 'black belts' who are charged with the responsibility for improving processes (Antony, 2004; Caulcut, 2001; Brewer and Bagranoff, 2004). Six Sigma is an approach that integrates human elements such as culture change, customer focus, 'belts system' infrastructure with process improvement elements, such as process management, statistical analysis of process data and measurement system analysis (Antony, 2004).

2.1.6 Six Sigma approach techniques

As has been mentioned earlier, Six Sigma approach is a well-structured and disciplined way to manage business (Peter and Lawrence, 2002). Its strength is represented by the disciplined techniques that are represented by the scientific method and statistical measures and tools applied to improve the quality of process and products, as well as the belts system structure. The following is a demonstration of these techniques.

2.1.6.1 The scientific method for improving quality of processes and products

As an evolution of the Deming Cycle of Improvement methodology (PDCA), the scientific method has been proposed (Eckes, 2001; Nachtsheim and Jones, 2003; Linderman et al. 2003; Schroeder et al. 2008; Cheng, 2008; Savolainen and Haikonen, 2007; Tannock et al. 2007; Kuei and Madu, 2003). According to Benneyan and Chute (1993, cited Cheng, 2008), the general concept of the PDCA cycle the general concept of the PDCA cycle comprises four basic stages: plan, do, check and action stages. Briefly, a plan confirms the targets through the ‘plan’ stage. Then, the plan is tested in daily management through the ‘do’ stage. Next, the effects are evaluated and the results reviewed during the ‘check’ stage. Consequently, appropriate corrective actions are taken during the ‘action’ stage.

The scientific method of Six Sigma, by contrast, has begun with the MAIC cycle, which is an acronym for ‘measure, analyse, improve and control’ (de Koning and de Mast, 2006; Folaron et al. 2003). This cycle has been modified. A five-stage structure is proposed, in which a ‘define’ (D) stage precedes the other four. This modified cycle is DMAIC, which provides valuable guidance for identifying key tasks to improve the quality of processes, services and products to achieve customer satisfaction (Goh and Xie, 2004; Bañuelas and Antony, 2002; Kuei and Madu, 2003; Antony and Bañuelas, 2002; Folaron et al. 2003; Schroeder et al. 2008; McAdam and Evans, 2004; Tannock et al. 2007; de Koning and de Mast, 2006; Sekhar and Mahanti, 2006; Brewer and Bagranoff, 2004; Ehie and Sheu, 2005; Linderman et al. 2003; Savolainen and Haikonen, 2007; Cheng, 2008). As a result of persistent improvement of the scientific method, two other stages have been proposed. Pfeifer et al. (2004) have proposed a cycle that begins with ‘design’ (D) and ends with ‘verify’ (V) in addition to the same other stages, with the exception of the ‘define’ stage. Senapati (2004) has added ‘reporting’ (R) to the end of the DMAIC cycle. Thus, it should be called

DMAICR. This stage mainly involves reporting the benefits of the re-engineered process. In conclusion, this demonstration has shown that although there are various ways to conduct the scientific method of Six Sigma, most scholars suggest the DMAIC cycle as the preferred way of achieving this (de Koning and de Mast, 2006). For additional clarification, the following part is dedicated to elaborate the stages of the DMAIC cycle as the most popular way to conduct the Six Sigma scientific method and the statistical measures and tools related to these stages.

2.1.6.1.1 The stages of DMAIC cycle

As has been mentioned earlier, the DMAIC cycle comprises five stages. In order to perform these five stages, several steps should be taken. According to the literature that has been reviewed, there are no serious inconsistencies regarding the description of these stages and their steps (de Koning and de Mast, 2006). In this context, the ‘define’ stage is conducted in order to identify and assess the problem regarding the benefits that will be accomplished for the customer and the business (Goh and Xie, 2004). This includes, as de Koning and de Mast (2006) have claimed, problem selection and benefit analysis. This entails, according to Henderson and Evans (2000), project teams identifying a project suitable for Six Sigma efforts based on business objectives as well as customer needs and feedback. Also, this team identifies critical-to-quality characteristics that the customer considers to have the most impact on quality. Thus, according to a number of contributors, this stage could be achieved through four main stages: identifying and mapping relevant processes, identifying targeted stakeholders, determining and prioritising customer needs and requirements, and making a business case for the project (de Koning and de Mast, 2006).

In the ‘measure’ stage, as the second stage of the DMAIC cycle, the measurement capability is assured according to the determined current performance levels and CTQ characteristics (Goh and Xie, 2004). The aim of this stage, as de Koning and de Mast (2006) have stated, is to translate the problem into a measurable form and measure the current situation. This entails that the team identifies the key internal processes that influence CTQs and measures the defects currently generated relative to those processes (Henderson and Evans, 2000). Thus, according to a number of literatures, several steps are conducted in order to fulfil this stage (de Koning and de Mast, 2006). These steps include selecting one or more CTQs, determining operational definitions and requirements for CTQs, validating the measurement system of the CTQs, assessing the current process capability and lastly, defining objectives.

In the 'analyse' stage, as the third stage of the DMAIC cycle, the linkage between key process variables and the root causes of defective parts is discovered (Goh and Xie, 2004). This means that this stage includes the identification of causes, the establishment of the baseline process capability, as well as the implementation of corrective actions (de Koning and de Mast, 2006). This implies the team discovers the reasons for generating defects by identifying the key variables that are most likely to create process variation (Henderson and Evans, 2000). Therefore, according to a number of literatures, in order to perform this stage, two steps should be accomplished, namely identifying potential influence factors and selecting the vital few influence factors (de Koning and de Mast, 2006).

In the 'improve' stage, the effects of the key process variables on the CTQ characteristics are quantified, and the acceptable limits of these variables are determined to reduce the CTQ defect level through modification of the process (Goh and Xie, 2004). This includes designing and implementing adjustments to the process in order to improve the performance of the CTQs (de Koning and de Mast, 2006). This, in turn, entails that the team confirms the key variables and quantifies their effects on the CTQs, identifies the maximum acceptable ranges of the key variables and validates a system for measuring deviations of the variables, and modifies the process to stay within the acceptable range (Henderson and Evans, 2000). Thus, according to a number of literatures, in order to achieve this stage of the DMAIC cycle, three steps should be conducted (de Koning and de Mast, 2006). These steps are: quantifying the relationship between influence factors and CTQs, designing actions in order to modify the process or settings of influence factors in such a way that the CTQs are optimised, and lastly, conducting a pilot test of improvement actions.

Finally, in the 'control' stage, actions are taken to maintain the desirable performance level and to sustain short and long-term benefits (Goh and Xie, 2004). This includes modifying the process management and control system to maintain the improvements (de Koning and de Mast, 2006). This implies that tools are put in place to ensure that under the modified process, the key variables remain within the maximum acceptable ranges over time (Henderson and Evans, 2000). Therefore, according to a number of literatures, two steps are required to attain this stage (de Koning and de Mast, 2006): determining the new process capability and implementing control plans.

In order to achieve the aforementioned stages of the scientific method (DMAIC) in a systematic way, a number of statistical tools should be exploited. This is because one of Six

Sigma's features is fact or data orientation. Thus, these tools may be considered useful for the purposes of data collection, management and analysis. The following section is dedicated to demonstrating these main tools.

2.1.6.1.2 The statistical tools

A number of Six Sigma books that have been written for practical purposes such as Bhote (2003), Pande et al. (2002), Eckes (2001), Gitlow and Levine (2005) and Pande et al. (2000) includes a similar elaboration of a number of statistical tools that are associated with the DMAIC stages. The aim of these tools, according to these books, is to tackle the problem in hand and manage the improvement project that is suggested to solve this problem. Some of these tools are simple, whilst others are more advanced. The choice of the right tool depends on the degree of the breakthrough improvement in business processes (Antony and Bañuelas, 2002). Subsequently, in order to run a project successfully, it is often sufficient to possess an analytical background and to use only part of the available methods. The wise application of statistical tools can be accomplished through the use of statistical analysis software (Breyfogle et al. 2001, cited Pfeifer et al. 2004). Therefore, employees should be taught the purpose of exploiting each tool in order to be able to select the proper tools to successfully approach and complete Six Sigma projects (Henderson and Evans, 2000). This is because, as Pande et al. (2000) have claimed, each of these tools has one or more specific applications, and they could be misused or prove to be unproductive if not chosen and applied with care.

Accordingly, the following part is dedicated to a general elaboration of a number of these tools. This elaboration includes the purpose of exploiting the tool, its applications, and a brief description of the way of undertaking such applications. In addition, as the aim of the following part is a general elaboration of these tools and as there is an agreement among the authors who tackle this issue in the context of the Six Sigma approach, the following part is mainly a summary of the work of Pande et al. (2002) and Pande et al. (2000).

Pande et al. (2000) have demonstrated these tools based on their most common use in the Six Sigma improvement effort. Thus, the sequence of these tools begins with statistical process control and control charts. The purpose of these charts is to help an organisation or process owner to identify potential problems or unusual incidents in order to take actions that could promptly resolve such problems. This statistical process control involves the measurement and evaluation of variation in a process, and the efforts made to limit or control such variation.

The second group of statistical tools mentioned by Pande et al. (2000) are used to test statistical significance. This group involves Chi-Square, *t*-test and ANOVA. The aim of these tools is to define problems and analyse root causes. Moreover, this aim has been built on the assumption that it is often possible to draw valid conclusions by measuring and analysing the data related to a process or product. However, in order to ensure the validity of these conclusions, more rigorous statistical analysis methods are applied. These methods help to find or confirm trends or patterns in the data. Tests of statistical significance are considered as some of these methods. In the context of Six Sigma these tools have various possible applications. These include: confirming a problem or meaningful change in performance, checking data validity, determining the type of pattern or distribution in a group of continuous data, developing a root-cause hypothesis based on patterns and differences, and validating or disproving root-cause hypotheses.

As has been mentioned earlier, there are several methods to select in order to statistically test a hypothesis. The first is Chi-Square, a technique used with discrete data, and in some cases with continuous data. It could be applied to compare defect rates in two locations to see if they are significantly different. Moreover, it could be exploited to check and find out the continuous changes in customer product choices and used to test the impact of various staffing levels on customer satisfaction. The second method within this group is the *t*-test. Its purpose is to test the significance of two groups or samples of continuous data. This helps to compare the cycle time for a key step in a process at, for example, two weeks, in order to find out the meaningful change. This test may also assist in the examination of customer income levels, for example, in two regions. In addition, it helps to test the 'seek time' speed, for example, in two lots of disk drive. ANOVA is another test of significance for continuous data. It can be used to compare more than two groups or samples. Thus, the features of this method's applications are similar to that of the *t*-test with a different number of samples. Similarly, MANOVA is a method of multivariate analysis. It is used in order to determine the significance of several factors. Usually, it is best applied after an ANOVA test.

The tools of correlation and regression analysis are the third group. The aim of these tools is to analyse the relationships among two or more factors. This relationship is known as the correlation between two factors. This means a change in one factor will be accompanied by a change in the other. The strength of this relationship is measured by applying statistical calculations. This helps to draw a number of conclusions about the relationship. There are various reasons for conducting this type of analysis. It helps to test root-cause hypotheses by finding a link between the suspected cause and the response or output. In addition, regression analysis assists in the measurement and comparison of the influence of various factors on the results. In addition, it helps to predict the performance of a process, product or service under certain conditions. However, this analysis could be applied in the case of the availability of data for two or more factors that are matched on individual items.

Design of Experiments (DOE) is the fourth type. The aim of this tool is to test and optimise the performance of a process, product, service or solution. It draws heavily on the techniques that have just been reviewed in order to learn about the behaviour of a product or process under varying conditions. This tool facilitates the planning and control of the variable through conducting an experiment. DOE has several potential applications in the Six Sigma organisation. It helps to assess the voice of customer systems in order to find the best combination of methods producing valid feedback without annoying customers. DOE allows assessing factors to isolate the vital root cause of a problem or defect and assist in pilot or test combinations of possible solutions in order to find the optimal improvement strategy. In addition, DOE helps to evaluate product or service designs to identify potential problems and reduce defects right from the beginning.

Failure Modes and Effects Analysis (FMEA) is another statistical tool. This tool is a set of guidelines, a process and a form to identify and prioritise potential problems or failures. In addition, it helps a manager, improvement team or process owner to focus the energy and prevention resources, monitoring and response plans where they are most likely to pay off. Moreover, this tool has many applications in a Six Sigma environment, not only in terms of looking for problems in work processes and improvements, but also in data-collection activities, voice of the customer efforts, procedures and even the rollout of a Six Sigma initiative.

This demonstration is a summary description of a number of the main statistical tools that could be exploited in different stages of the DMAIC cycle as has been explained by Pande et al. (2000) and Pande et al. (2002). Combining these tools with the DMAIC cycle forms the scientific method that could be exploited to improve the quality of processes, products and services. This method, besides the ‘belts system’, represents the strength of the Six Sigma approach (Caulcut, 2001). The following part is an elaboration of the belt system and its role in distinguishing the Six Sigma approach from other quality improvement tools, approaches and philosophies.

2.1.6.2 The Belts system structure

Harry (1998) has stated that since organisations are built around individuals and their knowledge, the success of the Six Sigma approach depends upon employees being trained properly. These individuals have been considered as either improvement specialists (Linderman et al. 2003) or experts with specific roles and responsibilities (Henderson and Evans, 2000). Moreover, a high profile group of individuals is deployed and structured in a system. This system is known as the belts system (Ingle and Roe, 2001; Caulcut, 2001). In this system, employees' jobs are identified, and according to Senge (1990, cited Wiklund and Wiklund, 2002), depending on their role in the projects, they can either focus on the process improvement itself or on the implementation of methods needed for continuous improvement. The expert consultants act as problem-owners and problem-solvers.

Because Six Sigma is a top-down initiative, this group is organised in a hierarchical structure (Goh and Xie, 2004; Antony and Bañuelas, 2002; Buch and Tolentino, 2006). This structure includes, according to a number of authors (Goh and Xie, 2004; de Mast, 2004; Antony and Bañuelas, 2002; Henderson and Evans, 2000; Schroeder et al. 2008; Linderman et al. 2003; Savolainen and Haikonen, 2007; de Mast, 2004), Champion, Master Black Belts, Black Belts and Green Belts. In this respect, Champions are fully trained business leaders who promote and lead the deployment of Six Sigma in a significant area of the business (Henderson and Evans, 2000). Usually, they are vice presidents, superintendents, directors and group managers (Savolainen and Haikonen, 2007). So, their task is to identify strategically important projects for the improvement teams and provide resources (Linderman et al. 2003). Furthermore, they review the improvement projects with Black and Green belts in order to understand and ease the barriers to the progress of their projects (Antony and Bañuelas, 2002). Usually, Champions receive an introduction to Six Sigma rather than detailed training (Linderman et al. 2003). Typically, this training program runs from one to two days to give an overview about the philosophy (Savolainen and Haikonen, 2007).

Master Black Belts are more experienced professionals who provide guidance to Black Belts and Champions (Lynch et al. 2003; Wiklund and Wiklund, 2002). This is because of their integral role in effectively scoping projects that enable them to serve as a link balancing the sometimes conflicting underlying goals of the Black Belts and Champions

(Lynch et al. 2003). Therefore, they should be a member of Black Belt-led teams and provide the required expertise to complete the project successfully (Wiklund and Wiklund, 2002). However, in order to perform their tasks effectively, they should receive additional one-week training sessions after working a few years as a Black Belt. This session is designed to improve their quantitative skills and the ability to teach and mentor (Savolainen and Haikonen, 2007). Consequently, Master Black Belts are responsible for Six Sigma strategy, training, mentoring, deployment and results (Henderson and Evans, 2000).

Another level of the hierarchical structure is Black Belts. They have been considered either as heavyweight project managers (Clark and Fujimoto, 1991, cited Schroeder et al. 2008), high potential employees (Caulcut, 2001) or fully-trained Six Sigma experts (Henderson and Evans, 2000). Typically, they act as team leaders (Savolainen and Haikonen, 2007). Usually they are chosen from quality engineers and statisticians (Wiklund and Wiklund, 2002). They play a major role in deploying the Six Sigma philosophy and provide leadership for the teams working on the projects as well as doing a portion of the project work (Wiklund and Wiklund, 2002; Linderman et al. 2003; Caulcut, 2001; Henderson and Evans, 2000). So, they help maintain discipline and a vision of the big picture solution as the team explores the problem (Brown and Eisenhardt, 1995, cited Schroeder et al. 2008). Moreover, they play an essential role in Six Sigma because they bridge the gap between senior management and project improvement teams (Clark and Fujimoto, 1991 cited Schroeder et al. 2008). They are also responsible for educating Green Belts, where the focus is on statistical and other problem-solving tools and is offered to several categories of employees (Wiklund and Wiklund, 2002). Consequently, their tasks are to ‘mentor’, ‘teach’, ‘coach’, ‘transfer’, ‘identify’ and ‘influence’ (Harry, 1998).

Therefore, in order to achieve these tasks, they should possess several skills. They should have a clear understanding of their company's business strategies and objectives, as well as a strong process orientation. They should have a solid knowledge of and ability to apply statistical/analytical tools and techniques, as well as strong facilitation, teaching, and team-building skills. In addition, they should possess change management skills and experience of cross-functional business and work experience. Thus, considerable time is taken to select and equip them with the specific training required to successfully execute their roles (Byrne, 2003). This includes extensive training in statistics, interpersonal skills, problem-solving and project management (Caulcut, 2001). This program could be run either for four weeks (Savolainen and Haikonen, 2007; Linderman et al. 2003) or four months

(Wiklund and Wiklund, 2002). This depends on the amount of educational materials that should be delivered to them. However, although they are prepared properly and they could enjoy high job satisfaction and high status, they should move on after two years. A small number would become Master Black Belts, but many would return to line management with enhanced prospects of promotion (Caulcut, 2001).

Green Belts form another level of the belt hierarchical structure and act as part-time improvement specialists and a member of the Six Sigma team. Because of their limited role in Six Sigma teams, to assist Black Belts to accomplish improvement projects, they receive less training. This training program runs for two weeks in order to help develop understanding of the philosophy and the use of basic quality tools (Haikonen et al. 2004, cited Savolainen and Haikonen, 2007; Linderman et al. 2003).

To sum up, the belts system indicates that belt holders are the change agents who should spread Six Sigma principles throughout the company as well as operators who know their process better than anybody else. Thus, they receive proper training. However, this does not mean they are the only people who are in charge of Six Sigma, because it is an organisation-wide initiative as well as a responsibility of everyone in an organisation. Therefore, the belt system is one feature distinguishing the Six Sigma approach from other quality improvement philosophies, approaches and tools.

Overall, Six Sigma could be viewed as an approach that has developed from previous philosophies and practice to form a new and unique application. The novelty and uniqueness of this approach could be seen, as has been shown earlier, in several aspects. In this context, Schroeder et al. (2008) have claimed that the deployment approach and emergent structure of Six Sigma are new. In addition, Ingle and Roe (2001, cited McAdam et al. 2005), based on the work of Sanders and Hild (2000), have contended that the uniqueness of the Six Sigma approach comes from problem-solving as well as attention to bottom line results and performance outcomes over time. Moreover, McAdam et al. (2005) have emphasised that the novelty of Six Sigma is represented by developments in statistical and operational methods of data analysis. They have claimed, also, at a strategic level, that literature suggests that Six Sigma appears to offer a focus on quantifiable benefits. Thus, they have concluded that Six Sigma is seen as having a significant impact on improving operational efficiency.

Furthermore, Klefsjö et al. (2001) have asserted that the novelty of Six Sigma is its explicit linking of the tactical with the strategic. The new aspect of Six Sigma is so efficient. Often, statistical techniques are used in a systematic way to reduce variation and improve processes. There is a focus on results, including customer-related ones, that lead to enhanced marketplace performance and hence improved bottom line financial results. Karuppusami and Gandhinathan (2006) have drawn attention to the novelty of Six Sigma, represented by its target to reduce defects to near perfection. They have contended that it is a high performance, data-driven method for improving quality by removing defects (and their causes) in business process activities. The Six Sigma approach links customer requirements and process improvements with financial results, while simultaneously providing the desired speed, accuracy and agility in today's e-age. Similarly, Folaron et al. (2003) have emphasised that customer focus, data driven decision-making, business results focus and process understanding are not new approaches to quality improvement. The new aspect that makes Six Sigma so efficient is the combination of these elements with a rigorous, disciplined approach and well-publicised proven business successes. Thus, Six Sigma, as Pfeifer et al. (2004) have claimed, is the most effective concept because of the interrelationship between its strategy, organisational structures, procedures, tools and methods.

These claims and others regarding the novelty of Six Sigma are the issue of the next section. A lengthened comparison is conducted in order to show the similarities and differences between Six Sigma and other quality improvement tools, approaches and philosophies. This comparison is conducted in order to justify the choice of Six Sigma to be adopted as an alternative way to improve product quality.

2.2 Section 2: A comparison of the Six Sigma approach with other tools, approaches and philosophies of quality improvement

Despite Six Sigma being a new approach to quality improvement, it is deep-rooted in the quality improvement principles suggested by quality gurus. This includes Deming's fourteen points, Juran's ten steps and Crosby's fourteen steps to quality improvement (Badiru and Ayeni, 1993; Mitra, 1993; Elshennawy, 2004). Looking into these principles shows that it is difficult to argue that any change management philosophy or methodology is new. Grint (1997, cited McAdam and Lafferty, 2004) and Willmott (1995, cited McAdam and Lafferty, 2004) have argued that any supposedly new or emergent approach to business improvement has historical ancestry. Grint has contended that this history influences the current development of such approaches. Thus, it can be argued that Six Sigma must have historical roots despite the uniqueness and newness of this approach (Ecks, 2000, cited McAdam and Lafferty, 2004). Thus, there are a number of similarities and differences between this approach and other quality improvement tools, approaches and philosophies. This section is dedicated to discuss these similarities and differences through an extensive comparison between them. This comparison is conducted in two parts. The first part proceeds with a detailed comparison of the definitions of these tools, approaches and philosophies. It is followed by a generic comparison that includes features, techniques, advantages, and drawbacks.

2.2.1 Comparing the Six Sigma approach definition with the definitions of other quality improvement tools, approaches and philosophies

In order to show the similarities and differences between the definition of the Six Sigma approach and other quality improvement tools, approaches and philosophies, a large number of definitions of the latter will be demonstrated and discussed in the following part. The aim of this comparison is to elaborate the evolution of Six Sigma. This comparison begins with definitions of the traditional quality improvement tools, namely, inspection, quality control and quality assurance followed by definitions of the strategic quality management approaches and philosophies such as total quality control, total quality management and business process re-engineering.

2.2.1.1 Comparing with traditional quality improvement tools definitions

A number of writers depend on the definition of British Standards (BS) and/or International Organisation of Standards (ISO) to define the traditional quality improvement tools. According to BS 4778, 1987; ISO 8402, 1986 (cited Yong and Wilkinson, 2002), inspection is defined as activities such as measuring, examining, testing, gauging one or more characteristics of a product or service and comparing these with specified requirements to determine conformity. Moreover, BS 4778, 1987; ISO 8402, 1986 (cited Yong and Wilkinson, 2002; Komashie et al. 2007; Ishikawa, 1985; Pond, 1994; Bestfield, 1990) quality control has been defined as the operational techniques and activities that are used to fulfil requirements for quality. Furthermore, BS 4778, 1987;ISO 8402, 1986 quality assurance has been defined as the entire planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality (Pike and Barnes, 1994; Mitra, 1993; Bestfield, 1990; Yong and Wilkinson, 2002).

These definitions show that the essence of traditional quality improvement tools is simple compared with that of Six Sigma. Whilst, the former are a set of activities or actions, the essence of Six Sigma is more complicated. It is, as has been shown earlier, an integrated set of strategic initiatives which includes plans, projects, programs and tools. The definitions of traditional quality improvement tools are manufacturing-based definitions, whilst Six Sigma is defined on manufacturing and customer bases. This is attributed to the aim of the former which is to confirm specifications by measuring, examining, testing, gauging one or more characteristics of a product or service, whilst Six Sigma aims to satisfy both customers and shareholders by achieving a level of product and service quality excellence of equal to 3.4 defects per million.

In this researcher's opinion, the simplicity of the definitions of traditional quality improvement tools initiates from the simplicity of the evolutionary necessity of each tool. In this respect, the evolution of inspection is attributed to the large number of shoddy products that have been yielded as a result of mass production. (Rao, Tummala and Tang, 1996; Folaron et al. 2003; Yong and Wilkinson, 2002). However, inspection does not prevent the production of defective items, despite inspection beginning with checking the raw material. Therefore, defects are usually discovered only after production process completion. Thus, these defects should be reworked or scrapped. Both these solutions are wastes that should be avoided (Badiru. and Ayeni, 1993; Mitra, 1993; Dale and Cooper, 1992). Therefore, in order to prevent customers consuming defective items, a 100 per cent inspection should be conducted. However, this is considered to be a time and resource consuming procedure (Folaron et al. 2003).

Quality control is innovated to control product variables through sample plans. These plans are a system that does not rely on 100 per cent inspection to decide whether a lot of material is acceptable. These control charts were originally suggested by Shewart in the 1920's (Yong and Wilkinson, 2002; Raho and Mears, 1997). In this period and with this chart, statistical quality control was first pioneered (Banks, 1989). According to this development, the role of inspection was not cancelled, but reduced. However, as a result of a huge rise in demand for civilian goods at the end of World War II, shoddy merchandise flooded the market. This was because manufacturers produced and shipped products that comprised cheap quality materials and minimum inspection (Jacques, 1996). Thus, quality assurance was necessary to maintain product quality.

As a result of this need, quality assurance was developed. This tool requires that quality should be built into the design stage of products and processes (Dale and Cooper, 1992). This is because shoddy quality could be more easily avoided in the early stages and not in the later control stage after production. This means that quality methods have shifted from fire-fighting activities to prevention of defects (Juran 1995 cited Jacques, 1996). Moreover, quality assurance gives a significant role to the involvement of management in order to assure quality of products and services (Raho and Mears, 1997). Therefore, as a result of intensification of the role of management in quality improvement activities, the necessity of company-wide efforts for improving quality was recognised. This motivated the initiation of modern quality improvement tools, approaches and philosophies.

2.2.1.2 Comparing with the definitions of the modern tools, approaches and philosophies

According to the nature of the improvement that could be achieved by exploiting modern tools, approaches and philosophies, they are classified into two categories. They are 'continuous' and 'breakthrough improvement' (Johnston et al. 2001; Cole, 2001; Harrington, 1995; Behara et al. 1995; Henderson and Evans, 2000; Ivanovic' and Majstorovic', 2006). Amongst others total quality control and total quality management are two examples of the former category. In contrast, Business Process Re-engineering and Six Sigma, amongst others, are examples of the latter category. The following part shows a comparison of the definitions of the approaches and philosophies of these two categories in order to clarify the similarities and differences between these definitions. This comparison begins with the first category.

2.2.1.2.1 The definitions of the continuous quality improvement approaches and philosophies

A continuous or evolutionary improvement as has been suggested by Johnston et al. (2001), Ivanovic' and Majstorovic' (2006) and Cole (2001) is a philosophy or a paradigm of change (whether in terms of basic strategies, culture and management systems) followed by changes during the development process. This category includes approaches and philosophies such as total quality control, total quality management and ISO 9000/2000. The comparison begins with total quality control and is followed by total quality management and ISO 9000/2000.

2.2.1.2.1.1 The definitions of total quality control and related methods

The first philosophy in this category is total quality control (TQC). It is a Japanese way for attaining company-wide quality improvements. This philosophy has been built on the earlier contributions of Shewart. However, Feigenbaum is considered the guru who originally proposed this philosophy in 1956 (Ishikawa, 1985; Yong and Wilkinson, 2002; Raho and Mears, 1997). Feigenbaum extended Juran's notion of managing for quality to be of the entire organisation. In his own terminology, TQC is defined as: "*an effective system for integrating quality development, quality maintenance, and quality improvement efforts of the various groups in an organisation so as to enable production and service at the most economical levels which allow for full customer satisfaction"* (Feigenbaum, 1983. p. 6 cited Yong and Wilkinson, 2002). Although he preached the integration of quality improvement efforts of the various groups in an organisation, he feared that quality would ultimately be no one person's responsibility. Therefore, he proposed to dedicate responsibility to employees working as quality improvement specialists. However, Ishikawa, one of the Japanese quality improvement gurus disagreed with him and insisted that quality should be everyone's responsibility in the organisation (Ishikawa, 1985).

Simultaneously, two new quality improvement methods have been initiated according to TQC philosophy. These methods are Quality Control Circles (QCC) and Quality Function Deployment (QFD) (Martínez-Lorente et al. 1998). The former is an actual application of the principle of people involvement in quality improvement efforts as suggested by Ishikawa in the 1960s (Salaheldin and Zain, 2007). QCC has been defined as a small group of people of up to twelve individuals. These individuals who are from the same workplace meet voluntarily on a regular basis. The purpose of these groups is to study their work-related problems and suggest solutions (Goh, 2000; Canel and Kadipasaoglu, 2002; Salaheldin and Zain, 2007). The main purpose of these quality circles is to focus upon attaining both internal and external customer satisfaction. In addition, QCCs require ambitious coordinated teamwork that continuously improves quality (Bestfield, 1990; Goh, 2000; Salaheldin and Zain, 2007).

QFD is another method that has been initiated according to TQC. This method was proposed by a Japanese Professor Yoji Akao in the late 1960's to early 1970's (Bouchereau and Rowlands, 2000; Herrmann et al. 2006; Lockamy III and Khurana, 1995). QFD is an actual application of principles of customer focus and design for quality that have been suggested by most quality gurus. This method consists of two elements (Lockamy III and Khurana, 1995). The first element is quality deployment which fulfils customers' requirements and expectations in the design process. The second element is function deployment, which involves the joining of different organisational functions into the design-to-manufacturing transition through forming design teams. Therefore, QFD has been defined as the method (Kathawala and Motwani, 1994; Srinidhi, 1998) for planning in order to achieve a product quality design (Herrmann et al. 2006) that translates customer voices (Bouchereau and Rowlands, 2000) into design specifications (Chao and Ishii, 2004). According to this definition, the aim of quality function deployment is to identify real customers' requirements in order to develop products that satisfy them (Herrmann et al. 2006; Kathawala and Motwani, 1994).

Examining the aforementioned philosophy and the related method definitions, it could be inferred that some similarities exist between the definition of Six Sigma and these definitions. All of the definitions are customer-based. Their aim is to satisfy customers in order to achieve their loyalty. Moreover, according to Ishikawa's (1985) clarification, total quality control definition entails top management satisfaction through developing and maintaining organisational reputation. Although this aim is similar to one of Six Sigma's aims, the latter is more comprehensive because it includes shareholders. In addition, achieving the best quality in the world as one of the total quality control objectives is too wide compared with the specific goal of Six Sigma that identifies the level of quality excellence equal to 3.4 defects per million. Utilising statistical tools, also, is similar in both total quality control and Six Sigma. However, statistical tools in the former are used for quality control whilst in Six Sigma they are used for different purposes as elaborated in pages 28-32.

Furthermore, the definitions of TQC and the related methods show two other new concepts. The first is company-wide quality improvement that entails people involvement at different levels in quality improvement activities. The second concept is an effective system that includes quality improvement activities and actions. These two concepts are similar to the Six Sigma definition. However, the company-wide involvement concept was not clear. This is attributed to the contradiction between both quality gurus Feigenbaum (1983. p. 6 cited Yong and Wilkinson, 2002) and Ishikawa (1985) regarding quality responsibility. However, in Six Sigma this concept is represented by the belts system. In addition, the system concept in total quality control is limited compared to the integrated system that is shown in the Six Sigma definition in pages 15-22. This is because, as has been argued by Martínez-Lorente et al. (1998) and Ehigie and McAndrew (2005), the term ‘control’ within the TQC philosophy has limited meanings, because quality is not just a matter of control, it has to be managed. Therefore, this led to the development of total quality management as a new quality improvement philosophy. The next part is dedicated to the comparison between total quality management and Six Sigma definitions.

2.2.1.2.1.2 The definitions of total quality management

The second philosophy in the continuous quality improvement category is total quality management (TQM). As a result of manipulating the shortcomings of the previous philosophy, TQM was coined, as has been argued by Ehigie and McAndrew (2005), in 1985 by Naval Air Systems. Subsequent to this, TQM has been considered as a preferred integrative management philosophy for improving quality and organisations’ productivity (Karuppusami and Gandhinathan, 2006; Karia and Asaari, 2006; Elshennawy, 2004). Generally, its main aim is to improve the quality of products and services to achieve customer satisfaction (Ehigie and McAndrew, 2005; Karuppusami and Gandhinathan, 2006).

Although there is an international definition of the term TQM in the ISO 9000 standard, there is no universally agreed definition amongst quality scholars, authors and researchers (Martínez-Lorente et al. 1998; Isaksson, 2006; Raho and Mears, 1997). According to these scholars and others (Yang, 2006; Hoang et al. 2006), there are many different definitions of this term. Isaksson (2006) and Gore Jr (1999) have argued that no single definition can encapsulate the entire totality of TQM. Other writers (Ahire and Golhar, 1996; Hellsten and Klefsjö, 2002; Yang, 2003 cited Yang, 2006) have claimed that researchers have approached this issue from different perspectives. Nevertheless, there is still a general consensus regarding the essential principles, practices and values of TQM. However, Martínez-Lorente et al. (1998) have contended that this is not an easy task because every author defines this term according to their beliefs, prejudices and business and/or academic experience. Table 4 presents various TQM definitions. This table is divided into six columns. Each column represents definitions that have been categorised according to their respective essence.

Broad definition	Element	System	Model	Philosophy includes system	Philosophy
A constant endeavour to fulfil and preferably exceed, customer needs and expectations at the lowest cost, by continuous improvement work, to which all involved are committed, focusing on the processes in the organisation (Bergman and Klefsjö, 2003 cited Isaksson, 2006). This definition, also, indicates the importance of providing more value at a lower cost (Isaksson, 2006). According to Tarí (2005) who reviews a number of definitions that are suggested by a number of authors such as Dale and Shaw, (1991), Bunney and Dale (1997), Stephens (1997), Hellsten and Klefsjö (2000) and Curry and Kadasah (2002), also shows that TQM is rather more than a mere set of factors, a network of interdependent components, a management system consisting of critical factors, techniques and tools. In fact, techniques and tools are vital to support and develop the quality improvement process. As such, (Prajogo and McDermott, 2005) claimed, we adopted the definition of TQM articulated by Ross (1995, p. 1) as the integration of all functions and processes within an organisation to achieve	Boaden (1997 cited Yang, 2006) views TQM as one element of cultural change, along with human business process re-engineering).	Luthans (1995 cited Karia and Asaari, 2006) summarised TQM as being a participative system that empowers all employees to take responsibility for improving quality within the organisation. TQM, according to Isaksson (2006) who reviews a number of definitions that are suggested by Hellsten and Klefsjö, (2000), Bergman and Klefsjö (2003) TQM can be seen as a management system based on values, methodologies and tools. Yang, (2006) reported Hellsten and Klefsjö (2002) and Hansson and Klefsjö, (2003) definitions of TQM as “a management system in continuous change, which is constituted of values, methodologies and tools, the aim of which is to increase external and internal customer satisfaction with a reduced amount of resources”.	TQM is a management model that aims to meet customer needs and expectations within an organisation through continuous improvement of the quality of goods and services and by integrating all functions and processes within an organisation (Prajogo and McDermott, 2005)	TQM is one such philosophy, which aims to provide organisations with a template for success through customer satisfaction. TQM can be described as the development of an organisational culture, which is defined by, and supports, the constant attainment of customer satisfaction through an integrated system of techniques and tools. TQM is a way of managing to improve the effectiveness, efficiency, flexibility and competitiveness of a business as a whole (Ho and Fung, 1994 cited Rad, 2006). Yang (2006) cited Short and Rahim (1995) and Boon et al. (2005) definitions that view TQM as a programme or a system, but as a set of philosophies and methods used by an organisation to guide it in continual improvement in all aspects of its business.	TQM is a management philosophy that seeks to integrate all organisational functions to focus on meeting customer needs and organisational objectives (Hashmi, 2000-2004 cited Ehigie and McAndrew, 2005). TQM is a management philosophy that makes use of a particular set of principles, practices and techniques to expand business and profits. Because unequivocally, increased market share is a direct consequence of better quality that provides a bypass to enhanced productivity by avoiding rework, rejects, waste, customer complaints and high cost (Deming, 1986 cited Rahman and Siddiqui, 2006) The word TQM, as Thakkar et al. (2006) concluded, itself suggests many associations in the mind of user. Various views on the acceptance of the approach as the philosophy or process have generated numerous definitions. For example: • Witcher (1990) defines the term by breaking the phrase into three terms, whereby ‘total’, implies every person is involved (including customers and suppliers), ‘quality’, implies customer requirements are met exactly; and ‘management’, implies senior executives are committed. • Taylor and Hill (1992) define TQM as a customer-focused process which

Table 4: The categories of TQM definition (continued below)

Broad definition	Element	System	Model	Philosophy includes system	Philosophy
continuous improvement of the quality of goods and services with the ultimate goal being customer satisfaction. McAdam and Henderson (2004) reported a definition that is based on the work of Dale et al. (2001), Hermel (1997), Hackman and Wageman (1995) and DeCock and Hipkin (1997), who defined TQM as embodying the following constructs: TQM is strategically linked to organisational goals. -Customer satisfaction and understanding is vital within the organisation. -Employee participation and understanding at all levels is required within the organisation. -There is a need for management commitment and consistency of purpose within the organisation. -The organisation is perceived as a series of processes, which incorporate customer-supplier relationships. Thus, a broad and inclusive TQM definition is used, avoiding the restrictive dangers of narrow mechanistic codicils (Wilkinson and Willmott, 1994 cited McAdam and Henderson, 2004).					seeks continuous improvement in meeting customers' perceptions. • Williams (1993, p. 374) concludes that there are two dimensions of TQM. On the one hand "it is a management tool to increase productivity, keep customers happy, and cut down waste". On the other hand "it is a means of making us better people, of developing our professional good manners, and providing us with a moral education". A comprehensive view of definitions suggests that the entire philosophy of TQM mainly revolves around involvement of people at all levels, understanding customer requirements and working towards their satisfaction, commitment of top management and development of a culture where organisation-wide impact can be realised (Thakkar et al. 2006). According to Yang (2006), Ross (1993) and Yang (2005), they assert that TQM is an integrated management philosophy and a set of practices that emphasises, among other things, continuous improvement, meeting customers' requirements, reducing rework, long-range thinking, increased employee involvement and team-work, process redesign, competitive benchmarking, team-based problem-solving, constant measurement of results, and closer relationships with suppliers. According to Motwani (2001 cited Hoang et al. 2006), the philosophy of TQM could be visualised as constructing a house with top management commitment being the foundation or base. On top of a solid foundation, four pillars are constructed that include process management, quality measurement and control, employee training, and customer focus. Dale et al. (2001 cited McAdam and Henderson, 2004) conclude: "TQM is a continuum of theories, touching soft and hard aspects of organisations".

Table 4: The categories of TQM definition

Table 4 shows that TQM could be defined according to its essence either as an element of cultural change (Boaden 1997 cited Yang, 2006), a management model (Prajogo and McDermott, 2005), a management system (Luthans, 1995 cited Karia and Asaari, 2006; Hellsten and Klefsjö, 2000; Bergman and Klefsjö, 2003 cited Isaksson, 2006; Hansson and Klefsjö, 2003 cited Yang, 2006) or a management philosophy (Hashmi, 2000-2004 cited Ehigie and McAndrew, 2005; Deming, 1986 cited Rahman and Siddiqui, 2006;Thakkar et al. 2006; Ross, 1993 and Yang, 2005 cited Yang, 2006; Motwani, 2001 cited Hoang et al. 2006; Dale et al. 2001 cited McAdam and Henderson, 2004).

Moreover, table 4 clarifies that some authors (Bergman and Klefsjö, 2003 cited Isaksson, 2006; Hellsten and Klefsjö, 2000; Dale and Shaw, 1991, Bunney and Dale, 1997, Stephens, 1997 and Curry and Kadasah, 2002 cited Tarí, 2005; Ross 1995 cited Prajogo and McDermott, 2005; Hermel, 1997, Hackman and Wageman, 1995 and DeCock and Hipkin, 1997 cited McAdam and Henderson, 2004) have not identified the essence of TQM. Instead, they identified this term by describing either its features, components, functions, aims or a combination of all of these categories. So they were very broad in their definition, whilst other authors (Ho and Fung, 1994 cited Rad, 2006; Short and Rahim,1995 and Boon et al. 2005 cited Yang, 2006) are more specific. They define TQM as a management philosophy consisting of an integrated system of techniques and tools to improve the quality of products and services and thus achieve customer satisfaction.

Since reaching an agreed definition is not an easy task and is not one of the objectives of this research, this researcher agrees with the last proposed essence of TQM. This is because this term has been built upon several principles and practices that reflect the organisation’s way of thinking about achieving customer satisfaction through continuous quality improvement (Ehigie and McAndrew, 2005). However, in order to reach a clearer definition, the components of this philosophy should be clarified.

Although the components of TQM vary from author to author, this discussion could begin with Witcher’s opinion (1990, cited Thakkar et al. 2006) that this term has been broken down into three entities. Thus ‘total’ implies that every person is involved (including customers and suppliers); ‘quality’ implies customers’ requirements are met exactly; and ‘management’ implies senior executives are committed. Hackman and Wageman, (1995, cited Ehigie and McAndrew, 2005) have excluded suppliers from this term’s components and added organisational production, whereas Karia and Asaari (2006) eliminated the role of executive management and emphasised continuous improvement. Moreover, Rad (2006) has claimed TQM contains organisational culture, attitudes and organisation, whilst Tarí (2005) has contended that this term includes other components such as tools and techniques. In addition, Tarí (2005) has argued that despite the large number of components that have been suggested to comprise TQM, they could revolve around a common core. This common core includes, as has been suggested by several scholars (Curkovic et al. 2000; Dean and Bowen, 1994; Gobeli and Brown, 1993; Sitkinet al. 1994 cited Prajogo and McDermott, 2005) customer focus, continuous improvement and total involvement.

According to the aforementioned discussion and for the purpose of this research, this researcher considers TQM as an integrated managerial system that is provided with tools and techniques to continuously improve quality. This system has been built upon the principles of a continuous quality improvement philosophy. This philosophy encourages the entire people of an organisation at different levels, including other parties such as suppliers, to produce products of a desirable quality level in an economic way in order to meet the exact customers' requirements and expectations. This definition considers TQM as a managerial system that has been built upon a continuous quality improvement philosophy. In addition, it includes the elements of the common core of TQM that has been discussed above.

The comparison between TQM and Six Sigma is an important issue. This is attributed to the large debate regarding the novelty of the structure and techniques of the Six Sigma approach. This debate intensifies by tackling the relationship between TQM and Six Sigma. Some authors would argue that Six Sigma is the latest banner of TQM, whilst others claim that Six Sigma is something new. This is because of the dominance of TQM as a theoretical and empirical paradigm for quality management during the 1990s (Schroeder et al. 2008). Looking into the definitions of both TQM and Six Sigma it could be noticed that there are huge similarities between them. It could be claimed that they are similar to the extent that Six Sigma could be viewed as an approach that has developed from TQM. This could be attributed to the ancestry of these modern tools, approaches and philosophies that are built upon a similar set of quality improvement principles suggested by quality gurus such as Deming, Juran, and Crosby. Both of them are integrative management systems for improving quality and organisational productivity. Their main aim is to improve product and service quality to achieve customer satisfaction. However, this aim of TQM is achieved through continuous quality improvement whilst Six Sigma's aim is achieved through breakthrough improvement.

Following on from this discussion, although Six Sigma applies the principles of TQM philosophy, the novelty of Six Sigma could be seen in several aspects. Briefly, these aspects, as mentioned in the last section, are the deployment approach, emergent structure of Six Sigma (Schroeder et al. 2008), problem-solving, attention to bottom-line results, performance outcomes over time (Ingle and Roe, 2001), developments in statistical and operational methods of data analysis and focus on quantifiable benefits (McAdam et al. 2005). Thus, they have concluded that Six Sigma is seen as having a significant impact on improving operational efficiency.

Top management involvement is essential to both TQM and Six Sigma (Harry and Schroeder, 2000; Kaynak, 2003 cited Schroeder et al. 2008). Camgoz-Akdag (2007) observes that the results of many studies show that Six Sigma can provide leaders with the strategy, methods and tools to change their organisation. This is a key leadership skill that has been, until now, missing from leadership development. Moreover, Schroeder et al. (2008) have stated that structure in Six Sigma demands more involvement of leaders in improvement projects. In addition, Six Sigma engages leaders in the improvement process on an ongoing basis. Champions, for example, help direct and support improvement projects. However, Six Sigma is not distinctive by insisting on top management leadership, because this element is important in every type of quality management initiative. The Six Sigma approach, however, provides a well-defined organisational structure that facilitates leadership engagement (Schroeder et al. 2008).

Since the involvement of top management is vital in the Six Sigma approach, the focus is on improving the bottom-line within a short period of time. Thus, it could be claimed that Six Sigma has a much better record of effectiveness than TQM (Bailey et al. 2001 cited Cheng, 2008). Rather, TQM merely offers organisations the opportunity to carry out small improvements and focuses on getting closer to customers. This is because, as Freiesleben (2006) has justified from reviewing a number of studies, for decades, quality had been regarded largely as a cost as opposed to a profit driver, and indeed as an unpleasant necessity to be achieved at minimal cost. This is attributed to the notion of most of the quality gurus such as Deming, Juran, Crosby and Feigenbaum who have argued for focusing on quality because it is more beneficial than focusing on profit (Komashie et al. 2007).

Despite the focus of Six Sigma on improving the bottom-line, it is a customer-centric approach. Thus, Six Sigma focuses on customer satisfaction just as does TQM. In both TQM and Six Sigma, customer input is important at two levels, namely the organisation and project levels (Schroeder et al. 2008). However, Black and Revere's (2006) claimed that quality efforts through TQM were sometimes aimed at processes or operations that were not critical to the customer. However, exploiting the robust statistical methods through the Six Sigma approach helps to focus on the processes and operations critical to the customers. This focus has reflected on the number of defects that could be accepted. (Cheng, 2008).

As a result of the aforementioned discussion that shows a widespread disagreement amongst TQM proponents regarding its definition and components, the necessity of initiating quality management systems, such as ISO 9001:2000 standard, Baldrige National Quality Award and European Foundation for Quality Management, has been enhanced. Moreover, this enhancement has intensified because of the significant influence of these systems on the development of the Six Sigma approach (Folaron et al. 2003). Motorola was the first organisation applying Six Sigma to win the Baldrige Award. Therefore, this award has affected the means of improving quality in this organisation that has been metric-based and customer-focussed. The following is a demonstration of one of these quality systems. This system is ISO 9001:2000 standard, which has been selected because it is a universally accepted standard developed by the International Organisation of Standards (ISO). Moreover, it is most associated with TQM and can be used as an alternative application (Jacques, 1996; Pfeifer et al. 2004; Folaron et al. 2003; Yong and Wilkinson, 2002; Magd, 2008).

2.2.1.2.1.3 The definition of ISO9000/2000

Briefly, a quality management system could be defined as: controlling and directing the entire components of an organisation in order to manage quality. These components include the coordinated activities in an organisation such as policies, procedures, plans, resources, processes and delineation of responsibility and authority (Ivanovic' and Majstorovic', 2006; Magd, 2008). The aim of this system is to successfully provide a supportive mechanism to implement relevant quality activities in an organisation. Therefore, the ISO 9001:2000 standard has been developed to meet this aim (Pfeifer et al. 2004).

Originally, this standard was introduced in 1987 as part of the ISO 9000 series, which consists of ISO 9001, 9002 and 9003:1994. At the beginning of 2000, the series was combined to form ISO 9001:2000 (Zaramdini, on line). Prior to this, in 1979, the British Standard BS 5750 had been initiated in order to "*build a structure of quality assurance bodies with mutual acceptance of approvals to avoid multiple assessments"* (Warner, 1977, p. 7 cited Yong and Wilkinson, 2002). So, ISO 9001: 2000 is an effective means for assessing the ability of an organisation to consistently design, produce and deliver quality products/services in order to satisfy its customers through meeting their requirements and expectations. This standard has been considered as a means for developing broader and deeper business excellence (Magd, 2008; Feng et al. 2008; Pfeifer et al. 2004).

The standard has been built upon eight principles, namely, customer focus, leadership, involvement of people, process approach, system approach to management, continual improvement, factual approach to decision-making and mutually beneficial supplier relationships (Pfeifer et al. 2004). Looking into these principles, it could be argued that they are similar to the principles of TQM, suggesting that the former has been developed on the principles of the latter. Thus, in order to avoid repetition, the aforementioned comparison between TQM and Six Sigma is valid in the case of comparing the former with ISO9000/2000. Recalling one of the differences, the impact of the ISO 9000/2000 standard on profit is also arguable whilst Six Sigma, as was shown earlier, has a real impact on the bottom-line. Feng et al (2008) in reference to several studies have demonstrated that there is not a real profit improvement as a result of applying the ISO 9001:2000 standard. Similarly, the results of a study (Zaramdini, on line) that observed ISO certified companies in the UAE indicate that the perceived benefits related to quality of procedures come first. However, the real impact on the bottom-line and cost reduction comes last.

This standard is a mechanical and paperwork-driven approach that discourages creative and critical thinking. This is because employees are subjected to work according to these well-documented procedures (Magd, 2008; Pfeifer et al. 2004). Therefore, this drawback negatively affects continuous improvement. In addition, the standard provides neither proceedings nor convenient instruments for operationally supporting quality improvement (Pfeifer et al. 2004; Ivanovic' and Majstorovic', 2006). Therefore, there is a real need for initiating a well- disciplined approach to guide quality improvement.

As a result of the shortcomings of continuous quality improvement approaches and philosophies, breakthrough quality improvement approaches are initiated in order to fill these gaps. The following part is dedicated to elaborate one of the most important breakthrough approaches usually associated with the Six Sigma approach, namely Business Process Re-engineering. The aim of this elaboration, besides discussing another example of a breakthrough quality improvement approach, is outlining the distinct features of Six Sigma in terms of its structured and well-disciplined approach.

2.2.1.2.2 The definition of the breakthrough quality improvement approaches

Breakthrough or revolutionary improvement as has been proposed by Henderson and Evans (2000) and Ivanovic' and Majstorovic' (2006) is to comply with radical changes in a short time frame. Furthermore, it involves streamlining, reorganising and integrating activities to create new ways of working in order to improve quality (Johnston et al. 2001). As has been mentioned above, Six Sigma is one example of this category and business process re-engineering is another. This part proceeds with an elaboration of this approach and ends with a comparison between both of them.

2.2.1.2.2.1 The definition of Business Process Re-engineering (BPR)

As a consequence of the incremental improvements TQM and its slow pay-offs that do not satisfy top management, BPR was developed to satisfy the requirement for quicker returns (Gore Jr, 1999). Moreover, the slow returns generated by incremental improvements have been considered unsuitable for developing organisations(Settles, 1993; Robson, 1996 cited Zhang and Cao, 2002). This is attributed to the needs of this type of organisation for rapid and quantum-leap improvements to catch up with more established competitors (Zhang and Cao, 2002). Therefore, re-engineering the organisation has been proposed as the only solution for solving these problems now associated with the rapid technological and business changes in the competitive environment.

Although some scholars (Gore Jr, 1999) have maintained a relationship between BPR and TQM as both of them focus on process, others (Hesson et al. 2007) have considered the former to be a relatively new concept, whereby its method, approaches and even definition are still developing. Therefore, as Marjanovic (2000) has claimed, there are many definitions of this term. However, according to Grover (1993, cited Marjanovic, 2000, p.43) this approach has several common features that could lead to an agreed definition, in that *"business process re-engineering involves the radical redesign of business process, it typically employs information technology as an enabler of new business process, it attempts to achieve organisational level strategic outcomes and tends to be inter-functional in its efforts".*

In order to define this term, most of the studies that have been reviewed (Gore Jr, 1999; Zhang and Cao, 2002; Shin and Jemella, 2002; Al-Mashari et al. 2001; Tennant and Wu, 2005) have agreed with Hammar and Champy's (1993) definition, where BPR concerns *"the fundamental rethinking and radical redesign of business processes to achieve dramatic* *improvements in critical, contemporary measures of performance such as cost, quality service, and speed"*. Comparing this definition with the previous features, it clarifies that this definition contains three out of the four features of BPR that were mentioned earlier. Two of them have been mentioned explicitly, whilst the third could be tacitly understood. The former are 'radical redesign of business process' and 'strategic outcomes'. The latter is 'inter-functional efforts'. Since the processes usually cumulate the efforts of a number of functions, it could be tacitly understood that in order to attain radical process redesign, inter-functional efforts are needed. However, the fourth feature that has not been mentioned in this definition is the employment of information technology (IT).

Therefore, Al-Mashari and Zairi (2000, cited Al-Mashari et al. 2001 p.437) have defined BPR as *"a continuum of change initiatives with varying degrees of radicalness supported by IT means, at the heart of which is to deliver superior performance standards through establishing process sustainable capability"*. They have considered this definition as an integrative and holistic view of BPR. Thus, this definition has asserted the role of IT to attain process redesign (Shin and Jemella, 2002). Moreover, Marjanovic (2000) has considered combining business and information technology domains as a challenging task for many organisations. According to Parnisto (1995, cited Marjanovic, 2000) this challenge is represented by the functional integration of IT and BPR. This integration occurs at two levels. The first level is the capability of IT to shape and support business strategy. The second level is the role of IT in improving existing or enabling new business processes. This means that existing business processes are redesigned with the help of IT.

In spite of this significant role of IT, sometimes it has caused a real problem for the success of implementation of this approach. This could be attributed to difficulties and the high cost of exploiting this technology (Tennant and Wu, 2005). Moreover, the intensive concentration on IT made by some practitioners, left the soft side of BPR represented by human resources, neglected (Marjanovic, 2000). Consequently, this leads to resistance to the implementation, particularly implementation efforts associated with restructuring and downsizing plans that create fear in employees to accept new processes. In contrast, inadequate and limited IT capabilities may lead to implementation failure (Ahmad et al. 2007). Therefore, this enhances the importance of combining business and IT domains.

Looking into the aforementioned definitions, it could be inferred that the similarity between BPR and Six Sigma emerges from their focus on improving the existing business processes or developing new ones in a radical way. Therefore, they are breakthrough quality improvement approaches and represent process thinking which will be discussed in more detail in the next section (p. 67 and 98). However, according to its definition, the essence of BPR is limited to the way of redesigning business processes through inter-functional efforts whilst Six Sigma, as has been shown earlier, is an integrative set of strategic initiatives which includes plans, projects, programs and tools. In addition, BPR's aim is broad because it is identified as achieving organisational level strategic outcomes through delivering superior performance standards by establishing sustainable process capability. In contrast, Six Sigma's aim is determined by 3.4 defects per million.

BPR relies heavily on IT in order to attain process redesign. However, the role is limited by the capability of IT to shape and support business strategy and to improve or enable new business processes. In addition, it neglects the role of human resources. On the other hand, Six Sigma considers the role of IT to organise and analyse a large amount of data as well as the role of human resource to apply Six Sigma plans and projects. The latter could be seen in the different aspects of top management, and people involvement in Six Sigma schemes such as belts activities.

To sum up the comparison of the definitions of Six Sigma and other quality improvement tools, approaches and philosophies, Table 5 concludes the similarities and differences between these definitions followed by a generic comparison.

Details / Tools, approaches and philosophies	Perspective (Six Sigma versus others)		Essence (Six Sigma versus others)		Aims (Six Sigma versus others)	
	Similarities	Differences	Similarities	Differences	Similarities	Differences
Traditional quality improvement tools	Manufacturing –based definition	Mainly, quality control		Set of activities and actions		Used to fulfil requirements for quality
Total quality control	Customer-based definition	Continuous quality improvement	System for integrating quality development, maintenance, and improvement efforts	Limited to control activities	• Satisfying customers to win their loyalty • Satisfying top management • Achieving the best quality in the world	• Limited to customers and top management. • Broad aim
Total quality management	Customer-based definition	Continuous quality improvement	Integrative management system for improving quality		• Improving quality of products and services to achieve customer satisfaction. • Focusing on customer satisfaction	• focusing on quality more than focusing on profit • quality efforts through total quality management were sometimes aimed at processes or operations that were not critical to the customer
ISO 9000/2000	Customer-based definition	Continuous quality improvement		A mechanical and paperwork- driven approach	Providing a supportive mechanism to implement relevant quality activities in an organisation successfully	The documentation creates a bureaucratic environment
Business process re-engineering	Customer-based definition Breakthrough quality improvement			Way of redesigning business processes through inter-functional efforts	• Focusing on improving the existing business processes or developing new ones in a radical way • Achieving organisational level strategic outcomes.	Broad because it is achieved through delivering superior performance standards by establishing process sustainable capability

Table 5: The comparison of the definitions of Six Sigma and other quality improvement tools, approaches and philosophies

2.2.2 A generic comparison between Six Sigma and other quality improvement tools approaches and philosophies

Continuing with the comparison that began with definitions, the following part is dedicated to compare the concept, features and techniques of the Six Sigma approach with other quality improvement tools, approaches and philosophies, especially with TQM, in order to show the similarities and differences between them which will lead to answer the question about the distinctiveness of Six Sigma.

First, the generic comparison begins with the concept of Six Sigma. As has been mentioned earlier, specific metrics have been used within the Six Sigma approach. Prior to this, processes had not been measured in terms of their DPMO, critical-to-quality, or process sigma (Breyfogle, 1999; Hamel, 2000 cited Schroeder et al. 2008). The effect of these measures highlights the importance of improvement, and encourages difficult but attainable improvement goals. However, it could be claimed that these measures built on other concepts such as quality cost and zero defects. In 1951, Juran maintained that the cost of quality could be divided into avoidable and unavoidable costs. The former consists of defects and product failures, while unavoidable costs are associated with prevention activities such as inspection and sampling. Furthermore, Juran contended that failure costs could be significantly reduced by investing in prevention activities. Philip Crosby is the best-known guru of zero defects. This concept stresses the fact that all errors are preventable (Behara et al. 1995). Therefore, it could be claimed that the concept of Six Sigma is deep-rooted in quality improvement principles.

Second, Six Sigma is distinguished by its structure. Some authors (Schroeder et al. 2008) have claimed that within organisations there was less emphasis upon using a well-structured method. However, the Six Sigma approach has promoted both more control and exploration in improvement efforts. This is referred to, as Cheng (2008) has contended, the difference of the cycles of quality improvement. Although the DMAIC cycle that is followed to improve quality through Six Sigma, is, as has been elaborated earlier, the improved version of the PDCA cycle that is followed through other tools, approaches and philosophies of quality improvement including TQM, there is more intensity in the control phase in order to maintain improvements. Thus, the context of these tools, approaches and philosophies has been affected by the type of quality improvement cycle.

Although TQM and Six Sigma include statistical and non-statistical topics such as QFD and FMEA, Six Sigma tends to combine traditional statistical tools with tools from other disciplines, such as FMEA, problem solving, or QFD (Hoerl, 2001 cited Cheng, 2008). As already clarified, Six Sigma includes traditional tools. These statistical tools have been used since the beginning of the quality control era. During this era two methods have been developed in association with the drive to improve quality control. These methods are outgoing quality level and acceptable quality level. Although these methods have reduced the reliance on 100 per cent inspection to avoid defects, they have added sophistication to the way of applying the methods of quality improvement (Folaron et al. 2003). Moreover, they do not help to find out the real causes of the variation nor improve processes (Raho and Mears, 1997). In addition, these methods were limited to shop floor employees and did not actively involve management in quality improvement efforts. Therefore, there was a need for a preventative approach, such as Six Sigma, that transcended the production function. This approach required a change in management style and thinking.

Another example of a non-statistical tool, QFD is, as has been mentioned earlier, associated with TQC. The main features of this method are meeting marketing needs through exploiting customers' statements, applying multidisciplinary teams to work effectively and applying comprehensive matrices for documenting information and decisions (Herrmann et al. 2006). In addition, it has been considered the most complete and convincing method for planning the goals and aligning a stream of processes to meet customer requirements (Kathawala and Motwani, 1994; Jiang et al. 2007).

Since the aim of this method is to interpret customers' requirements in product design, one of the main benefits is to gain customer loyalty (Herrmann et al. 2006). This could be achieved because this method is more oriented toward customer satisfaction through improving product quality (Bouchereau and Rowlands, 2000; Lockamy III and Khurana, 1995). Moreover, this method is very efficient because it provides a more detailed statement of customer requirements and applies a methodological analysis to examine these requirements (Lu and Kuei, 1995). However, this method is very time consuming because teams need to invest considerable time in identifying customers' requirements and translating them carefully in technical language through manually feeding inputs. Moreover, this method is not a quick fix for short-term problems, rather it is a strategic planning process for long-term improvements (Lu and Kuei, 1995). Because the shortcomings of this method reduce efficiency, Six Sigma combines traditional statistical tools with tools from other disciplines.

In addition, the structured nature of the Six Sigma approach requires a special structural approach, namely the belts system. This structural approach, as has been explained earlier, works in parallel to and not as an alternative of the organisation's usual way of operating. However, parallel structures are not new to quality management. Scholars (Adler et al. 1999; Lawler, 1996 cited Schroeder et al. 2008) often cite quality control circles (QCC) as an example of a parallel structure. (Goh, 2000; Canel and Kadipasaoglu, 2002; Salaheldin and Zain, 2007). From this perspective, it might be argued that Six Sigma and QCC are isomorphic and lack discriminatory validity. Therefore, Six Sigma could benefit from the main advantage of this method as it is a low cost source solution provided by employee feedback to improve organisational efficiency and quality (Goh, 2000; Canel and Kadipasaoglu, 2002; Salaheldin and Zain, 2007). However, the QCC has faced unique challenges in implementation. This is attributed to its main disadvantage, namely, time commitment. So, people voluntarily attend these groups. Moreover, due to misunderstandings about this method, some members of management have seen QCC as an encroachment on their authority. Therefore, this in turn, creates a resistance to change. Consequently, although QCC allowed employees to explore problems, many organisations experienced a fundamental failure with control and authority in implementation. In contrast, Six Sigma provides enough suitable authority to belt holders in order to achieve its goals.

In order to enable these belt holders to perform effectively, their skills have been improved through intensive training programs. However, both TQM and Six Sigma training programs include, as Cheng (2008) has claimed, basic and advanced courses. The former teaches basic quality control skills, and the latter may also use basic quality control skills to integrate DMAIC methodology. However, other quality management programs, including TQM, deliver standardised training to everyone. In other words, it is a one-size-fits-all program (Linderman et al. 2003). In contrast, Six

Sigma organisations, also need to use a methodology involving fundamental Six Sigma concepts and tools application to train all their people (Ingle and Roe, 2001 cited Cheng, 2008). However, organisations provide a differentiated level of training for Black Belts, Green Belts, and Project Champions (Linderman et al. 2003). Thus, training for quality is dramatically different between TQM and Six Sigma (Saraph et al. 1989 cited Schroeder et al. 2008).

Accordingly, it could be claimed that different ways are used for people involvement and participation through different quality improvement tools, approaches and philosophies. Flynn et al. (1994 cited Schroeder et al. 2008) have contended that one objective of the TQM team is to involve all employees, frequently at the shop-floor level and in the workplace. In Six Sigma, however, projects are designated at a strategic level and teams are formed along process lines to improve a particular process. There is no objective of wide team participation. Thus, Six Sigma teams are disbanded after the process improvement is implemented, unlike TQM teams, which often have an on-going charter for improvement in their work areas (Schroeder et al. 2008).

In order to conclude this discussion, Table 6 shows the ancestry of the Six Sigma concept, techniques within the quality improvement tools, approaches and philosophies.

Details / S. S. concept techniques	Origin	Evolution
DPMO	Originated in quality control era based on concepts such as quality cost that is suggested by Juran and zero defect that is suggested by Crosby	Within the Six Sigma approach there is recognition of a correlation between the number of defective products, wasted operating costs and the level of customer satisfaction. Thus, statistical methods measure the capability of the process to perform defect-free work. Sigma capability reflects the performance target that applies to a single Critical To Quality (CTQ) characteristic
DMAIC	Deming Cycle of improvement methodology (PDCA) that consists of four basic stages; plan, do, check and action stages.	A five-stage structure is proposed, in which a Define (D) stage precedes the other four. This modified cycle is DMAIC, which provides valuable guidance for identifying key tasks to improve the quality of processes, services and products to achieve customer satisfaction
Statistical tools	Utilising statistical tools in quality improvement activities begins in the quality control era such as outgoing quality level and acceptable quality level.	Exploiting a number of statistical tools to facilitate DMAIC stages in order to manage the improvement project. These tools are a combination of traditional and advanced tools.
Non statistical tools	QFD is an example of utilising non statistical tools in quality improvement activities.	In order to avoid the qualitative nature of QFD, Six Sigma exploit both of statistical and non-statistical tools
Belt system	QCC is an example of a parallel structure that is associated with total quality control.	Avoiding QCC implementation challenges, Six Sigma provides enough and suitable authorities to belt holders in order to achieve its goals as well as improves their skill through a differentiated level of training programs.

Table 6: The evolution of Six Sigma concept techniques.

Finally, since the evolution of quality improvement tools, approaches and philosophies, successive movement and a critique of older quality improvement forms, create a foundation for subsequent developments (Ivanovic and Majstorovic 2006; Yong and Wilkinson 2002). Thus, the comparison proceeds with a demonstration of the shortcomings of traditional and modern quality improvement tools, approaches and philosophies in order to clarify their influence on the evolution of Six Sigma. The shortcomings of a number of traditional and modern quality improvement tools, approaches and philosophies are mentioned earlier. Table 7 depicts these shortcomings and their impact on Six Sigma evolution.

Details / Tools, approaches, philosophies	Shortcomings	Evolutions
Inspection	• Defects are usually discovered only after production process completion. • A 100 per cent inspection should be conducted. However, this is considered to be a time and resource consuming procedure	• Innovating sample plans in order to control product variables. • According to this development, the role of inspection has not been cancelled, but reduces.
Quality control	• Still defects are discovered only after production process completion. • Focusing on specifications.	• Quality should be built in design stage of products and processes • Shifting from fire-fighting activities to prevention of defects
Quality assurance	• Quality improvement is engineers' responsibility. • Focusing on specifications.	• Intensifying role of management in quality improvement efforts. • Company-wide quality improvement. • Focusing on customer satisfaction.
Total quality control	• Disagreement regarding quality improvement responsibility. • Constraining quality improvement system to control stage	Initiating integrative management philosophy for quality improvement.
Total quality management	• Utilising the preliminary PDCA cycle for quality improvement. • Achieving customer satisfaction is a broad aim. • Since quality is the concern of this philosophy, little impact on the bottom-line. • Needing top management commitment only. • Unstructured people involvement. • Focusing on processes and operations improvements that are not critical to the customer.	• Improving quality through well-structured cycle (DMAIC) and exploiting statistical and non-statistical tools for problems-solving. • Initiating DPMO concept and Six Sigma level of quality • Focusing on bottom-line results and quantifiable benefits. • Engaging top management in quality and in the improvement process on an ongoing basis such as Champions • Initiating belt system for people involvement • Prioritising improvement projects according to customer critical inputs. • Constituting defects according to attributes that are critical-to-quality.
ISO 9000/2000	• Same as the shortcomings of TQM. • Discourage creative and critical thinking. • Provide neither proceedings nor convenient instrument for supporting operationally the improvement of quality.	Initiating a well-disciplined approach to improve quality in Motorola.

Table 7: the evolution of Six Sigma from the shortcomings of other quality improvement tools, approaches and philosophies

Although Table 7 shows a number of the shortcomings of the traditional and modern quality improvement tools, approaches and philosophies, none of these is eliminated. This is because each of these quality improvement tools, approaches and philosophies plays a role in quality improvement activities, especially TQM and ISO 9000/2000. This is attributed to the benefits that could be achieved by applying them. For instance, by applying TQM, a number of benefits could be gained, such as increasing customer satisfaction, producing products or providing services at a desirable quality level through eliminating defects, improving employee quality through creating positive relationships with managers, and improving employees satisfaction and commitment (Karia and Asaari, 2006; Yang, 2006; Rad, 2006). In addition, production performance is enhanced through reduced rework, lead times and inventory levels (Karia and Asaari, 2006; Yang, 2006; Rad, 2006). Therefore, cost is also reduced (Yang, 2006; Rad, 2006; Tarí, 2005) and business competitiveness is enhanced (Yang, 2006; Rad, 2006).

Similarly, a number of benefits could be gained by achieving ISO 9000/2000 certification. According to Magd (2008) recent studies have concluded that the most important benefits are customer satisfaction, continuous improvement, process improvements, marketing benefits and profit maximisation. Moreover, the procedure of auditing for certification creates a good opportunity to encourage potential suppliers to subject their quality procedures to auditing (Folaron et al. 2003). Moreover, BPR benefits do not differ from those that could be achieved by other modern quality improvement tools, approaches and philosophies. Amongst others, reducing costs and improving customer satisfaction are some of these benefits. However, as some studies (Hesson et al. 2007; Tennant and Wu, 2005) have claimed, this approach by comparison to other modern quality improvement tools, approaches and philosophies generates a stronger impact on the bottom-line within the organisation. In addition, exploiting this approach leads to achieving a breakthrough performance in delivery times, customer service and quality.

To sum up, as a corollary of change in the quality improvement tools, approaches and philosophies, the Six Sigma approach has evolved gradually. As has been elaborated in both sections of this chapter, the evolution of this approach filled the gaps that were noted as shortcomings of the previous quality improvement tools, approaches and philosophies. Smith (2001) attributes this evolution to the change in the level of thinking that has occurred within various domains, which in turn has affected the evolution of these tools, approaches and philosophies. Smith (2001) has built his notion on Nam Suh's [Chairman of the Mechanical Engineering Department at Massachusetts Institute for Technology (MIT)] model formulated in the late 1970s, and Peter Senge's, (professor at MIT) levels of thinking. Suh's model includes four domains, namely, the customer, functional, physical and process domains. Suh believes that the creation of great products or services involves selecting strategies associated with these domains. Senge's levels of thinking include events, patterns and structure levels. He has identified the event level as the forced reactions toward something happening. Pattern-thinking involves understanding longer-term trends and assessing implications, whilst structure-thinking involves looking at the total system elements as related to each other in order to discover the reason why the patterns behave the way they do. Smith (2001) believes that the evolution of quality improvement tools, approaches and philosophies has transpired because of the change associated with the level of thinking that has occurred within the various domains. Thus, the Six Sigma approach has been constructed on the principles of quality improvement as suggested by quality gurus such as Deming, Shewart, Juran, Crosby and others. However, Six Sigma has been developed in a unique and new way. This uniqueness and novelty can be seen in its deployment and emergent structure. It links tactical to strategic schemes in order to solve production problems and improve new products. In order to attain this linkage, data analysis statistical and operational techniques have been developed. Moreover, these statistical techniques are exploited in a systematic way to reduce variation and improve processes to eliminate defects and reach near perfection. Subsequently, this approach pays attention to bottom-line results and performance outcomes over time. Thus, Six Sigma links customers' requirements and process improvement with financial results. It focuses on quantifiable benefits and customer satisfaction. Therefore, it has a significant impact on improving operational efficiency and so provides the desired speed, accuracy and agility.

Following on from the previous lengthy comparison between Six Sigma and other traditional and modern quality improvement tools, approaches and philosophies, the following section is dedicated to discussing another important issue, namely the implementation of the Six Sigma approach. This includes an investigation into the factors affecting the success of this implementation in order to induce a means to complete it. This importance arises from shareholders' feelings regarding the frustrating results from the previous implementation of quality improvement tools, approaches and philosophies, which failed to meet particular targets and outcomes.

2.3 Section 3: The critical factors of successful implementation of the Six Sigma approach

Many companies that have implemented one or more quality improvement approaches for a long period of time, eventually found that the implemented approach was unsuitable for their organisational environment. However, this realisation came too late since these companies had substantially invested money and time without achieving the desired results. Thus, shareholders have felt that these quality improvement approaches yield little of benefit, other than extra costs. So, they turned away from them (Eckes, 2001). Consequently, in order to correct this tendency, it has become crucial to investigate the appropriateness of the business environment prior to the implementation of these approaches, including the Six Sigma approach. In this respect, according to the reviewed literature, there are two ways to complete this investigation.

One way is to exploit the assessment criteria of the quality awards (Armistead et al., 1999). In this context, there are several national quality awards around the world, the three most famous being the Deming Prize (DP) in Japan, the Malcolm Baldrige National Quality Award (MBNQA) in the USA and the European Quality Award (EQA) (Xie et al. 1998). Appendix 8 shows an example of the adoption of some national quality awards to one or more of these famous awards. Typically, these awards contain seven to ten examination criteria and twenty to thirty sub-criteria. The criteria and sub-criteria have been drawn from the principles of Deming, Juran and TQM (Xie et al. 1998; Tan, 2002). Appendix 9 presents a summary describing these criteria.

However, in a study of several major national quality awards, Laszlo (1996, p. 17) has criticised these awards; in that *"several cases have been documented where past Quality Award winners encountered major problems in subsequent years."*. In another study, Ghobadian and Woo (1996) reached the same conclusions in their comparison between four main awards. They have attributed this shortcoming to the awards focussing primarily on management systems, and not solely on the quality of products and services. Also, they added that attention has been paid more to publicity in order to capture the attention of top management than to quality improvement which is the main purpose of these awards. In addition, in another comparative study of nine national quality awards, Xie et al. (1998) have enhanced this result and have shown that the mean weight given to the process quality criterion has only been 11.8 per cent when compared to other criteria. In contrast, 40 per cent has been given to both results and customer management and 16 per cent to human resource management. This subdivision is unsuitable to assess quality efforts and activities since the target of the Six Sigma approach is to improve the quality of processes to reach zero defects. This result agrees with Schonberger (2005) who has mentioned in a recent study, that the Baldrige Quality Award, the European Quality Award and other related honours are moving away from quality. Therefore, the assessment criteria of the quality awards, in this researcher's opinion, are unsuitable to comprehensively investigate the success of Six Sigma implementation. This is because these awards have been designed according to the principles of TQM and are shifting away from quality.

Another way to complete this investigation is to investigate the factors that could affect the success of implementing the Six Sigma approach. According to many scholars (Rockart, 1979 cited Bañuelas and Antony, 2002; Bañuelas and Antony, 2002; Antony and Bañuelas, 2002; Hoerl, 1998 cited Klefsjö et al. 2001; Henderson and Evans, 2000), there is a number of these possible factors. However, there is disagreement among the authors upon these factors. Therefore, there is a real need for developing a means of compromise between these factors in order to investigate the success of implementing the Six Sigma approach. This is the aim of this section. However, in order to achieve this aim, it begins with looking into the critical success factors of Six Sigma approach implementation. This includes examining the authors' agreement and disagreement regarding these factors from a review of their studies. Following this examination, the attempt of gathering these factors into a theoretical framework is demonstrated. This includes a demonstration of the theoretical base and a discussion about the appropriateness of this framework to the investigation. This discussion is followed by research positioning to pinpoint this author's stand regarding this attempt. This helps to determine the gap in literature that should be filled. Prior to this elaboration, it is first necessary to outline a scenario of Six Sigma implementation.

2.3.1 The Scenario of Six Sigma approach implementation

There appears to be an agreement regarding the scenario of implementation of Six Sigma approach in the literature that has been reviewed (Caulcut, 2001; Pande et al., 2002; Motwani et al. 2004; Peter and Lawrence, 2002; Eckes, 2003; Nachtsheim and Jones, 2003; Blakeslee, 1999; Sitnikov, 2002; Gitlow and Levine, 2005). This scenario begins with the recognition by top management of the benefits of this approach. Their realisation is built upon a response to crisis and/or a clear vision. As a result of this, top management commits to and leads the implementation.

Therefore, in order to implement this approach successfully, they need to retain a master black belt who stewards these implementation processes through developing a Six Sigma transformation plan. This plan determines functions and roles such as leadership groups or councils, project sponsors and champions, and implementation leaders. In addition, this plan includes several steps, for instance determining critical processes, measurement criteria, analytic tools and process owners, bearing in mind that the aim of these steps is to manipulate several factors that affect the implementation of the Six Sigma approach. These factors are discussed in the following part.

2.3.2 Critical success factors of Six Sigma approach implementation

Since the Six Sigma approach is one of the quality improvement approaches, it could succeed or fail (Byrne, 2003). There are many things that could influence success or failure. These influences have been given different names by the authors whose studies have been reviewed such as ‘elements’ (Caulcut, 2001), ‘principles’ (Blakeslee, 1999), ‘ingredients’ (Antony and Bañuelas, 2002) or ‘factors’ (Bañuelas and Antony, 2002). The importance of these influences for Six Sigma implementation according to Bañuelas and Antony (2002) is represented in its role in making the difference between successful implementation or a complete waste of effort, time and money. For the purpose of this research, this author has chosen the term ‘factors’. This choice is attributed to the meaning of this word, which, according to the Oxford Dictionary means one of several things that cause or influence something. Although the authors have disagreed with the choice of name, they agree with the general description. Preceding more discussion, Table 8 presents these factors according to each author.

Details / Factors	Description	Nonthaleerak and Hendry (2008)	Schroeder, et al., (2008)	Pandey, A., (2007)	Buch and Tolentino (2006)	Raisinghani, et al., (2005)	Brewer and Bagranoff, (2004)	Knowles et al. (2004)	McAdam and Evans, (2004)	Pfeifer, et al., (2004)	Byrne (2003)	Lynch , et al., (2003)	Antony and Bañuelas (2002)	Bañuelas and Antony (2002)	Caulcutt, (2001)	Klefsjö et al. (2001)	Smith (2001)	Henderson and Evans (2000)	Kendall and Fulenwider, (2000)	Blakeslee (1999)	Frequency Description
Management involvement and commitment	The continuous support of management at different levels to implementation efforts. Amongst others, this support is represented in a provision of appropriate resources and training, leadership of top management to Six Sigma programs, cascading Six Sigma knowledge and work practices.	√	√		√	√	√		√		√		√	√	√	√		√		√	Maj.
Linking Six Sigma approach to business strategy	Making strategic decisions in order to adapt business strategy of an organisation to fulfil the financial and operational goals of Six Sigma approach implementation.	√				√	√		√	√			√	√	√					√	Maj.
Understanding Six Sigma methodology, tools and techniques	Understanding different tools and techniques of Six Sigma approach in order to create common understanding and language to facilitate communication through the organisation.	√					√	√			√	√	√	√			√	√			Maj.
Training	The programs that are exploited to communicate why and how Six Sigma approach will be implemented in order to assist employees' understanding.	√			√	√	√	√	√		√		√	√	√			√		√	Maj.
Project prioritisation, selection, reviews and tracking	Selecting, reviewing and tracking improvement projects according to proper criteria (Nonthaleerak and Hendry, 2008).	√		√		√	√		√		√	√	√	√	√	√				√	Maj.
Linking Six Sigma approach to customers	Studying the dynamic requirements of customers as an input of transformation processes and to end with customers' satisfaction; an output of Six Sigma approach.	√								√			√	√	√	√				√	Min.
Organisational infrastructure	Due to the special nature of Six Sigma approach, its infrastructure is distinguished by cross-functional borders. Amongst others, open communication, IT platforms are active and the organisational structure is horizontal and cross-functional.	√							√				√	√	√			√	√		Min.

Table 8: The critical success factors of Six Sigma approach implementation (continued)

Details / Factors	Description	Nonthaleerak and Hendry (2008)	Schroeder, et al., (2008)	Pandey, (2007)	Buch and Tolentino (2006)	Raisinghani, et al., (2005)	Brewer and Bagranoff, (2004)	Knowles et al. (2004)	McAdam and Evans, (2004)	Pfeifer, et al., (2004)	Byrne (2003)	Lynch et al., (2003)	Antony and Bañuelas (2002)	Bañuelas and Antony (2002)	Caulcutt, (2001)	Klefsjö et al. (2001)	Smith (2001)	Henderson and Evans (2000)	Kendall and Fulenwider, (2000)	Blakeslee (1999)	Frequency Description
Linking Six Sigma approach to human resources	Modifying the regulations of human resources to suit the principles of Six Sigma approach. Amongst others, linking the rewards and promotions schemes to the progress of achieving the aims and goals of Six Sigma approach, and associating the criteria of recruiting new staff to the level of understanding Six Sigma approach.	√		√			√						√	√	√			√			Min.
Culture change	Adapting the organisational values, beliefs, behaviours, attitudes and language of individuals within an organisation to match the culture of Six Sigma approach	√				√	√						√	√	√						Min.
Improving project management skills	Improving project management skills of individuals working on improvement projects. Amongst others, these skills are setting agendas, setting and keeping ground rules and determining the meetings roles and responsibilities.	√					√						√	√	√						Min.
Linking Six Sigma approach to suppliers	Dealing with few suppliers that believe in the implementation of Six Sigma approach in their activities.	√											√	√					√		Min.
Communication	Initiating communication channels in order to clarify the plans and programs of Six Sigma approach to all employees in the organisation.	√						√						√	√			√			Min.
The impact of Six Sigma approach on the bottom line	Seeing quick, real and substantial improvement in profit encourages shareholders and top management to apply and assure a complete commitment to Six Sigma approach.					√	√			√		√			√	√				√	Min.
Linking activity to business measures and quantifiable terms	Quantifying critical to quality characteristics to measure organisational performance.							√				√			√	√					Min.
Total		12	1	2	2	6	9	4	5	3	4	4	11	12	12	5	1	6	2	6	

Table 8: The critical success factors of Six Sigma approach implementation

Table 8 presents the number of the critical success factors has been another issue of disagreement among the reviewed articles. The majority of them (Knowles et al. 2004; Pfeifer et al. 2004; Klefsjö et al. 2001; Henderson and Evans, 2000; Smith, 2001; Blakeslee, 1999; Schroeder et al., 2008; McAdam and Evans, 2004; Raisinghani et al., 2005; Byrne, 2003; Kendall and Fulenwider, 2000; Buch and Tolentino, 2006; Pandey, 2007; Lynch et al., 2003) have counted less than nine factors. The rest (Bañuelas and Antony, 2002; Antony and Bañuelas, 2002; Nonthaleerak and Hendry, 2008; Caulcut, 2001; Brewer and Bagranoff, 2004), have counted more than nine.

Nonthaleerak and Hendry (2008), in their most recent study, have agreed with the twelve factors of Bañuelas and Antony (2002) and considered these factors as the most comprehensive list to date. Similarly, most of the authors who have been reviewed, have agreed with one or more of these factors. However, as a result of Nonthaleerak and Hendry's (2008) study, they have concluded that there is a gap in the literature regarding a comprehensive set of critical success factors of Six Sigma approach implementation. This could be interpreted by the extensive disagreement amongst the reviewed authors, regarding the number and kind of factors. This gap could be attributed, in the researcher's opinion, to the sparse theoretical background that underpins the interpretation of how and why these factors guarantee successful implementation of the Six Sigma approach, since they have been identified through a revision of the experience of some companies that have successfully implemented the Six Sigma approach

Therefore, the necessity of developing a theoretical framework has emerged, one that accounts for how and why these critical factors guarantee successful Six Sigma approach implementation. This framework should also include the critical implementation factors. This is because it may prove the validity of this framework to theoretically interpret the success of the implementation of the Six Sigma approach in each of the previous studies. Therefore, more probably a new theoretical model could help interpret the success of other cases in addition to the case company of this current study. Also, such a framework may help in reducing the variation among these factors. The following part discusses these issues further.

2.3.3 Developing a theoretical framework for investigating the success of Six Sigma approach implementation

In order to develop a theoretical framework that fulfils the aforementioned necessity, this researcher has looked into the literature that theoretically tackles the success of the Six

Sigma approach. The researcher has found only one attempt within the literature that may fulfil this necessity. This attempt has been made by Motwani et al. (2004), who explain the success of the implementation of the Six Sigma approach according to a theoretical framework. These scholars have adapted the Business Process Change (BPC) management theoretical framework, suggested by Kettinger and Grover (1995) in order to fit the Six Sigma approach. Similar to this researcher's claim, these scholars have attributed their exploitation of this theoretical framework to their belief that applying another company's plan, problem-solving process, team structure, or training package, does not ensure success for other companies that intend to implement the Six Sigma approach.

Therefore, in order to explain the findings of their case study of the Dow Chemicals, they feel that the *"BPC management theoretical framework may prove useful in explaining the outcomes of the case study"* (Motwani et al., 2004. pp.273-274). This could be attributed to the similarity between the aim of their case study and the aim of the BPC management theoretical framework. The aim of the former is, according to Motwani et al (2004, pp.273-274) identification, to *"examine the factors that facilitated and inhibited the success of Six Sigma quality efforts at the Dow Chemicals Company"*. Similarly, the aim of the BPC management theoretical framework is, according to Kettinger and Grover's (1995) identification; describing, explaining and predicting the effectiveness of the BPC or BPR approach (as they are alternative terms) upon the performance of organisation.

This aim may justify the usefulness of exploiting the BPC management theoretical framework to underpin the required theoretical framework that this research is developing. In addition to this reason, there are other reasons that could justify this usefulness. For this purpose, the following part has been dedicated to outline these reasons.

2.3.3.1 Justifications for exploiting the BPC management theoretical framework to underpin the required theoretical framework

Besides the similarity of the aim of the above frameworks, there are three other reasons that may justify the usefulness of exploiting the BPC management theoretical framework as a theoretical underpinning of the required theoretical framework for investigating the success of Six Sigma approach implementation. One of these reasons is that the ancestry of the BPC management theoretical framework is deep-rooted in the literature concerning the diagnosis of organisational behaviour such as the works of Rockart and Scott Morton (1984) and Nadler and Tushman (1980). Another reason is that both BPR and the Six

Sigma approach represent two breakthrough quality improvement approaches and both highlight process thinking, which will be explained in the forthcoming part of this section. Furthermore, the BPC management theoretical framework could be considered as a suitable framework to include the entire critical success factors of Six Sigma approach implementation. Therefore, it could fill the gap in the literature regarding this matter mentioned by Nonthaleerak and Hendry (2008). The following is an elaboration of these reasons.

2.3.3.1.1 The theoretical ancestry of the BPC management theoretical framework

Motwani et al., (2004) have adapted the BPC management theoretical framework as suggested by Kettinger and Grover (1995). The latter have built this theoretical framework on the notions of Rockart and Scott Morton (1984), Nadler and Tushman (1980) and Scott Morton, (1991). In three different studies, these scholars have built their conclusions on studies conducted by Harold Leavitt at Carnegie Mellon University in 1958 and Alfred Chandler at MIT in the 1950s. These gurus claimed in two different studies that since the organisation is a socioeconomic system, it reacts with its external environment. This environment includes two main forces - ‘socioeconomic’ and ‘technology’. The reaction is represented by the change of the state of four organisation elements, namely task, technology, people and organisational structure. They attributed this to the dynamic nature of the socioeconomic system. This means that the elements of the system are in a state of balance. However, they react to any external forces that influence one or more of them in order to return to this balanced state. These resultant changes are required to maintain the effectiveness of the organisation.

With reference to this notion, Nadler and Tushman (1980) have proposed a model of organisational behaviour diagnosis (Appendix 10) whilst Rockart and Scott Morton (1984) proposed a conceptual model of the impact of technology on the effectiveness of organisations (appendix 11). These models represent a system that includes three components, namely inputs, outputs and transformation process. The entities of these components differ from one model to another. This is attributed to the importance of the role of these components in business process management. Based on these contributions, Kettinger and Grover have proposed a descriptive model of BPC (appendix 12). Similar to the aforementioned models, it represents a system. Comparatively, the entities of the system’s components of this model are similar to those mentioned earlier. Table 9 presents and summarises these similarities.

Scholars and their models / Model components	Notions of Leavitt and Chandler	Nadler and Tushman (1980) A congruence model for organisation analysis	Rockart and Scott Morton (1984) A conceptual model of technology impact	Ketinger and Grover (1995) Business process change model
Inputs	Inputs equal the external environment forces that have been suggested by these gurus. These forces include: • socioeconomic forces • technology	Four elements: • environment • organisation resources • organisation history • strategy	Inputs equal external environmental forces: • socioeconomic forces • technology	Inputs equal environmental factors that have been suggested by these scholars. It includes: • customer and supplier power • economic conditions • cultural factors • political factors • technological innovation
Outputs	Maintaining organisational effectiveness	They have identified several levels of organisational outputs: • product • group functions, unit of group or unit within the organisation • function of individual organisation members which includes affective reactions such as satisfaction, stress or experienced quality of working life	Maintaining organisational effectiveness	Products, services and performance that could be measured by: • cost • quality • customer satisfaction • flexibility innovation • shareholder values

Organisation component	Four elements:
	• task
	• technology
	• people
	• organisational structure
		Organisation is considered as a transformation process. It has four components:
		• task
		• individual
		• formal organisational arrangements
		• informal organisation
			Five components:
			• organisational strategy
			• organisational structure and corporate culture
			• individuals
			• technology
			• process management
				Four components led by strategy which include several elements:
				• business process includes three elements:
				  o inter-functional
				  o cross-functional
				  o inter-organisational
				• management includes three elements:
				  o style
				  o system
				  o measures
				• information and technology includes four elements:
				  o data
				  o information
				  o IT
				  o production technologies
				• people includes four elements:
				  o skills
				  o behaviour
				  o culture
				  o values
				• structure includes six elements:
				  o formal organisation
				  o informal organisation
				  o team work groups
				  o coordination
				  o control
				  o jobs

Table 9: The similarity of business process change model proposed by Kettinger and Grover (1995) with previous models

Table 9 shows that there is an agreement concerning the environmental factors amongst all contributors, since the first three factors are components of the socioeconomic environment and the last one is the force of technology on an organisation. Furthermore, this table shows that the outputs of the descriptive model, as Kettinger and Grover (1995) have claimed, include process products and services that may be measured in terms of cost, quality, customer satisfaction or shareholder value. This agrees completely with the outputs that have been mentioned by the authors, because these outputs reflect the effectiveness of an organisation.

A combination of the components of the transformation process that have been suggested by the former gurus and scholars include the components of the transformation process suggested by Kettinger and Grover (1995) in this model. According to their statement, it includes five components and each component of the transformation process consists of several elements. Three out of five of these components agree with those that have been proposed by Rockart and Scott Morton (1984). The first component is business process. This component includes three elements, namely inter-functional, cross-functional or inter-organisational processes. They have considered this as a core component because the aim of BPC/BPR is to improve processes in order to improve the performance of organisations so the entire components are linked to this one. This consideration agrees with Rocart and Scott Morton's (1984) suggestion of considering management processes as a core component in their model. However, it represents one part of this component, another is management, which has been considered as another component of the transformation process in Kettinger and Grover's (1995) model. Management, according to them, includes style, systems and measures.

The third component that has been suggested by Kettinger and Grover's (1995) and agrees with Rockart and Scott Morton's suggestion is information and technology. This component includes four elements, namely data, information, IT and production technologies. This indicates the important role of IT in improving the effectiveness of organisations and to the new style of management that relies on data in order to make decisions. The other two components of the transformation process include people and structure. In this researcher's opinion, there is an agreement amongst all the reviewed scholars in these two components. 'People', as the fourth component, includes improving their skills and adjusting their behaviour to create new values, and organisational culture to support BPC/BPR. The fifth component is structure. This component includes six elements, namely formal and informal organisation, teamwork groups, coordination, control and jobs.

According to Kettinger and Grover (1995) the descriptive model of BPC examines the essence of BPC/BPR and justifies the achievement of the strategic results of the effective adoption of process change management. Moreover, in order to examine the relationship between its components, they have linked this model with ten principles of BPC/BPR that are believed to relate to the success of this approach (Appendix 13). Based on these consequences, they have suggested the BPC management theoretical framework (Appendix 14). The inputs of this system include a combination of the elements of the inputs and the transformation process of the BPC model. This combination has been called change organisational environment. It includes five factors. Strategic initiatives, which lie at the core of these factors, are associated with the support and commitment of top management. This central factor is surrounded by cultural readiness, knowledge capacity and IT leveragability, relationship balancing and learning capacity. Table 10 shows the description of these factors and summarises the way that the inputs and some components of the transformation process of the BPC model have been relocated to form the factors of the change organisational environment in the BPC management theoretical framework.

Factors of change organisational environment \ Details	Description of the factors of change organisational environment	Business Process Change model			
		Inputs	Components of the transformation process		
			People	Structure	Information and technology
Strategic initiatives	The delineation of a strategic plan that helps ensure customer success through a specific plan of action. In order to achieve this goal, top management should define and communicate strategic initiatives and motivate the entire organisation to cooperate and pursue these initiatives.	The strategic initiatives are influenced by several environmental forces: • customer and supplier power • economic conditions • cultural factors • political factors • technological innovation			
Learning capacity	The ability to achieve higher-level learning that impacts on the entire organisation, develops understanding of causation and complex associations involving new actions, and is characterised by change in network relationships and decision-making.		• skills		
Cultural readiness	Cultural beliefs, values and norms constitute an organisation's cultural potency to influence behaviour.		• behaviour • culture • values		
Knowledge capability and IT leveragability	Knowledge-sharing as the combination of learning and information, applied to a context, has a dynamic quality and is defined by individuals in shared and coordinated interactions. IT leveragability as an organisational resource, providing the necessary means to accomplish required knowledge processing and thereby induces organisational change.				• data • information • IT • production technologies
Relationship balancing	Network relationships balancing as re-engineering the value chain of the organisation by proactively leveraging boundaries and relationships in order to balance internal and external networks in terms of the dialectic of cooperation and competition. This suggests that organisations continuously manage this cooperation and competition which has a greater propensity to benefit from employee incentives and controls as well as to maintain profitable long-term relationships.			• formal organisation • informal organisation • team work groups • coordination • control • jobs	

Table 10: The components of the factors of change organisational environment within the BPC management theoretical framework compared with some components of the BPC model

To conclude, the aforementioned discussion indicates that the theoretical ancestry of the BPC management theoretical framework is deep-rooted in the literature that handles diagnosing organisational behaviour. Therefore, this could justify the exploitation of this theoretical framework to underpin the required theoretical framework that this research is looking for, in order to investigate the success of Six Sigma approach implementation. This conclusion could be attributed to three reasons that have been inferred from the previous discussion of the contributions of the gurus and scholars. First, as the models of Nadler and Tushman (1980), Rockart and Scott Morton (1984) and Scott Morton (1991) are general models for analysing organisation behaviour; these scholars have encouraged other researchers to exploit these models as guidance and direction towards the development of more integrated perspectives concerning the processes of organisational change. Thus, in this researcher's opinion, these models may provide a useful theoretical base for developing other frameworks for specific approaches accounting for organisational changes fostered by strategic quality improvement tools, approaches and philosophies. This is attributed to the aim of these approaches to improve the quality of products and services through applying some changes to the organisational environment to improve overall organisational effectiveness. Therefore, as BPC/BPR and the Six Sigma approach are two of them, these models could be useful guidance for interpreting the impact of these approaches upon the effectiveness of an organisation's performance. Second, the BPC management theoretical framework has been built upon the notion of the organisation as a system, as has been suggested by all the reviewed gurus and scholars. According to this notion, the organisation has been considered as a dynamic socioeconomic system that is composed of inputs, outputs and transformation process. The transformation process represents an organisation that comprises several components. These components are in a congruent state. As a result of the impact of several external environmental forces, which form the inputs of this system upon one or more of these components, the system loses its congruence. Thus, these components react against each other in order to return to the congruent state. This reaction is supposed to improve the effectiveness of the organisation. Building on this notion, the descriptive model of BPC and the BPC management theoretical framework have been proposed to interpret the achievement of strategic results of the effective adoption of BPC/BPR. Third, as one of the outputs of the combined models and theoretical framework concerns measurable performance gains such as cost reduction and growth of shareholder value, it indicates the similarity between the output of these models and framework with the output of the Six Sigma approach. This output, amongst others, is to reduce defects to near perfection to the extent that costs are reduced and shareholder value increases. Following this discussion, the second reason that justifies the exploitation of the BPC management theoretical framework to underpin the required framework is discussed.

2.3.3.1.2 Business process change/business process reengineering and Six Sigma approach represent process thinking

The similarity between BPC/BPR and the Six Sigma approach is another reason that may justify this exploitation. This similarity could be seen in two ways. First, they are, as has been shown in section two of this chapter, two approaches of strategic quality improvement. Second, due to the quality improvement movement, the improvement efforts eventually shift from improving a particular task or business function to an entire process (Davenport and Short, 1990; Armistead, 1996). As both BPC/BPR and Six Sigma focus on the improvement of processes, they both represent process thinking. This is attributed to two reasons. On the one hand, Eckes (2001) has addressed business process management as the strategic component of the Six Sigma approach. On the other hand, Armistead et al. (1999) have stated that amongst other performance improvement approaches, BPR is based on the notion of process. Therefore, both approaches focus on improving business processes in order to improve the quality of products or services.

Moreover, Eckes, (2001) has emphasised the significance of managing change. He has stated that many change quality efforts fail because too much emphasis has been placed on technical change, while not enough effort has been invested in ensuring acceptance of the quality effort. Eckes (2001) has thus claimed that a key element of change initiative is mobilising commitment to the Six Sigma organisation. Identifying the sources of resistance to the Six Sigma approach and planning a strategy to overcome such resistance are the core missions underlining the success of this approach.

In contrast, Kettinger and Grover (1995) have asserted that process and change management practices contribute to better business processes. Moreover, these practices help in attaining an improved quality of work-life. Both these outcomes are prerequisites for customer success and, ultimately, in achieving measurable and sustainable competitive performance gains. Moreover, they claim that change management is effectively balancing forces in favour of change over forces of resistance. Therefore, this is another point where BPC/BPR agrees with the Six Sigma approach. Based on this elaboration (as the BPC management theoretical framework has been suggested to interpret the achievement of strategic results of the effective adoption of the BPC/BPR) it may be useful to exploit this theoretical framework as a theoretical underpinning for the required theoretical framework to investigate the success of Six Sigma approach implementation. The last reason is discussed in the following part.

2.3.3.1.3 The factors of change organisational environment within the BPC management theoretical framework may represent a comprehensive set of the critical factors to the success of the implementation of the Six Sigma approach

Another reason that may prove the usefulness of exploiting the BPC management framework as a theoretical underpinning for the required theoretical framework is the ability of the factors of change organisational environment within the BPC management theoretical framework to include all the critical factors underpinning the success of Six Sigma approach implementation. As a result of this ability, it could be claimed that it represents a comprehensive theoretical base for these critical factors. This means that it may prove the validity of this framework to theoretically interpret the success of the implementation of the Six Sigma approach in each of the previous cases. Thus, more probably, it could interpret the success of other cases, including the case company of this research. For this purpose, Table 11 has been prepared in order to demonstrate the way that these critical factors could be distributed within the BPC management theoretical framework. This distribution is built on the previous discussion about the evolvement of these factors and the description of the critical factors underpinning the implementation of the Six Sigma approach (Table 8).

Factors of change organisational environment \ Details	The entities of the factors of change organisational environment	The critical factors underpinning effective implementation of Six Sigma approach
Strategic initiatives	The strategic initiative is influenced by several environmental forces: • customer and supplier power • economic conditions • cultural factors • political factors • technological innovation	• management involvement and commitment • linking Six Sigma approach to business strategy • linking Six Sigma approach to the customer • project prioritisation selection, reviews and tracking • linking Six Sigma approach to suppliers • the impact of Six Sigma approach on the bottom line • linking activity to business measured and quantifiable terms
Learning capacity	• skills	• understanding Six Sigma methodology, tools and techniques • training • improving project management skills
Cultural readiness	• behaviour • culture • values	• culture change
Knowledge capability and IT leveragability	• data • information • IT • production technologies	• organisational infrastructure
Relationship balancing	• formal organisation • informal organisation • team work groups • coordination • control • jobs	• linking Six Sigma approach to human resources • communication

Table 11: the distribution of the critical factors underpinning the implementation of Six Sigma approach on the factors of change organisational environment within the BPC management theoretical framework

Table 11 shows that there is extensive similarity between the critical factors of the successful implementation of the Six Sigma approach and the factors of change organisational environment within the BPC management theoretical framework. The first factor, strategic initiatives, includes several critical factors necessary for the implementation of the Six Sigma approach. These critical factors are related to the entities of this factor of change organisational environment. For example, looking into the description of management involvement and commitment, it could be claimed that, as has been discussed earlier, the same prerequisite is required for the success of BPC/BPR. Moreover, looking into the description of linking the success of the Six Sigma approach to the customers and suppliers, is similar to the environmental force that affects the success of BPC/BPR. Similarly, looking into the description of the rest of the critical factors concerning the implementation of the Six Sigma approach, including strategic initiatives, they could be considered as features that could lead to measurable performance gains, as has been suggested in the tenth principle of the success of BPC/BPR.

In addition, three other critical factors relating to the implementation of the Six Sigma approach could be included in learning capacity as one of the factors of change organisational environment. These three factors are training, improving project management skills and understanding Six Sigma methodology, tools and techniques. The descriptions of these factors could elaborate this distribution. This is because these descriptions focus upon the role of these factors in improving people skills that is the entity of learning capacity and agrees with the third principle of the success of BPC/BPR (Appendix 13). Moreover, another critical factor to the success of the implementation of the Six Sigma approach could be included in cultural readiness as one of the factors of change organisational environment. This factor is culture change. Looking into the description of this factor, its similarity with cultural readiness is noted. According to this description, the planned implementation urges changes in organisational values, beliefs, behaviours and languages in order to match the culture of the Six Sigma approach.

Furthermore, the description of organisational infrastructure suggests that this critical factor could be included in knowledge capability and IT leveragability, which is one of the factors of change organisational environment. This could be attributed to the nature of the Six Sigma approach that depends upon crossing organisational borders. This nature facilitates knowledge sharing capability through a reliable IT system. In addition, the descriptions of linking the Six Sigma approach to human resources and communication suggest that these two critical factors to the implementation of the Six Sigma approach could be included in relationship balancing which is one of the factors of change organisational environment. This is because the role of these two critical factors is to facilitate the relationship balancing. For example, a clear promotion scheme that is related to the progress of achieving the aims of the Six Sigma approach satisfies people. This satisfaction creates more cooperation and coordination. Similarly, open and honest communication facilitates teamwork tasks.

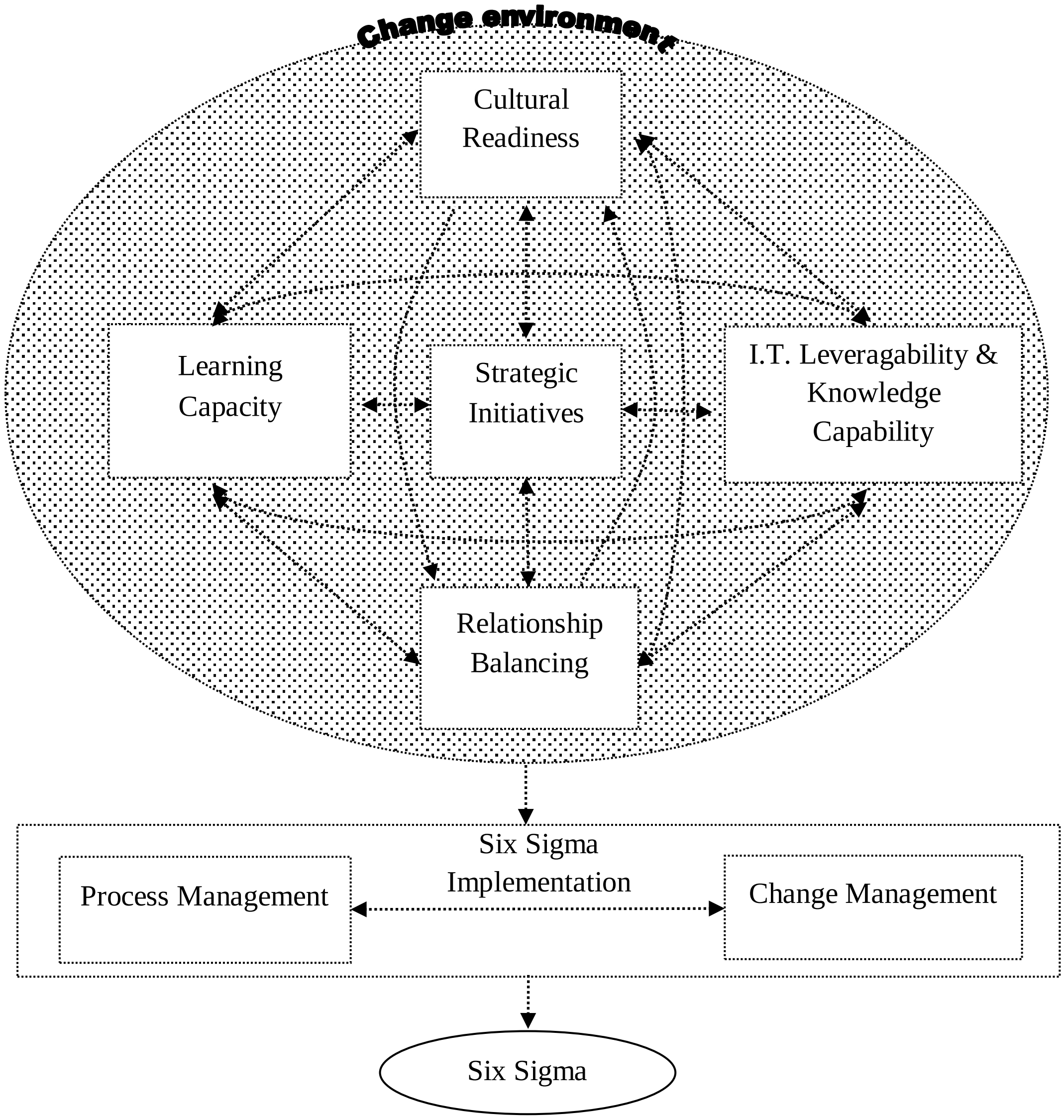
In conclusion, the aforementioned discussion shows that the factors of change organisational environment within the BPC management theoretical framework are able to include all the critical success factors required for Six Sigma approach implementation. As a result of this ability, it could be claimed that it represents a theoretical comprehensive set of these critical factors that reduce its variation. This means that it may prove the validity of this theoretical framework to theoretically interpret the success of Six Sigma approach implementation in each of the previous studies. Thus, more probably, it could interpret the success of other cases including the case company of this research. Thus, it potentially fills the gap in the literature regarding this issue addressed by Nonthaleerak and Hendry (2008).

Overall, the aforementioned discussion in the previous part of this section shows that the BPC management theoretical framework could be a useful theoretical underpinning for the required framework, to investigate the success of Six Sigma approach implementation. Subsequently, this conclusion justifies Motwani's et al. (2004) adoption of the BPC management theoretical framework to explain the findings of their study of Dow Chemical. A fuller discussion of this adoption follows below.

2.3.3.2 BPC management in the context of the Six Sigma approach:

Motwani et al. (2004) have adapted the theoretical framework in order to assist in the explanation of the findings of their case study that assesses the implementation of the Six Sigma approach in Dow Chemical. The adapted framework is presented in figure 1.

Figure 1: Theoretical framework for Six Sigma implementation:



Source: Motwani et al (2004)

Figure 1 illustrates the effect of change organisational environment on implementing the Six Sigma approach. The change organisational environment factors include cultural readiness, learning capacity, IT leveragability and knowledge capability and network relationship balancing. This change organisational environment should be supported by strategic initiatives and committed to by top management. These factors of change organisational environment affect each other. For this purpose, unidirectional arrows indicate cause and effect and bi-directional arrows represent correlation (Kettinger and Grover, 1995). Thus, from this relational diagram, the success of the implementation is influenced by the factors of change organisational environment that lead to achieving performance levels that equate to Six Sigma. This shows that Motwani et al. (2004) have merged the outputs of this framework in one main output whilst they have kept the entire constructs of the factors of change organisational environment which are suggested by Kettinger and Grover (1995). In this regard, this researcher agrees with them because in order to achieve Six Sigma, subsequently all other outputs that are suggested by Kettinger and Grover (1995) should be achieved. Moreover, this means the focus should be on the components of change organisational environment.

Motwani et al., (2004) considered "*their paper to act as a good reference for organisations intending to pursue such a quality program"* (Motwani et al., 2004. p.274). Therefore, this researcher has adopted their recommendation because since this research proposes the Six Sigma approach as a solution to the problem of insufficient quality of locally manufactured products in the UAE, it aims to develop a means for investigating the readiness of the organisational environment of the companies within this sector for the potential successful implementation of this approach. However, this researcher will use the theoretical framework in a manner consistent with the assumptions of learning from the participant (Creswell, 2003). Thus, he will exploit the BPC theoretical framework of Motwani et al (2004) as a theoretical base to underpin the developed theoretical framework that will be inferred from the experience of Ducab in the successful implementation of the Six Sigma approach.

Although this researcher intends to use an inductive approach to conduct this research, it does not conflict with exploiting this framework as it will be discussed in the next chapter. This is because despite using this framework as a theoretical underpinning of this research, it will not stop the researcher from criticising this framework in order to find out the gap in knowledge. This critical review is conducted in the light of the reviewed literatures that tackle similar issues. In this regard, Anfara and Mertz (2006, p. 193) have concluded from the insights of the contributors to their book *"Theoretical framework in qualitative research"* that theoretical frameworks have the ability to reveal and conceal meaning and understanding. They claimed that *"Although we acknowledge that theories can allow us to see familiar phenomena in novel ways, they can also blind us to aspects of the phenomena that are not part of the theory. As part of theory's ability to reveal and conceal, we are cognisant that a theoretical framework can distort the phenomena being studied by filtering out critical pieces of data. Researchers needed to recognise this characteristic of a theoretical framework and give serious thought to what is being concealed. This ability to* *reveal and conceal makes it all the more important for researchers to tell their readers, if possible, what is concealed. This is, after all, the essence of a study's delimitations".*

In other words, it is preferred that qualitative researchers enter the field with open minds about the things that could be investigated. However, this does not mean that they should not begin with research questions. Therefore, researchers usually pose questions in order to determine the issues that they want to understand by conducting their studies (Maxwell, 1996). According to Miles and Huberman (1994), these questions make theoretical assumptions more explicit. In addition, they pinpoint the issues that should be known first. Furthermore, they help to set rough boundaries for subsequent data analysis. This could be achieved by proposing several statements that are key to these questions. These statements are a coherent set of explanations of the researcher's thoughts that are formalised and systematised during the research progress. This set of explanations is often called propositions in qualitative research as opposed to hypotheses in quantitative research (Maxwell, 1996; Miles and Huberman, 1994). As a result of the critical review of the constructs of the change environment within the theoretical framework adapted by Motwani et al (2004) in the following part, several theory questions (TQ) are raised and the answers to these questions (ATQ) are proposed.

2.3.3.2.1 Theoretical questions and propositions

As observed in Motwani et al (2004) discussion of the constructs of change environment within the BPC management theoretical framework, these scholars have constrained their discussion to specific questions consistent with their research objectives. Therefore, they have *"described the basic foundation for Six Sigma implementation, the cultural change within an organisation when adopting this program and the challenges or barriers that can be expected along the way"* (Motwani et al., 2004. p.274). However, these constraints resulted in several unanswered theoretical questions that have created the gap in knowledge that follows.

2.3.3.2.1.1 Strategic initiatives

Strategic initiatives, as one of the change organisational environment factors, are identified as signals important changes in an organisation, affecting its long-term direction and the scope of its activities. Operations are affected as the strategic initiative is deployed, changing day-to-day routines (Saunders and Mann, 2008).

There is widespread agreement within the reviewed literature regarding the necessity of top management to lead the change towards any quality improvement movement, especially in terms of a radical approach like Six Sigma (Bañuelas and Antony, 2002; Antony and Bañuelas, 2002; Henderson and Evans, 2000; Blakeslee, 1999). This commitment is necessary because the change involves strategic initiatives that have a direct impact on both financial and operational goals. In addition, these initiatives are linked to customers, core processes and competitiveness (Pande et al. 2000 cited Bañuelas and Antony, 2002). Thus, authors such as Raisinghani et al. (2005) and Wessel and Burcher (2004) asserted the important role of convincing top management and process owners to ease the implementation of Six Sigma through knowing the benefits of this approach. Furthermore, Buch and Tolentino (2006) considered top management experience in Six Sigma as an important element in attaining their commitment. This commitment, which has several aspects, should move beyond the sponsors' role and should be ready for deeper involvement (Pandey, 2007). A variety of leadership styles such as charismatic and instrumental leadership may be appropriate to interpret these aspects, depending upon how the organisation is normally managed and led (Nadler and Tushman (1990).

In contrast, Motwani et al (2004) have provided a minimal account of the theoretical background underpinning this factor of change organisational environment. They state only that top management plays an important role in initiating the strategic initiatives without providing a sufficient explanation of the way this role is played. Thus, a question of whether the commitment of top management is necessary is left unanswered. In order to answer this question, several issues should be clarified, such as the way of convincing top management to ensure their commitment, and the aspects of this commitment. Thus, a theoretical question is raised:

TQ 1: Is top management commitment necessary to initiate the Six Sigma approach? Why? And how could it be attained?

In order to answer this theoretical question, it can be proposed:

ATQ1: Since the initiative of the Six Sigma Approach first requires radical organisational changes, the commitment of top management is so significant.

Moreover, Kotter (1995) has maintained that strategic initiatives include a specific plan of action and then motivate the organisation entirely towards achieving the goals of this plan. This depends on the ability of top leaders to make tough decisions affecting the long-term success of their businesses, to challenge conventional thinking and sometimes recommend unpopular or unusual ideas as part of focusing the organisation on necessary change

(Raisinghani et al, 2005). Consistent with Six Sigma, some academic research supports the view that decision rights to initiate improvement projects should be allocated to management (Wruck and Jensen, 1994, 1998 cited Schroeder et al, 2008). Giving management the decision rights to initiate a project helps ensure that project selection is based on strategic importance and not on convenience (Schroeder et al, 2008). In the same context, Schroeder et al (2008) stated that the benefits of Six Sigma go beyond promoting rational decision-making. Strategic process selection in Six Sigma allocates decision rights to different organisational members in the improvement process which promotes control. Senior managers decide which improvement projects to select (via the project hopper), whereas Black Belts and Green Belts decide how to make improvements. In Six Sigma, projects are designated at a strategic level, and teams are formed along process lines to improve a particular process. There is no objective of wide team participation.

In contrast, Motwani et al (2004) limited their demonstration of the strategic initiatives by comparing the situation in Dow Chemical before and after Six Sigma execution. The initiatives that have been pursued before the execution are, for example, employing a number of measures to streamline competitive position, putting in place value-based management tools to institute quality performance mechanisms and establishing global work stations on communication pipelines. On the other hand, they provided only a single example of the key decisions that were made and distinguished between Dow's implementation of Six Sigma from that of others. This decision involved integrating Six Sigma into the business strategies of the company where accountability for results related directly to top management. Thus, this demonstration left a theoretical question unanswered. This question is:

TQ1.1: What sort of strategic decisions in the context of Six Sigma are made, and what are the factors that affect this process?

In order to answer this theoretical question, several issues will be investigated such as how these decisions are made, the managerial levels that are involved and the external and internal factors that affect this process. However, initially it can be proposed that:

ATQ1.1: The strategic initiatives include a specific plan of action to motivate the entire organisation towards achieving the goals of the Six Sigma approach.

2.3.3.2.1.2 Cultural readiness

Among management gurus there would appear to be fairly broad agreement that culture is the key factor underpinning success in terms of developing the necessary commitment to any form of change (Sinclair and Collins, 1994). In addition, the readiness of the culture helps to ease the reluctance to change that follows the wide change that goes against the strong values held by individuals. Organisational culture, therefore, could be defined as the general pattern of mindsets, beliefs and values that members of the organisation share in common, and which shape behaviours, practices and other artefacts of the organisation which are easily observable (Sathe, 1985; Schein, 1985 cited Prajogo and McDermott, 2005). In addition, organisational culture could be defined as the values, attitudes, behaviours and language that are common amongst individuals within the organisation (Kuei and Madu, 2003; Motwani et al. 2004). As there is not much difference between both definitions and for the purpose of this research, the latter definition is adopted.

The literature that was reviewed shows two different trends regarding the readiness of the organisational culture prior to, or during the process of Six Sigma implementation. A number of authors consider organisational culture as a significant component so it should be ready to pioneer new strategic initiatives (Sathe, 1985; Schein, 1985 cited Prajogo and McDermott, 2005). On the other hand, some authors consider this component as significant for the introduction of the Six Sigma approach because this approach involves adjustments to the organisation's culture and changes in the attitudes of its individuals (Bañuelas and Antony, 2002; Antony and Bañuelas, 2002). Comparatively, in their discussion, Motwani et al (2004) have not explored this issue. They demonstrate the staircase of change leadership that Dow employed to develop an implementation designed to drive change in a revolutionary, yet sustainable, manner. Although the staircase steps that include vision, values, attitude, language and behaviour are successive and each one is built upon the previous step, the way of attaining these steps has not been sufficiently explained. In addition, the articulation of the contents of these steps causes confusion because it is unclear whether they are originally the content of the company or content from Six Sigma implementation. Thus, another theoretical question is posed. This question is:

TQ2: Should the organisational culture be ready or adjusted for initiating the Six Sigma approach?

According to the reviewed literature, it could be proposed that:

ATQ2: The organisational culture should be ready or (adjusted) to align with Six Sigma culture.

Motwani et al (2004) briefly define organisational culture and emphasise its importance in facilitating (or inhibiting) the integration of individual learning with organisational learning, through influencing the organisation's ability to learn, share information and make decisions. Moreover, they stress the role of open communication, information sharing, cross-functional training and personnel movement in promoting a common culture and innovative behaviour in organisations. However, they have not explained how and why these means could achieve this common culture. In addition, they have contended that organisational culture is composed of values, attitudes, behaviours and language. Organisational values include integrity, respect for people, unity, outside-in focus, agility and innovation. In addition, they described Six Sigma's attitudes as a mindset of change that focuses on results, accountability, and data-driven decision-making. The behaviours include adopting intolerance for variation, measuring inputs not just outputs, demanding measurement and accountability, requiring sustainable gains and delivering on customers' competitive advantage. Furthermore, as a result of the unity in Six Sigma culture, a common language is shared amongst individuals. Although, Motwani et al (2004) have suggested a number of entities that they believe composed the components of Six Sigma culture, the question of what are the contents of organisational culture in the context of Six Sigma requires further exploration. Thus, a theoretical question is raised:

TQ2.1: What are the contents of organisational culture that are associated with the Six Sigma approach?

In order to answer this question, it can be proposed:

ATQ2.1: The components of organisational culture that are associated with the Six Sigma approach could be more than those that have been identified by Motwani et al (2004).

2.3.3.2.1.3 Learning capacity

The literature that has been reviewed shows that there are a number of definitions of organisational learning. Amongst others, Huber's (1991) definition is applied as follows: an entity learns through the processing of information, potential behaviour changes and acquiring knowledge that it recognises as potentially useful to the organisation. Three main views in organisational learning can be identified according to Easterby-Smith and Araujo (1999), the technical, social and cycle views. The technical view is characterized by the effective processing, interpretation of, and response to information inside and outside the organisation. Argyris and Schön (1978) distinguish between two types of learning; namely single-loop learning and double-loop learning. The former, according to Savolainen and Haikonen's (2007) opinion, which is reminiscent of the type of learning the Six Sigma approach represents, is the detection and correction of errors within a given set of governing variables. Double-loop learning involves changing those variables. In the same way, Kettinger and Grover (1995) stated that to accommodate equivocality of information and uncertainty in cause-and-effect relationships, learning organisations undertake decision-making in multiple cycles and with fewer rules. First-order single-loop learning serves to maintain stable relationships and has a direct effect on establishing business process stability. First-order learning occurs through repetition, in a well-understood context, focusing on behavioural outcomes and institutionalised formal rules. In this way, single-loop learning maintains the organisation's culture, seeking to detect and correct errors within a process. However, learning also takes place through previous actions, not just by examining consequences. Second-order double-loop learning seeks out contradictions in order to resolve them. The detection of contradictions produces learning that results in changes to underlying beliefs, values and norms. Therefore, this researcher defines organisational learning as knowledge acquisition and behaviour change processes resulting from an effective response to, and interpretation of, information inside and outside the organisation. This process could be achieved through single or double-loop learning cycles.

In this context, this researcher agrees with Guha's et al (1997) definition of learning capacity. They have contended that learning capacity is the ability to adapt and improve, build internal and external knowledge and achieve higher levels of learning. There is a huge need to enlarge the capacity of learning within individuals of the organisation through training programs (Henderson and Evans, 2000). The Six Sigma approach training programs should contain answers to 'how' and 'why' questions related to the implementation of this approach that give individuals confidence in their work performance (Bañuelas and Antony, 2002). In contrast, in their discussion of this factor of change organisational environment, Motwani et al (2004) limited their discussion to a generic identification of the major goal of learning which is to provide positive outcomes, without specifying these outcomes. Therefore, another theoretical question is posed:

TQ3: What has been meant by the learning capacity as a factor within the theoretical framework?

According to aforementioned elaboration, it can be proposed that:

ATQ3: Learning capacity is the ability to adapt and improve, build internal and external knowledge and achieve higher levels of learning.

The learning programs should include some training in project management skills such as setting agendas, setting and keeping ground rules and determining a meeting's roles. Furthermore, individuals should be taught the proper tools and techniques that are necessary to measure their performance. These tools have been classified in three groups, namely team, process and statistical tools (Henderson and Evans, 2000). Clearly, the existence of an advanced IT system in the organisation enhances the transformation of information and knowledge within individuals and supports the change of organisational culture and enlarges learning capacity.

In contrast, Motwani et al (2004) limited the means of achieving this major goal to effective adaptation to environmental changes and improved efficiency in the process of learning. The former, according to them, involves making appropriate responses to technological changes and learning from other organisations that have achieved the best practices in the industry, whilst increased efficiency can come from learning by doing and accumulation of knowledge through cross-functional interfaces. However, they do not explain how and why these means work.

In addition, they state that learning can be brought about by scanning external information by organisational employees, consultants and from customers. The latter is the main source of learning, as Motwani et al (2004) described in Dow Chemical. They have attributed this to Dow's values that form the cornerstone of doing things in this company. Thus, as one of these values is outside-in-focus, Dow focuses on the opportunities that could be learned from customers in order to gain their loyalty. According to this belief Motwani et al (2004) state that loyalty and leveraging processes as well as skills, are embedded in Dow's Six Sigma black belt curriculum. However, the means of achieving remains unexplored in their discussion. As a result of the aforementioned elaboration, a new theoretical question is posed:

TQ 3.1: What sort of programs, schemes and techniques could be conducted to enlarge the learning capacity necessary for Six Sigma?

According to aforementioned discussion, it can be proposed:

ATQ3.1: Training programs have a huge need to enlarge individuals' learning capacity. It should contain answers to how and why to implement Six Sigma. This could be achieved through the belt system which provides good opportunities for individuals to expand their knowledge and skills.

2.3.3.2.1.4 IT leveragability and knowledge-sharing capability

Six Sigma is a highly data-oriented approach and supports the adoption of a data-driven decision-making process. As a consequence, implementation of the DMAIC concepts is heavily based on statistical tools and the statistical design of experiments (DoE). Therefore, the importance of gathering and managing data has increased (Savolainen and Haikonen, 2007).

The literature that has been reviewed shows that in order to move from fire-fighting to genuine quality improvement, engineers must be able to go beyond the selection of key characteristics or processes which are causing an obvious non-conformance. Effective IT support is needed to achieve this aim in complex, high-variety manufacturing environments, where many hundreds of processes and thousands of quality characteristics are involved (Tannock, et al 2007). Paul (1999, cited Henderson and Evans, 2000) has asserted that IT infrastructure either enhances or breaks the efforts of the Six Sigma approach . This role is more significant in large and international organisations where the data is either unavailable or is stored on computer platforms which are difficult to reach. Therefore, a planned and integrated IT is more effective and supportive for knowledge-sharing (Henderson and Evans, 2000).

In addition, the literature shows that the generally accepted idea that tacit organisational knowledge is becoming the true source of competitive advantage. Stewart, (1997) suggests that organisations which are unable to engage individual employees in surfacing, sharing and exploiting tacit knowledge place themselves at long-term competitive risk. But actively managing knowledge relies on an individual's effort and co-operation, so the new model of knowledge management is about personal relevance (Bailey and Clarke, 2001). It is about people and actions and their behaviour in aligning knowledge processes with organisational objectives (Politis, 2003). It is about how we move from the old way of doing things where knowledge was power, to sharing knowledge and achieving a competitive advantage. The key to successfully implementing a learning organisation is to create an organisational culture in which power is equated with sharing knowledge, rather than retaining it. The objective of IT leveraging and knowledge-sharing, therefore, is to enable individuals to develop knowledge through a process of co-ordinated interaction that leads to successful change (Kotter, 1995). This collaborative computing will enable users to co-ordinate work within and between organisations and to access and integrate information effectively (Jacques, 1996).

Motwani, et al. (2004) has described the IT infrastructure within the Six Sigma approach as a socio-technical design approach. This approach according to Hoplin (1994) and Mumford (1994, cited Motwani, et al. 2004) is a mutual bi-directional relationship between IT, individuals and organisation. However, Motwani et al (2004) mentioned data only twice during the discussion of the fourth change organisational environment factor. They describe the new management style as comprising a facts and data-based style. In addition, they describe the role of leveraging champions as data mining for leveraging opportunities. In this respect, they limit the identification of leveraging to the effective multiple implementations of demonstrated best practices whilst the leveragability of IT involves other than this role. Thus, in this author's opinion, two important theoretical questions remain unanswered. These questions are:

TQ 4: How does data affect the implementation of the Six Sigma approach?

TQ 4.1: What is the role of IT in data gathering and decision-making to facilitate Six Sigma implementation?

According to the aforementioned discussion, the answers to the previous questions are:

ATQ4: The significance of the data trace back to the Six Sigma approach supports the adoption of data-driven decision-making. According to this process, the right data should be available at the right time.

ATQ4.1: Planned and integrated IT systems enhance data-driven decision-making to facilitate more effective and supportive knowledge-sharing in order to ease individuals' resistance to the implementation of Six Sigma.

2.3.3.2.1.5 Network relationships balancing

Kitchen and Daly (2002) have pointed to the role of visible and simultaneous information in helping network members to take business decisions on different characters. They have stated that networks reshape the responsibility for decision-making. In addition, they have mentioned that networks integrate decision-making horizontally at the lowest managerial level. However, the literature review showed that one of the main hurdles of implementing strategic quality management such as Six Sigma is the departmentalisation and fragmentation of organisations. Such a departmental structure with individual responsibility centres makes the administration of rewards and penalties easy. Unfortunately, it creates an internally focused and narrow departmental mindset amongst managers. Each manager is concerned only about his or her departmental measures and hands-off the product to the next department. Quality management under this system requires extensive inspection at all points of hand-off. Prevention becomes nobody's responsibility and inspection takes precedent. There is no process ownership and the co-ordination between different activities in the process is weak. This lack of process co-ordination kills quality management. Individual responsibility places departmental managers in conflicting positions and makes it impossible to have good cross-departmental teamwork which is essential for quality management. It also makes the managers focus on the short-term and internally on their departmental performance rather than on the customer or the environment (Srinidhi, 1998).

Because of this, conflicts could be created amongst individuals due to the focus of the Six Sigma approach on process and quality improvement which need horizontal relationships between individuals who are process owners in the organisation (Cheng, 2008). Balanced relationships, especially within inter-functional groups in the organisation, are so important. They can result in greater openness, knowledge and understanding (Kotter, 1995). Therefore, a balance should exist between competition and co-operation amongst individuals.

In this respect, the reviewed literature showed that Six Sigma provides a hierarchical structure where leaders (Champions) initiate, support, and review key improvement projects; Black Belts then serve as project leaders who mentor Green Belts in problem-solving efforts (Barney, 2002; Sinha and Van de Ven, 2005). Both manufacturing and service support the importance of connecting multiple levels of the organisation together in improvement projects. Various mechanisms in Six Sigma – such as strategic project selection and leadership engagement – help achieve multilevel integration. DMAIC also involves different organisational members at different steps in the method. Champions play an active role in the Define step but a supporting role in the remaining steps. On the other hand, Process Owners take a much more active role in the control step but a supporting role in the other steps. Green Belts tend to take a more active role in the measure, analyse, and improve steps. Finally, Black Belts serve as project leaders and are active in all steps of the process (Schroeder, et al 2008).

In contrast, in their discussion of the fifth factor of change organisational environment, Motwani et al (2004) emphasise the role of cooperative, interpersonal and group behaviour in achieving superior performance. Moreover, they highlight the benefits that could be achieved through partnering with external suppliers. In addition, they conclude that management of these aspects of competition and cooperation can continuously benefit from employee incentives and controls, as well as instil change more effectively. However, they do not explain how these aspects (and others) could lead to network relationship balancing in the context of Six Sigma. Therefore, a new theoretical question is raised as follows:

TQ5: How could network relationships be balanced?

According to aforementioned discussion, the answer to this question is as follows:

ATQ 5: Balanced network relationships between competition and co-operation among individuals exist through connecting multiple levels of the organisation together in improvement projects. This could be achieved by various mechanisms in Six Sigma. ; The belts system, amongst others, provides a good example of integrating decision-making horizontally at the lowest managerial level.

As observed in the aforementioned discussion, Motwani et al (2004) tackle the constructs of the BPC management theoretical framework on the macro level. Therefore, a number of questions relating to the components of these constructs on the micro level remain unanswered. As a result of this discussion, a number of answers are suggested. However, another set of theory questions should be raised. These questions are regarded as the essence of the constructs of change organisational environment within the BPC management theoretical framework. These bases are questioned in order to avoid taking the bases of these constructs for granted. Therefore, it prevents this research being led by the theoretical framework because it could distort the phenomena by filtering out critical pieces of data (Anfara and Mertz, 2006). These questions are as follows:

TQ6: Is changing the organisational environment necessary to achieve successful implementation of the Six Sigma approach?

TQ6.1: Are the factors of change organisational environment, which have been mentioned in the theoretical framework, the only ones having a vital effect upon the success of the implementation of the Six Sigma approach?

TQ6.2: How do the factors of change environment influence each other?

TQ6.3: Do the factors of change environment have the same influence upon the implementation of the Six Sigma approach?

According to the reviewed literature, the answers to these questions are as follows:

ATQ6: The successful implementation of the Six Sigma approach should concern the creation (or change) of an organisational environment (Kettinger and Grover, 1995).

ATQ6.1: The factors of change organisational environment, which have been mentioned in the theoretical framework, are the critical factors to successfully implement the Six Sigma approach (Motwani et al. 2004; Kettinger and Grover, 1995).

ATQ6.2: The factors of change organisational environment have a bidirectional influence upon each other (Kettinger and Grover, 1995).

ATQ6.3: All factors of change organisational environment exert the same influence on the implementation of the Six Sigma approach.

Table (12) summarises the theoretical questions, propositions and key issues that are reflected by these propositions.

TQ	ATQ (propositions)	Key issues reflected by propositions
1: Is top management commitment necessary to initiate Six Sigma approach? Why? And how could it be attained?	1: Since the initiative of Six Sigma approach first requires radical organisational changes, the commitment of top management is so significant.	• Top management commitment is necessary (Bañuelas and Antony, 2002; Antony and Bañuelas, 2002; Henderson and Evans, 2000; Blakeslee, 1999; Pande et al. 2000 cited Bañuelas and Antony, 2002) • Convincing top management and process owners leads to commitment (Raisinghani et al. 2005; Wessel and Burcher, 2004) • Top management experience is an important element to implement Six Sigma (Buch and Tolentino, 2006). • Top management commitment has several aspects (Pandey, 2007) that could be interpreted by a variety of leadership styles (Nadler and Tushman, 1990).
1.1: What sort of strategic decisions in the context of Six Sigma are made, and what are the factors that affect this process?	1.1: The strategic initiatives include a specific plan of action to motivate the entire organisation towards achieving the goals of Six Sigma approach.	• Strategic initiatives include a specific plan of action (Kotter, 1995). • Top management are able to make strategic decisions (Raisinghani et al, 2005). • Different managerial levels are involved in the decision-making process (Schroeder et al, 2008) • Belts members decide how to make improvements coordinated with teams along process lines (Schroeder et al, 2008).
2: Should the organisational culture be ready or adjusted for initiating Six Sigma approach?	2: The organisational culture should be ready or (adjusted) to align with Six Sigma culture.	• The readiness of organisational culture helps to ease change resistance (Sinclair and Collins, 1994). • There are two trends regarding the readiness of the culture prior or during the process of Six Sigma implementation(Sathe, 1985; Schein, 1985 cited Prajogo and McDermott, 2005; Bañuelas and Antony, 2002; Antony and Bañuelas, 2002)) • Organisational culture is composed from values, beliefs, attitudes, behaviours and language (Sathe, 1985; Schein, 1985 cited Prajogo and McDermott, 2005; Kuei and Madu, 2003).
2.1: What are the contents of organisational culture that associate with Six Sigma approach?	2.1: The components of organisational culture that associate with Six Sigma approach could be more than those that have been identified by Motwani et al (2004).	The components of Six Sigma culture are composed of one or more of those mentioned by Motwai et al (2004). These components include (values) such as integrity, respect for people, unity, outside-in focus and agility and innovation, (attitudes) such as a mind-set of change that focuses on results, accountability, and data-driven decision-making, (behaviours) such as adopting intolerance for variation, measuring inputs not just outputs, demanding measurement and accountability, requiring sustainable gains and delivering on customer competitive advantage and (language).

Table 12: the theoretical questions, propositions and key issues reflected by propositions (continued)

TQ	ATQ (propositions)	Key issues reflected by propositions
3: What has been meant by the learning capacity as a factor within the theoretical framework?	3: Learning capacity is the ability to adapt and improve, to build internal and external knowledge, and to achieve a higher level of learning.	• Process of information, potential behaviour change and acquiring knowledge (Huber, 1991) • Effective processing, interpretation of an response to information inside and outside the organisation (Easterby-Smith and Araujo, 1999) • Detection and correction of errors within a given set of governing variables (single-loop learning) and/or involving changing those variables (double-loop learning) (Argyris and Schön, 1978; Savolainen and Haikonen, 2007; Kettinger and Grover, 1995) • The ability to adapt and improve, to build internal and external knowledge, and to achieve a higher level of learning (Guha et al 1997)
3.1: What sort of programs, schemes and techniques could be conducted to enlarge the learning capacity necessary for Six Sigma?	3.1: Training programs have a huge need to enlarge individuals' learning capacity. They should contain answers for how and why to implement Six Sigma. This could be achieved through the Belt system which provides good opportunities for individuals to expand their knowledge and skills.	• Training program runs for two weeks in order to help develop understanding of the philosophy and the use of basic quality tools (Haikonen et al. 2004, cited Savolainen and Haikonen, 2007; Linderman et al. 2003) • Extensive training program could be run either for four weeks (Savolainen and Haikonen, 2007; Linderman et al. 2003) or four months (Wiklund and Wiklund, 2002). This program includes statistics, interpersonal skills, problem-solving and project management (Caulcut, 2001). • Introduction training program runs from one to two days to give an overview of Six Sigma (Linderman et al. 2003;Savolainen and Haikonen, 2007)
4: How does data affect the implementation of Six Sigma approach?	4: The significance of the data trace back to Six Sigma approach supports the adoption of data-driven decision-making. According to this process, the right data should be available at the right time.	• Six Sigma is a highly data-oriented approach. As a consequence, implementation of the DMAIC concepts is heavily based on statistical tools and the statistical design of experiments (DoE) (Savolainen and Haikonen, 2007). • Information helps individuals make decisions on different characters (Kitchen and Daly, 2002)
4.1: What is the role of IT in data gathering and decision-making to facilitate Six Sigma implementation?	4.1: Planned and integrated IT system enhances data-driven decision-making to facilitate more effective and supportive knowledge-sharing in order to ease individuals' reluctance to implement Six Sigma.	• IT supports an effective investigation in order to find the real causes of quality problems (Tannock, et al 2007) • The role of IT is to sort and manage a large amount of data in order to support knowledge-sharing (Henderson and Evans, 2000). • IT enables users to co-ordinate work within and between organisations, and to access and integrate information effectively (Jacques, 1996)

Table 12: the theoretical questions, propositions and key issues reflected by propositions (continued)

TQ	ATQ (propositions)	Key issues reflected by propositions
5: How could network relationships be balanced?	5: Balanced network relationships exist between competition and co-operation among individuals through connecting multiple levels of the organisation together in improvement projects. This could be achieved by various mechanisms in Six Sigma, amongst others; the Belts system provides a good example of integrating decision-making horizontally at the lowest managerial level.	• Networks reshape the responsibility for decision-making by integrating it horizontally at the lowest managerial level (Kitchen and Daly, 2002). • Connecting multiple levels of the organisation together in improvement projects (Schroeder, et al 2008). • Various mechanisms in Six Sigma – such as strategic project selection and leadership engagement – help achieve multilevel integration (Schroeder, et al 2008). • A balance should exist between competition and co-operation among individuals (Kotter, 1995). • Six Sigma provides a hierarchical structure where leaders (Champions) initiate, support, and review key improvement projects; Black Belts then serve as project leaders who mentor Green Belts in problem-solving efforts (Barney, 2002; Sinha and Van de Ven, 2005).
6: Is changing the organisational environment necessary to achieve successful implementation of Six Sigma approach?	6: The successful implementation of Six Sigma approach should concern the creation (or change) of an organisational environment.	The creation or change of an organisational environment is necessary to the implementation of Six Sigma (Kettinger and Grover, 1995).
6.1: Are the factors of change organisational environment, which have been mentioned in the theoretical framework, the only ones having a vital effect upon the success of the implementation of Six Sigma approach?	6.1: The factors of change organisational environment, which have been mentioned in the theoretical framework, are the critical factors to successfully implement Six Sigma approach.	The factors of change organisational environment within BPC management theoretical framework are the only ones that have a vital effect on the success of Six Sigma implementation (Motwani et al. 2004; Kettinger and Grover, 1995).
6.2: How do the factors of change environment influence each other?	6.2: The factors of change organisational environment have a bidirectional influence upon each other .	The form of the relationship between the factors of change organisational environment is bi-directional (Kettinger and Grover, 1995).
6.3: Do the factors of change environment have the same influence upon the implementation of Six Sigma approach?	6.3: All factors of change organisational environment exert the same influence on the implementation of Six Sigma approach.	The influence of the factors of change organisational environment upon Six Sigma implementation is the same.

Table 12: the theoretical questions, propositions and key issues reflected by propositions

Overall, these theoretical questions and the propositions are proposed in order to answer a central research question that represents the gap of knowledge.

2.3.3.2.2 Central Research Question (CRQ)

The central research question is the key research question. It is the statement of the question being investigated in the study in its most general form. This is in order not to delimit the inquiry (Creswell, 2003). The central question of this research that has been posed is stated as follow, "how" and "why" the factors of change environment within the BPC theoretical framework are attained in order to successfully implement Six Sigma.

In conclusion, as has been mentioned earlier in section two of this chapter, studies have shown that a large number of quality improvement efforts have failed even in the early application stages. Furthermore, these studies have attributed this failure to a large number of causes. Therefore, a large number of factors has been proposed in order to ensure a successful implementation of quality improvement efforts. However, there is disagreement regarding the sort and significance of these factors to the implementation of quality improvement efforts.

According to the reviewed literature, in the modern era of quality improvement tools, approaches and philosophies, there are two main attempts to merge these factors into a system or model in order to facilitate the implementation of these efforts. The first attempt has been the initiative of quality management systems such as the National Quality Awards and the ISO 9001-2000 standard. These systems have been proposed in order to compromise the variety of the definitions, components of TQM philosophy and to suggest a means to investigate the success of the implementation. Therefore, these systems have been built upon the principles of this philosophy.

In practice, although quality awareness has been enhanced in organisations that have exploited these systems, there has not been a real impact on the bottom line of these organisations. This result has discouraged the top management of a large number of organisations from applying quality improvement efforts. In addition, several studies that have compared a number of national quality awards, such as the Baldrige National Quality Award, the European Foundation for Quality Management and the Deming Prize, have shown that the evaluation criteria of some of these awards have moved towards performance improvement and promotion activities as opposed to quality improvement efforts.

The second attempt is the BPC management theoretical framework. The initial proponents, Kettinger and Grover (1995), have attributed the high percentage of failure of BPR to the absence of a theory that describes, explains and predicts effective BPR upon the effectiveness of organisations. Therefore, this theoretical framework has been proposed. Moreover, as a result of lengthened discussion in 2.3.3.1.1 of this section, this researcher could claim that this framework is well built theoretically because it has been built on the notion of the congruence of components of an organisation. This notion has been proposed by a number of organisational behaviour gurus and scholars such as Leavitt, Chandler, Nadler, Tushman, Rockart and Scott Morton. With reference to this notion, these scholars built a number of models. These theoretical models provide the basis for generic organisational analysis because it describes, explains and predicts the effectiveness of an organisation. Since these models are generic, a sub-model is necessary in order to specifically analyse the effectiveness of an organisation. So, the BPC management theoretical framework has been exploited to analyse the effectiveness of organisations that apply the BPR approach. In other words, this theoretical framework is a means to investigate the success of the implementation of the BPR approach. For the same purpose, this framework has been adapted by Motwani at el. (2004) in order to fit the Six Sigma approach. This can be attributed to the similarity between both approaches, represented by three common features.

First, both BPR and the Six Sigma approaches represent process thinking. Second, the outcome of both approaches is the same in that both approaches aim to satisfy customers and achieve measurable performance gains. Third, there is a huge similarity between the critical success factors of Six Sigma approach implementation and the components of the descriptive model of BPC. Moreover, it fits completely in the factor of change organisational environment within the theoretical framework of BPC management. Therefore, this researcher believes the BPC management theoretical framework may prove useful to underpin the required theoretical framework that this study is developing. The aim of the required framework is to investigate the factors that facilitate and inhibit the success of the Six Sigma approach and to exploit this framework as guidance for the potential implementation of this approach. However, because of a number of constraints, Matwani et al (2004) discuss the constructs of the organisational environment on the macro level that resulted in many unanswered questions on the micro level. Thus, this researcher has considered these unanswered questions as a gap in knowledge to be addressed in this current study. These questions, propositions and key issues that are reflected by these propositions are shown in Table (12). As a result of answering these questions, one of the objectives of this research will be addressed, namely the development of a theoretical framework to explain the impact of the upfront entities of the factors of the change organisational environment upon the attainment of these factors.

3 Chapter 3: Research Methodology

Usually, researchers and practitioners are facing new experiences in their everyday routine. These new experiences are subjected to their judgements. These judgements are influenced by the researchers' and practitioners' knowledge. Thus, they use an epistemological analysis in order to make sense of organisational events and phenomena or they discern and evaluate possible courses of action (Johnson and Duberley 2000). In addition, any epistemological analysis of the grounds of certain knowledge or the scientificity of truth claims involves ontological assumptions about the nature of the world. (Bhaskar, 1975 cited Johnson and Duberley, 2000). Furthermore, with the ontological assumptions, the researchers must decide whether they consider the world is objective and external to the research, or socially constructed and only understood by examining the perceptions of the human actors (Crewell, 1994 cited Collis and Hussey 2003). Thus, the philosophical terms epistemology and ontology are key terminology in management research. Epistemology is a Greek word that has been derived from two words. These words are episteme which means knowledge or science; and logos which means knowledge, information, theory or account. So, according to Gill and Johnson (2002) and Johnson and Duberley (2000) epistemology is the knowledge about knowledge. In other words, it is the study of the criteria in order to know what does and does not constitute warranted, or scientific, knowledge. On the other hand, ontology is the study of phenomena and the nature of their existence (Gill and Johnson 2002). Briefly, ontology is claims about what is knowledge whilst epistemology is claims about how we know it (Creswell 2003).

According to the aforementioned notion and following the literature review and for the purpose of linking theory with practice, this research is looking into one of the most important problems facing the manufacturing sector in the United Arab Emirates (UAE). As previously mentioned in the first chapter, this problem concerns the sub-standard quality of products manufactured in the UAE. This problem has been recognised by manufacturers. Thus, several tools, approaches and philosophies have been applied to address this issue. Moreover, a large number of these manufacturers have achieved the ISO 9001-2000 standard and national quality awards. However, although product quality has been improved, further improvements need to be made. This researcher has experienced this problem in two ways. Firstly, from his previous study of the quality of the foodstuff manufacturing sector in the UAE, he noted that sub-standard quality was a key issue. Secondly, this result is further supported by the level of customer complaints received by the UAE Department of Standardisation and Specification, the researcher's past employer.

Likewise, this problem is not purely restricted to the UAE, but is global in scope. However, the issue of quality differs from country to country. A result of a North American study (Harry, 1998) has shown that most companies are working near four sigma. This result highlights the problematic nature of poor quality products manufactured in one of the most developed industrial countries. Certainly, the view of product quality in the UAE is comparatively worse. This is attributed to the fact that the UAE is a developing country. Moreover, manufacturing activities have only recently begun in this country.

Furthermore, a study (Zaramdini, on line) conducted in the UAE indicates that the real impact on the bottom-line and cost reduction comes last in the list of the perceived benefits of obtaining the ISO 9000-2000 certificate. This finding supports the work of a study (Bergquist and Ramsing, 1999) conducted in the USA, where many companies that have achieved one national quality award or more, immediately lost their business after this achievement. These studies have emphasised the need for a critique of the tools, approaches and philosophies of evolutionary quality improvement. As has been discussed in the literature review, several studies have criticised these tools, approaches and philosophies. One of these critiques is that they have a limited positive impact on the bottom line. Therefore, some shareholders considered these tools, approaches and philosophies as added costs that offered little real benefit to their businesses.

However, as has been mentioned in the second chapter, several studies show that there is a strong tendency towards implementing the Six Sigma approach broadly in order to achieve perfect product quality. This approach is deemed to satisfy all stakeholders, in that the Six Sigma approach enables product quality improvements (satisfying customers). Similarly, it has a real impact upon the bottom line (satisfying shareholders). By contrast, there is not a tendency towards this approach in the UAE. This has been found via a pilot survey conducted by this researcher in 2005 and updated in 2008. This survey included all consultants and organisations working in the quality field at the UAE (Appendix 2 shows names of the consultants and organisations). The result is surprising because there is only one company that has implemented this approach in the entire UAE manufacturing sector. This company is Dubai Cable Company (Ducab). Therefore, this result has enhanced the necessity of adopting this approach in the manufacturing sector in the UAE. In addition, this pilot study has highlighted a unique phenomenon in this sector (Ducab), suggesting that other companies in the UAE could also successfully implement Six Sigma. Thus, additional research in this field could be beneficial.

However, prior to this enquiry, the way of doing it and its justification should be demonstrated. Therefore, this chapter presents and discusses the methodological features and decisions made with regard to the data collection methods and subsequent analysis of primary data. First, the theoretical features of this study, namely the adopted philosophical stance, guiding the thinking of the nature of knowledge and this study in particular, will be discussed. The focus will then shift to consider the associated research strategy and applied method.

3.1 Research philosophy

According to Saunders et al., (2003) research philosophy is the way that researchers think about the development of knowledge. Assumptions are underlying this way(Maylor and Blackmon, 2005; Collis and Hussey, 2003). In this context, this researcher constructs his way of thinking upon the following assumptions.

3.1.1 Subjectivism and interpretivism

This researcher believes that the internal logic of human action should be understood. For this purpose, a 'verstehen' Process (Johnson and Duberley, 2000); (Gill and Johnson, 2002) is conducted. According to Gill and Johnson (2002, p.229) verstehen entails "*explanation of the actions of subjects by understanding the subjective dimensions of their behaviour*". This assumption involves the adoption of an interpretivism research approach. The aim of this approach is to understand how people make sense of their worlds (Maylor and Blackmon, 2005).

Accordingly, this approach is often associated with social constructionism (Saunders et al., 2003), which views reality as being socially constructed. According to this concept, people not only interact with their environment, but also seek to make sense of it through their interpretation of events and the meanings that they draw from such events.

3.1.2 Phenomenological paradigm

According to Collis and Hussey (2003), the term paradigm refers to how research should be conducted. Paradigms offer a framework comprising an accepted set of theories, methods and ways of defining data. They also contended that the term paradigm is used quite loosely in academic research and can mean different things to different people. In order to help clarify the uncertainties, Morgan (1979 cited Collis and Hussey, 2003) suggests that the term can be used at different levels. Amongst others, at the philosophical level it is used to reflect basic beliefs about the world which will be reflected in the way the researcher designs the research. In this context, Collis and Hussey stated that there are two main research paradigms or philosophies. Although there is considerable blurring, the two paradigms can be labelled positivist and phenomenological. Collis and Hussey (2003) contended it was not long before some social scientists began to argue against positivism. These scientists pointed out that physical sciences deal with objects which are outside us, whereas the social sciences deal with action and behaviour which are generated from within the human mind.

A number of authors agree on the definition of the term phenomenology. In this respect, Collis and Hussey (2003) define phenomenology as the science of phenomena. A phenomena is, according to Allen (1990 cited Collis and Hussey, 2003), a fact or occurrence that appears or is perceived, especially one of which the cause is in question. The word is derived from the Greek verb to appear or show. Therefore, the phenomenological paradigm is concerned with understanding human behaviour from the participant's own frame of reference. According to this paradigm, considerable regard is paid to the subjective state of the individual. Thus, this paradigm stresses the subjective aspects of human activity by focusing on the meaning of social phenomena. Moreover, to varying degrees, phenomenologists believe that social reality is dependent upon the mind. There is no reality independent of the mind; therefore, what is researched cannot be unaffected by the process of the research. The research methods used under this paradigm are an array of interpretive techniques which seek to describe, translate and otherwise come to terms with the meaning, not the frequency of certain more or less naturally occurring phenomena in the social world (Van Maanen, 1983 cited Collis and Hussey, 2003).

In the same way, Gill and Johnson (2002) considered phenomenology as an opposite to positivism. They defined phenomenology as a study of how things appear to people – how people experience the world. On the other hand, they defined positivism as an approach that emphasises the use of the methods, presumed to be used in the natural sciences, in the social sciences. Likewise, Saunders et al (2003) defined phenomenology as a research philosophy that sees social phenomenon as socially constructed, and is particularly concerned with generating meanings and gaining insights into those phenomena. Similarly, Creswell (2003) claimed that according to phenomenological research, the researcher identifies the essence of human experiences concerning a phenomenon, as described by participants in a study. Therefore, the phenomenological paradigm is adopted in order to conduct this enquiry. This is because the success of Six Sigma implementation in Ducab is a unique phenomenon in the UAE and this enquiry is exploring the participants' thoughts regarding this success.

3.1.3 Research method

As a result of applying the aforementioned philosophy, several different qualitative research methods could be selected to collect and analyse data (Creswell, 2003). These methods help in exploring participants' realities, examining their feelings and thoughts and also in searching for insiders' ('emic') viewpoints (Gill and Johnson, 2002). According to social constructionism and the phenomenological paradigm, the case study is an appropriate method for selection (Collis and Hussey, 2003). The preference of applying this method to this enquiry is attributed to the fact that it allows the empirical investigation of a particular phenomenon within its real life context or setting, particularly the dynamic that takes place in this setting (Saunders et al., 2003; Maylor and Blackmon, 2005). Moreover, the case study method provides the flexibility for probing during interviews and gathering of in-house documentary evidence (Eng, 2008).

3.1.3.1 Case study

The case study is defined as an extensive investigation of a single instance of a phenomenon of interest and is an example of phenomenological methodology (Collis and Hussey, 2003). In addition, it is often associated with descriptive or exploratory research, without being restricted to these areas (Ghauri and Grongaug, 2005). Likewise, Maylor and Blackman (2005) state that a case study can answer either exploratory and descriptive or analytic research questions such as 'how' and 'why' questions. A case study can explain, describe, illustrate, explore or evaluate the social phenomenon of interest. Eisengardt (1989) and Collis and Hussy (2003) refer to the case study as a research study which focuses on understanding the dynamic present within a single setting. Bonoma (1985 cited Collis and Hussey 2003) notes that it must be constructed to be sensitive to the context in which management behaviour takes place. In addition, Creswell (2003) defines case studies in which the researcher explores in depth a program, an event, an activity, a process or one or more individuals. The case(s) are bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time.

As a result of reviewing a number of case study definitions, Yin (2009) technically defines a case study as part of a twofold. The first part begins with the scope of a case study. According to this part, the case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. The second part of the technical definition of a case study includes data collection and data analysis strategies. According to this part, the case study inquiry copes with the technically distinctive situation.

Looking into the aforementioned definitions, it could be observed that there is agreement amongst these definitions. The case study definition is composed of three essential elements. First, a case study is a research study applied in order to conduct an in depth enquiry for generating and testing theories that have provided the strategic management field with ground-breaking insights (Gibbert et al. 2008). Second, a case study is a research understanding of a single instance of a social phenomenon of interest that is constructed to be sensitive to its real-life context. Third, a case study is bounded by time and activity and is provided with a variety of data collection procedures.

3.1.3.1.1 The justification of case study method choice

In this researcher's opinion, integrating the essential elements of the case study definition with the three conditions that Yin (2009) refers to as the rationale for choosing the case study method above other alternatives, justifies the choice of applying the case study method for conducting this research as follows.

3.1.3.1.1.1 The relationship between research questions and propositions and collected data

Considering the nature of the questions of this study, the case study method is most likely to be appropriate for "how" and "why" questions (Yin, 2009). According to Yin's (2009) suggestion, the literature review is a helpful step to identify these questions. Therefore, this study, as shown in the literature review, investigates "how" and "why" the factors of change environment within the BPC theoretical framework affect the success of the implementation of Six Sigma. These "how" and "why" questions, capturing what this study is really interested in answering, led to the case study as the appropriate method in the first place (Yen, 2009). As shown in Table (12), this study is interested in answering a number of theoretical questions. Each answer represents one of this study's propositions. These propositions reflect a number of key issues that should be explored.

Moreover, this researcher looks into participants' experience of successful implementation of Six Sigma in Ducab through conducting interviews and collecting in-house evidence. The result of this exploration, besides inferring new notions of successful implementation of Six Sigma, leads to verifying or falsifying this research's propositions. For instance, this researcher looks into participants' thoughts regarding the strategic initiative in Ducab. This includes the way of convincing top management to accept innovatory strategic ideas and the top management way of showing their commitment. This interpretation helps verifying or falsifying the first proposition which reflects an important theoretical issue. This issue is the necessity of top management commitment for successful Six Sigma implementation. This is an example of the relationship between the collected data and the propositions and theoretical questions. The rest will be shown in Table (13) during the elaboration of the interview questions.

3.1.3.1.1.2 The extent of control over behavioural events

The extent of the investigator's control over, and access to, actual behavioural events, is another justification for the choice of the case study method. According to Yin (2003) the case study is preferred in examining contemporary events, but when the relevant behaviours cannot be manipulated. Analogically, this researcher investigates the successful implementation of Six Sigma in Ducab through conducting interviews without his interference in order to neutrally explore participants' experience in the implementation process. Moreover, since this process was begun in 2000 and is still continuing, there is no control over the past events that produce the data for this research. This situation differs from experiments that are done when an investigator can manipulate behaviour directly, precisely and systematically (Yin, 2009).

3.1.3.1.1.3 The degree of focusing on contemporary events

The case study method differs from histories because the former is able to deal with a full variety of evidence such as documents and interviews that is beyond what might be available in a conventional historical study. The case study, therefore, relies on many of the same techniques as history, but it adds other sources of evidence not usually included in the historians' repertoire, such as interviews of the people involved in the events (Yin, 2009). Thus, it is possible to gather factual evidence of past actions and outcomes that relate to current interpretations of the successful implementation of Six Sigma. These interpretations can be explored in conversations and interviews through good rapport between researchers and interviewees (Eng, 2009). According to aforementioned elaboration, this research focuses on events that transpired over a long period of time.

3.1.3.1.1.4 Investigating the social phenomenon within its real life context (Research context)

According to Yin (2009), the case study is used to understand a real-life phenomenon in depth, but such understanding encompassed important contextual conditions. In this respect, a summary of the research context that was shown in the first chapter recalls as follow. The UAE economy is featured by its fast growth. This growth is attributed to several reasons such as large oil revenues, fresh ideas and economic project initiatives. However, the UAE economy mainly depends upon oil revenues and relies heavily on expatriate workers. It is, also, featured as massive consumptive economy.

In order to diversify incomes streams, the UAE government encourages a mixture of light and heavy industries. Ducab was classified as one of the companies that operate within the equipment and machinery activity. This activity is considered as the fastest growing activity in 2009. Ducab has been manufacturing power cable in the UAE since 1979 with a total of forty million UAE Dirhams. This company has a workforce of more than five hundred employees. Ducab is, also, known for its high product quality. This is resulted in a winning several quality awards. As a result of the continuous quality journey, this company started Six Sigma schemes in 2000 with the assistance of Motorola University. As a result of this initiative, Ducab achieved impressive improvements in the following years that encourage the top management to sustain this initiative. The analysis has revealed that the value of benefits repaid the cost of implementing the Six Sigma scheme. As observed from aforementioned elaboration, the boundaries between phenomenon and context are not clearly evident so the case study is chosen to conduct this enquiry (Yin, 2009, Eng, 2009)

Since the choice of case study method is justified, the following is the rationale of single case study.

3.1.3.1.2 The rationale of single case

The Ducab successful implementation of Six Sigma represents a unique phenomenon in the UAE. This success could be observed from the positive outcomes, the growing number of Six Sigma projects in different departments and the top management enthusiasm to continue executing the Six Sigma schemes. This is because successful implementation means ensuring at least self-financing this implementation from the outset (Wessel and Burcher, 2004). Therefore, this case is single. This is because a single case may naturally occur when the case represents and extreme or a unique case that is worth documenting and analysing (Yin, 2009; Maylor and Blackmon, 2005). Moreover, the tentative definition of the unit of analysis is related to the way of identifying the research question (Yin,2009). Since the research question is "how" and "why" the factors of change environment within the BPC theoretical framework affect the success of the implementation of Six Sigma, Ducab is the unit of analysis. The experience of Ducab in successful Six Sigma implementation is explored through investigating the thoughts of participants who play vital roles in the implementation process. These participants represent the sub units (Yin, 2009). Therefore, the case is embedded single. The investigation could be resulted in new factors of successful Six Sigma implementation as well as leads to verify or falsify the research propositions. Therefore this case study is, according to the classification of Collis and Hussey (2003), illustrative and explanatory. This case study attempts to illustrate new and possibly innovative practices adopted by particular companies in order to develop a theoretical frame that is inferred from the participants thoughts and underpinned by BPC management theoretical framework. However, the role of the latter frame work is identified as follow.

3.1.4 Inductive strategy and the role of the theoretical framework

In order to maintain subjectivity in the enquiry, the inductive strategy, which helps in building theory, is conducted to gather and analyse data (Johnson and Duberley, 2000). This research strategy is best adopted when a close understanding of the research context is required (Saunders et al. 2003). Moreover, this strategy is a more flexible structure to permit changes of research emphasis as the research progresses and a realisation that the researcher is part of the research. In addition, it is less concerned with the need to generalise.

According to Eisenhardt & Graebner's (2007, p.26) claim, the justification for applying *"inductive case research depends on the nature of the research question. For theory-driven research questions that extend existing theory (Lee, et al., 1999 cited Eistenhardt & Graebner, 2007) a researcher has to frame the research within the context of this theory and then show how inductive theory building is necessary. Typically, the research questions tightly scoped within the context of an existing theory, and the justification rest heavily on the ability of qualitative data to offer insight into complex social processes the quantitative data cannot easily reveal."*

Accordingly, using a theoretical frame focuses a study in a number of ways as Anfara & Mertz (2006, pp. 192-193) have claimed. *"First, qualitative researchers often feel overwhelmed by mountains of data (e.g. interview transcripts, documents) that could be collected. By acting as a sieve or a lens, the theoretical framework assists the researcher in the process of sorting through these data. Second, the theoretical framework frames every* *aspect of a study from the questions asked, to the sample selected, to the analysis derived. The concepts, constructs and propositions that are part and parcel of theory help the researcher in formulating these component parts of the research process. Third, qualitative researchers are keenly aware of the existence of subjectivity and bias in their research, the theoretical framework helps the researcher to control this subjectivity by self-conscious revisiting of the theory and concomitant awareness that one is using a particular perspective. Fourth, the theoretical framework provides powerful concepts that may be used in the coding and the analysis of the data".*

Moreover, Anfara & Mertz (2006, p. 193) have concluded from the insights of the contributors to their book *"Theoretical framework in qualitative research"* that theoretical frameworks have the ability to reveal and conceal meaning and understanding. They claimed that *"Although we acknowledge that theories can allow us to see familiar phenomena in novel ways, they can also blind us to aspects of the phenomena that are not part of the theory. As part of theory's ability to reveal and conceal, we are cognizant that a theoretical framework can distort the phenomena being studied by filtering out critical pieces of data. Researchers needed to recognize this characteristic of a theoretical framework and give serious thought to what is being concealed. This ability to reveal and conceal makes it all the more important for researchers to tell their readers, if possible, what is concealed. This is, after all, the essence of a study's delimitations".*

As a result of aforementioned discussion, this research is concerned with how Ducab successfully implemented Six Sigma, and relating the participants' experiences to the BPC management theoretical framework. However, as has been concluded in the literature review, this theoretical framework left a number of questions unanswered regarding how and why the factors of the change organisational environment affect Six Sigma implementation. Thus, the theoretical framework will not be tested in this research but modified. At the end of this research, this author will suggest another theoretical framework that answers these questions - see Figure (7) on page 204.

3.2 Data collection techniques

There are a variety of techniques for qualitative data collection (Yin, 2003; Glesne and Peshkin, 1992; Creswell, 2003). Amongst others, observations, interviews, documents and audiovisual materials are some of these techniques. Each technique has its advantages and limitations (Creswell, 2003). Therefore, most of the scholars have suggested several guiding principles for data collection (Yin, 2003; Glesne and Peshkin, 1992; Creswell, 2003; Maxwell, 1996). The most important principle is data sources triangulation. According to Flick (2002) Miles and Huberman (1994), it is important to gather data from a range of sources via a combination of different methods. The aim of this principle is to contribute to the trustworthiness of the data (Glesne and Peshkin, 1992). Therefore, for the purpose of this research, two types of data collection techniques have been used, namely interviews and documents together with archival records. The following is an elaboration of these techniques.

3.2.1 Interviews

In order to answer the research questions empirically and know participants' thoughts, an open-ended question interview is the most appropriate data collection technique. This is because the interviewees have the opportunity to construct the meanings when reflecting on particular situations, issues and experiences (Creswell, 2003). Moreover, Flick (2002) has emphasised the role of semi-structured interviews as one of the techniques for data collection. According to Flick's method, these interviews are conducted through three sub-sessions (Wengraf, 2001). Doing the interview in this way is to ensure bias is avoided, giving the participants enough time to express their opinions. In addition, it is good way to capture missing data or equivocating from one interviewee to another.

In the first sub-session, a single open question is asked to encourage the participants to tell their stories. In this sub-session this researcher will listen first, not interrupt the interviewee and just take some notes for preparing further questions to be asked in the second sub-session. For this purpose, this researcher has adopted a matrix that has been suggested by Wengraf (2001) (Appendix 15 shows this matrix). The second sub-session will be conducted on the same day, seeking more details about what has been said in the first sub-session without seeking reasons for these actions. These questions will be prepared during a short break after the first sub-session. The third sub-session will be held after a week or more. This is in order to initially analyse the material that has been collected during the first and second sub-sessions. In this sub-session, some more questions will be asked seeking the interpretation of actions. The following part is a demonstration of interview (informant) questions and their indicators.

3.2.1.1 Interview (informant) Questions (IQ) and their indicators

Interview questions (IQ) and theory questions (TQ) are different. Theory questions are formulated in theory language of the research community whilst interview questions are formulated in interviewee's language (Wengraf, 2001). This is attributed to the aim of the formulation of each kind of these questions. The aim of research questions is to attain what the researcher wants to understand whilst the aim of interview questions is to gain peoples' understanding through asking this question. Thus, Maxwell (1996) has claimed that interview questions are judged not by whether they resemble the research questions but by whether they provide the data that will contribute to answering these questions. Moreover, Wengraf (2001) has asserted upon the operationalisation, instrumentation or interpretation of these questions. This term refers to the need for the work to link the theoretical concepts to the empirical indicators. The latter has been defined as a measurement, an observation and a datum that is taken to be evident for a particular theoretical concept being in one state or another.

In the same context, interview questions could be originated as Daren (cited Glesne and Peshkin, 1992) has claimed from researchers' knowledge of literature or from their reasoning. Thus, these questions could be established both before and during the course of interviewing. Such questions could be added or replaced by re-established ones (Glesne and Peshkin, 1992). In addition, the interviewer could start the course of interviewing with minimal intervention in order to build knowledge of, and rapport with the interviewee then shift to more specific questions. This tactic is used in order to discover unanticipated responses, motivate interviewees to provide detailed descriptions of events or situations and avoid researcher bias.

According to aforementioned elaboration and as the interviews of this study include three sub-sessions, the open question that will be asked at the first sub-session is the following: 'I would like you to put yourself in the position of my advisor. I am a manager of a company that has no idea about the Six Sigma scheme and has never heard about it. What would you advise me about this scheme and how does it work? What do I need to do to establish this scheme in my company?

As the research is progressing and according to the preliminary analysis, a number of specific questions could be asked during the third sub-sessions. However, it does not forbid preparing these questions in the early stage of the inquiry. Therefore, this researcher has prepared a number of these questions depending on his knowledge of the literature and its reasoning. Raising these questions has an additional purpose over and above using them during the third sub-session; they will be used to find indicators in order to link the theoretical concepts with the interviewee's thoughts. Depending on Table 12 that depicts the theory questions, proposition and the key issues reflected by these propositions, the following Table 13 is a demonstration of this linkage. This table consists of four columns, namely theoretical questions, informant questions, indicators and codes, respectively.

Theory Question (TQ)	Informant Questions (IQ)	Indicators	Codes
TQ1: Is top management commitment necessary to initiate Six Sigma approach? Why? And how could it be attained?	IQ1: What are your points of view about the roles of the different managerial levels (top, middle and line) in the implementation of the Six Sigma scheme?	From the answer, the role of each managerial level would be indicated. Therefore, the role of the top management would be compared with other managerial levels to find out the necessity of this role.	• The strategic initiatives need top management commitment ○ The participant agrees with this statement ○ The participant disagrees with this statement ▪ (sub-codes for new suggestions)
	IQ2: In your opinion, of all those you have mentioned, which is the most important one to successfully implement the Six Sigma scheme? Why?	To enhance the result of the previous question (IQ1).	
	IQ3: Do you think top management involvement has affected the implementation process?	To find out the actual role of top management that would enhance the result of the previous two questions (IQ 1,2).	
TQ1.1: What sort of strategic decisions in the context of Six Sigma are made, and what are the factors that affect this process?	IQ4: How do you describe the decisions that should be taken in order to begin the process of implementation?	The answer demonstrates understanding of the case about the importance of taking strategic decisions to initiate the implementation of the Six Sigma scheme.	• The strategic initiatives are essential for the implementation of the Six Sigma approach ○ The participant agrees with this statement ○ The participant disagrees with this statement ▪ (sub-codes for new suggestions)
	IQ5: At which managerial level, do you think, should the initiative decisions be made?	Depending on the answer, the managerial level that would be chosen would indicate the sort of decision that would be taken.	
	IQ6: From your point of view, how do these decisions impact on the work of the company? Why?	The extent of the impact shows the significance of the decisions.	• The impact of the decisions of embarking on the implementation is radical ○ The participant agrees with this statement ○ The participant disagrees with this statement ▪ (sub-codes for new suggestions)

Table 13: Theoretical questions, associated interviewees’ questions, indicators and codes (continued)

Theory Question (TQ)	Informant Questions (IQ)	Indicators	Codes
TQ2: Should the organisational culture be ready or (adjusted) for initiating the Six Sigma approach?	IQ7: How do you describe the way of doing things around your company (organisational culture) before and after the implementation of the Six Sigma scheme?	The difference between the preceding way of doing things around the case and the coming one after the implementation of the Six Sigma scheme would show the extent of the change (if any) in the organisation culture.	• The organisational culture should be ready or (adjusted) for initiating the Six Sigma approach ○ The participant agrees with this statement ○ The participant disagrees with this statement ▪ (sub-codes for new suggestions)
	IQ 8: Before you began to implement the Six Sigma scheme, did you consider whether the way of doing things around your company (organisational culture) could cope with the new scheme? Did you need to adjust organisational culture? Was this necessary? Why?	The answer shows the understanding of the case about the importance of organisational culture readiness for implementing the Six Sigma scheme.	
TQ2.1: What are the contents of the organisational culture associated with the Six Sigma approach?	IQ9: Of all those you have mentioned, which one (or more than one) do you consider associates with the Six Sigma scheme?	To find out the contents of the organisational culture associated with the Six Sigma approach from the participant's point of view and to compare this with that which has been mentioned in the theoretical framework.	• The contents of organisational culture include: ○ Values and beliefs ○ Attitudes and behaviours ○ Languages
TQ3: What has been meant by learning capacity as a factor within the theoretical framework?	IQ10: How do you consider the ability of the individuals to adapt and improve their knowledge about the Six Sigma scheme? Why?	The answer indicates the participants' understanding about learning capacity and the justification of this understanding.	• The participant understands the concept of learning capacity and the concept has been taken into account when they plan for the implementation of the Six Sigma approach. • Although the participant understands the concept of learning capacity, it has not been taken into consideration when planning for the implementation. The participant does not understand the concept of learning capacity.
	IQ11: What were the means that were used to ensure the precision of this consideration?	To know about the way that has been followed to measure the learning capacity of individuals in the case in order to implement the Six Sigma approach. Thus, it would show the possibility of taking this factor into consideration before and during the implementation period.	

Table 13: Theoretical questions, associated interviewees' questions, indicators and codes (continued)

Theory Question (TQ)	Informant Questions (IQ)	Indicators	Codes
TQ3.1: What sort of programs, schemes and techniques could be conducted to enlarge the learning capacity that is necessary for the Six Sigma approach?	IQ12: To what extent do you think individuals in your company need learning programs and techniques associated with the Six Sigma scheme? Why?	The answer shows the attention that has been paid to learning programs in the case, to enhance Six Sigma knowledge (triangulate the last question).	• The case justifies the attention that has been paid to learning capacities • The case justifies the inattention that has been paid to enlarging the learning capacity of their individuals.
	IQ13: (If the participant's reply is important) What are they?	The answer of this question assures that the participant was talking about Six Sigma learning programs and techniques.	• Six Sigma training programs • Other training programs
	IQ14: What is the way(s) or structure that has been followed to motivate and involve individuals in the learning programs?	The answer shows the possibility of using the Belts system in the case to spread Six Sigma knowledge.	• Through Belts system the learning capacity is enlarging • Other ways (sub-codes for each)
TQ4: How does data affect the implementation of the Six Sigma approach? TQ4.1: What is the role of IT in data gathering and decision- making to facilitate Six Sigma implementation?	IQ15: What does data mean to your company? Why?	To know the extent to which the case uses data in their decisions and operations.	• Data is an important source for decision-making and operations • Data could be useful for decision-making and operations. • No use of data • The case makes use of an IT system to save and manipulate data • No IT system in the case • All individuals could look at data • Some individuals could look at data • Nobody can look at data
	IQ16: How do you manipulate data? Why? IQ17: Which employees do you allow to look at data? Why?	To know the possibility of using IT to save and manipulate data and the possibility of permitting individuals to share information within the case.	

Table 13: Theoretical questions, associated Interviewees; questions, indicators and codes (continued)

Theory Question (TQ)	Informant Questions (IQ)	Indicators	Codes
TQ5: How could network relationships be balanced?	IQ18: How do you describe the relationship between the employees in your company?	The answer shows the sort of the relationship between individuals in the case, and the possibility of balancing the network relationships.	• The network relationships are balanced. • The relationship between individuals is characterised by conflict.
	IQ19: What are the sorts of communication between individuals at different managerial levels in different departments within the company?	The answer demonstrates the possibility of permitting individuals to communicate freely across functions and processes within the case.	• Communication is free, honest and open. • Communication is subject to bureaucracy.
TQ6: Is changing the organisational environment necessary to achieve successful implementation of the Six Sigma approach?	IQ20: How do you describe the situation, from different aspects, at your company before and after the implementation of the Six Sigma scheme?	The difference between the previous situation and the following one after the implementation of the Six Sigma scheme will show the extent (if any) of the change.	• Changing organisational environment ○ It is necessary ○ It is unnecessary.
	IQ21: Why have you decided to initiate the Six Sigma scheme in your company?	To know the real reasons that have led the company to initiate the Six Sigma scheme to find out if the change environment has been one of them.	
TQ6.1: Are the factors of the change organisational environment, which have been mentioned in the theoretical framework, the only ones having a vital effect upon the success of Six Sigma approach implementation?	IQ22: On which ‘elements’ have you relied to make the decision to initiate the Six Sigma scheme?	Using term ‘elements’ here = term ‘factors’ in the theory questions. Therefore, the interviewee’s answer reveals if s/he has made their decision depending on the same factors of the theoretical framework or if there are other factors that should be explored to verify or falsify the proposition.	• The factor of the change organisational environment, mentioned in the theoretical framework ○ They are the only ones that have a vital effect on the success of the implementation. ○ There are other factors that have vital effects (new sub-codes) ○ There are some factors that should be eliminated (new sub-codes)
	IQ23: Do you think these elements are the only ones that need to be depended upon to make your decision?	To be sure that the case did not find another element(s) that has been missed during the establishment of the scheme that could lead to better and more economical establishment.	
	IQ24: If you had another chance to decide, which element(s) would you eliminate?	The answer shows that the case has not been misled by depending upon these elements that have been chosen.	Same as previous codes

Table 13: Theoretical questions, associated interviewees’ questions, indicators and codes (continued)

Theory Question (TQ)	Informant Questions (IQ)	Indicators	Codes
TQ6.2: How do the factors of the change organisational environment influence each other?	IQ25: Do you think these elements influence each other or do they work independently? Why?	To determine the form of the relationship between the factors of the change organisational environment (bi-directional or unidirectional)	The form of the relationship between the factors of the change organisational environment change is ○ Bi-directional (including the justifications) ○ Unidirectional (including the justifications) ○ Other (new sub-codes including the justifications)
	IQ26: If your answer is 'yes', how do you think they work?	To find out the direction of the relationship (triangulate the result).	
TQ6.3: Do the factors of the change organisational environment have the same influence on the implementation of the Six Sigma approach?	IQ27: Do you think that some of these elements that have been mentioned have more influence on the implementation of the Six Sigma scheme than others, or do they have the same influence?	To conclude that all factors of the theoretical framework have the same influence on the implementation of the Six Sigma scheme or if they vary from one factor to another.	• The influence of the factors of the change organisational environment upon the implementation of the Six Sigma approach is ○ The same (new sub-codes for the justifications) ○ Different influence (new sub-codes for the justifications)

Table 13: Theoretical questions, associated interviewees' questions, indicators and codes

Table 13 depicts the way that the interviewees' questions have been articulated in order to collect the right data that contributes to answering the theoretical questions and the central research question. Therefore, several informant questions have been formulated in order to tackle each theoretical question. Furthermore, this table presents the linkage between theoretical concepts and participants' thoughts reflected in a number of indicators. As has been mentioned, these indicators are based upon this researcher's knowledge of the literature and associated with the propositions of this research. Consequently, this researcher has suggested a number of themes that could be used for organising and reducing the data to be collected. These themes include a number of sub-themes. The entire themes and sub-themes have been aligned within a tree. This tree is considered as the initial codes tree that will be revisited whilst the analysis progresses. Having presented the research and interview questions above, it is important to select the most appropriate interviewees. The following is a description of these participants.

3.2.1.2 Interviewees

The process of selecting participants who are interviewed according to qualitative research differs from the statistical sampling which is used in quantitative survey (Flick, 2002; Glesne and Peshkin, 1992). According to Flick (2002), making decisions to select participants may start from one of two levels. The first level involves selecting groups in order to conduct focus groups. The second level involves focusing directly on specific persons. Moreover, he has suggested that in both cases, the representativeness of selected participants is guaranteed neither by random sampling nor by stratification. Rather, individuals or groups are selected according to their expected level of new insights for the development theory in relation to the state of theory elaboration. Therefore, some scholars (Flick, 2002; Wengraf, 2001) have termed this process 'theoretical sampling'.

Thus, the participants of this research have been chosen using the purposive sampling technique. This is because purposive selection of participants in qualitative research potentially attains several goals (Maxwell, 1996). Amongst others, besides achieving representativeness of population, there is another vital goal. This goal involves exploring participants that are critical for the development of theory. Therefore, qualitative research usually starts with a small number of participants.

According to Miles and Huberman (1994) this is attributed to the need to situate these participants in their context and studying them in depth. Moreover, Glesne and Peshkin (1992) have asserted that for the purpose of in-depth studies, extended periods should be spent with a few participants repeatedly. However, this process should finish once a saturation point is reached, where no additional data is being found to enable the development of concepts and theories (Flick, 2002; Wengraf, 2001).

According to the aforementioned elaboration and in order to select appropriate participants, the organisational hierarchy of the case company Ducab is described in the following part. This description of the hierarchy is provided as it was in 2006, during the course of interviewing. This company consists of six departments that report to a managing director. Five of these departments are headed by general managers whilst the sixth is headed by a manager. These departments are sales, technical, manufacturing commercial, administration and government relations and strategic planning (Appendix 12 outlines the company's organisational hierarchy). Each of these departments (with the exception of manufacturing) is divided into several sections and supervised by line managers. The Abu Dhabi factory also reports to the manufacturing department. This factory is headed by a general manager and is divided into four sub-sections, namely manufacturing and maintenance, engineering, finance and logistics control and HR and administration. Accordingly, this company is managed by a managing director, six general managers and twenty-six line managers. Moreover, this company has five hundred employees at both sites.

Jointly with the company's management, seven employees have been selected for interview. They represent more than one fifth of the total top and middle management levels and are from two departments. Five of them are from manufacturing and two from the technical department. These departments represent one third of the entire departments of this company. In addition, although most of the employees of this company have been trained to participate in Six Sigma projects, the nature of research and interview questions pinpoints the level of interviewees' knowledge. Since these questions address the successful implementation of the Six Sigma approach, the interviewees should be involved in managing this establishment. Therefore, two general managers and five managers are included. One of these managers is a Six Sigma coordinator and two of them are from the Abu Dhabi factory.

The first participant is Hassan Omar. He is a male, resident and aged thirty-five years old. He is the Six Sigma coordinator in addition to his remit as the manufacturing manager in the main branch. He has been working for the company since 2004. He is a master black belt. He was interviewed for one hour and forty-two minutes on the 16th March 2006. In this study he will be called 'P1'. The second participant is Simon Baker 'P2'. He is a male of British nationality and is aged forty. He has been the general manager of the Abu Dhabi factory since 2004. He was interviewed for thirty-three minutes on the 18th May 2006. The third participant is Manoj Pillai 'P3', a male of Indian nationality, aged thirty-eight. He is an engineering manager, and has been working at the Abu Dhabi factory since 2004. In total, he has been working at Ducab for fifteen years. He was interviewed for one hour and eleven minutes on the 18th May 2006. The fourth participant is Graham Rafferty 'P4', a male of British nationality, aged fifty years old. He is the production manager in the Dubai factory. He has been working for Ducab since 1998. He was interviewed for one hour and eight minutes on the 15th May 2006. The fifth participant is T. Pandian 'P5'. He is a male of Indian nationality and aged fifty-three years old. He is the manufacturing and maintenance manager. He has been working for Ducab since 1996. He was interviewed for thirty-five minutes on the 15th May 2006. These five participants report to the general manager of the manufacturing department.

The sixth participant is Radhakrishnan 'P6', a male of Indian nationality, aged forty-eight years old. He is the quality and environment manager, and has been working for Ducab since 1998. He was interviewed for fifty-three minutes on the 15th May 2006. The seventh and final participant is Jon Vail 'P7', a male of British nationality, aged forty-four years old. He is the general manager of the technical department. He has been working for Ducab since 2002. He was interviewed for thirty-seven minutes on the 16th May 2006. Table14 summarise the participants' demography and interviews' details.

Initial	Name	Gender	Nationality	Age	Position	Experience	Location	interview Date	Interview duration
P1	Hassan Omar	Male	UAE	35	Six Sigma coordinator and manufacturing manager	2004	Main branch	March 2006	102 min.
P2	Simon Baker	Male	British	40	General manager	2004	Abu Dhabi	May 2006	33 min
P3	Manoj Pillai	Male	Indian	38	Engineering manager	2004	Abu Dhabi	May 2006	71 min
P4	Graham Rafferty	Male	British	50	Production manager	1998	Main branch	May 2006	68 min
P5	T. Pandian	Male	Indian	53	Manufacturing and maintenance manager	1996	Main branch	May 2006	35
P6	Radhakrishnan	Male	Indian	48	Quality and environment manager	1998	Main branch	May 2006	53 min
P7	Jon Vail	Male	British	44	General manager of the technical department	2002	Main branch	May 2006	37 min

Table 14: the participants' demography and interviews' details.

In spite of the differences in the duration of the interviews, the participants' answers (even from the first and second sub-sections) met most of the indicators that have been presented above. Therefore, there was no need to conduct a third sub-session. However, the difference in the interview duration, in this researcher's opinion, is attributable to two reasons. The first relates to the amount of participants' knowledge. So, the interview with the Six Sigma coordinator was the longest one. This is because this participant is proud of his company's achievements and he has talked at length about this experience. The second reason relates to the speed and content of the interview feedback. Some of the participants spoke faster than others so they took less time to complete their interviews. However, despite the initial challenge of fostering rapport, they were more relaxed and open by the end of the second sub-session of the interviews. Generally, all of the participants were open and cooperative. This researcher feels they transferred their knowledge honestly. This could be noted from the interview sequence and full transcripts. Appendix 13 shows the full transcripts of P1's interview as an example. The following section is a demonstration of the second source of data (documents and archival records) that has been collected for the purpose of this research.

3.2.2 Document and archival records

In order to enhance the robustness of the findings and conclusions and to contribute to the trustworthiness of the data, data will be collected from multiple sources to ensure evidence triangulation (Flick, 2002; Yin, 2003; Glesne and Peshkin, 1992; Maylor and Blackmon, 2005). Consequently, the data will be collected from documents such as letters, memoranda, announcements, proposals, progress reports and other internal records. Data will also be collected from archival records. These records include data concerning organisational charts and budgets related to Six Sigma projects.

These are additional sources of data that some writers (Saunders et al., 2003) have termed 'secondary data'. Creswell (2003) has claimed that these kinds of data sources have both advantages and limitations. Amongst their advantages they represent data that are thoughtful, in that participants have given attention to their compilation. In addition, they enable a researcher to obtain the language and words of participants. However, they could be unavailable to the public because they are confidential data.

So, this is one of the limitations of these kinds of sources. Moreover, they could be incomplete, inauthentic or inaccurate. As data is compiled, it needs to be condensed and ordered in preparation for structured analysis and write-up. Thus, the following part is an elaboration of the way that these data have been manipulated and analysed.

3.3 Data analysis

According to Miles and Huberman (1994), the process of data analysis consists of three concurrent sub-processes, namely data reduction, display and verification. The following part is thus presented according to these respective areas.

3.3.1 Data coding and categorising

As the interviews will be recorded onto tapes, they need to be transcribed. These words have to be refined into text in order to be clear to readers and analysts. Next, by following Miles and Huberman (1994), data reduction will be performed where the text will be categorised into codes and sub-codes, and then aligned through a codes tree. For this purpose, MAXQDA software has been used. This tree could be changed by adding or eliminating some of these initial codes during the preliminary analysis of each interview. Afterwards, these codes will be displayed in matrices and they will be loaded manually with associated interview extracts.

Since any given preliminary conclusion is always based on certain data and some data is stronger than other data, more weight can be given to the former in the conclusion. Miles and Huberman (1994) observe that data from some informants are better than others. This is because these informants may be articulate and reflective and enjoy talking about events and processes. In addition, they may be knowledgeable or closer to the event, action or processes. Therefore, the participants have been weighted according to their experience about the implementation of the Six Sigma approach. As has been mentioned earlier in this chapter, P1 is the Six Sigma coordinator, so his participation has been given stronger weight than the other interviewees. Moreover, the preliminary analysis has been conducted with his participation. In addition, the inferred framework has been built upon his thoughts. These findings have been supported by subsequent interviews with the remaining participants. As has been mentioned earlier, this is one way of triangulating the data. The following is an elaboration of the changes of the codes tree after the completion of the preliminary analysis of the initial reflections provided P1.

3.3.1.1 The primary codes tree of P1

As P1 is the primary participant, his codes tree has been named the primary codes tree and is therefore the base for categorising data and conducting comparisons with other participants' codes trees. The following is the primary codes tree.

1. The necessity of the change organisational environment
    1. Necessary
2. The factors of the change organisational environment
    1. Strategic initiatives
        1. The necessity of top management commitment to initiate the Six Sigma approach
            1. Necessary
                1. To attain top management commitment they should be convinced
                    1. The necessity of top management knowledge about the Six Sigma approach, there are ways to fulfil this necessity
                        1. They have enough previous background about the Six Sigma approach
                        2. They have no background about the Six Sigma approach, so it needs to be promoted by several selling points
                            1. Top management should be educated through introductory courses
                            2. Choosing good presenters
                            3. Manipulating the promotion from a marketing perspective
                            4. Showing good results of the strategic actions
                2. Aspects of top management commitment
                    1. Organising Six Sigma activities
                    2. Taking strategic actions to improve processes
                    3. Allocating a proper budget to fulfil Six Sigma objectives
                    4. Motivating people to complete their tasks
                    5. Monitoring and maintaining resolutions
        2. Essentiality of the strategic initiatives
            1. Essential
        3. The impact of the initiative decisions on the implementation
            1. Evolutional
        4. The managerial levels that are involved in strategic decision-making

    1. Top and middle management levels
  5. The impact of external and internal factors on strategic decision-making
    1. The impact of international competition
    2. The suitability of the Six Sigma approach to improve business
    3. The impact of marketing forces
    4. The influence of manufacturing and quality trends
    5. The impact of other quality improvement tools
    6. Financial results
2. Cultural readiness
  1. Could be adjusted
  2. The features of Six Sigma culture
    1. Rigorous discipline
    2. Mature management
    3. Data-oriented
    4. Blame free
    5. Building quality in design
    6. Methodical (structured) management
  3. The contents of organisational culture
    1. Values and beliefs
      1. Non-stop scheme
      2. Working according to vision
      3. The readiness of top management in terms of their outlook
      4. Qualified leaders
      5. Blame free
    2. Attitudes and behaviours
      1. Flexible management
      2. Experienced management
      3. Transparent management
      4. Patient management
    3. Languages
3. Learning capacity
  1. The concept is understandable
  2. The concept has been taken into account
  3. The sort of programs, schemes and techniques for enlarging learning capacity

1. Training programs
   1. Training program is necessary
   2. The levels that training programs are available
      1. All levels
   3. The sort of training programs
      1. Introductory course
      2. Belts training program
      3. Maths and statistics courses
   4. Steps for Six Sigma training programs
      1. Contracting with the right consultant
      2. Black belt pioneers
      3. Establishing Six Sigma forum
      4. Assigning Six Sigma coordinator
      5. Providing black belts with the right equipment
      6. Executing live projects
      7. Reviewing the progress
      8. Proceeding with the training programs
2. Self-education

4. IT leveragability and knowledge-sharing capability
   1. The importance of data
      1. Data is important
   2. Saving and manipulating data
      1. Using IT systems
   3. The availability of data to individuals
      1. All individuals can access data
   4. Steps for achieving IT leveragability and knowledge-sharing capacity
      1. Understanding the uses of statistical tools
      2. Facilitating connection to the IT system and providing suitable equipment
      3. Using statistical tools for this purpose
5. Network relationship balancing
   1. The nature of the network
      1. The network is balanced
   2. Communication within the organisation

1. Cross-functional
2. Freely and honestly open
3. Ways of network balancing
    1. Working as teamwork
    2. Integrating actions of different departments

From the aforementioned demonstration of the codes tree and comparing it with the initial codes trees presented in Table 13, most of the codes within the theoretical codes tree have been enhanced by P1. However, some codes have been divided into more specific sub-codes. The following is an elaboration of these changes. First, two new main sub-codes have been added to the strategic initiatives as one of the factors of the change organisational environment. These sub-codes address the managerial levels that are involved in strategic decision-making (2.1.4), and the impact of external and internal factors on strategic decision-making (2.1.5). These sub-codes have been divided into further sub-codes which represent these elements. Moreover, the first sub-code of this factor of the change organisational environment has been divided into two new main sub-codes. These sub-codes include the way of attaining top management commitment (2.1.1.1.1) and its aspects (2.1.1.1.2). The first sub-code has been divided into two other sub-codes which have also been divided into other sub-codes.

Furthermore, a new sub-code has been added to cultural readiness. This sub-code is the feature of Six Sigma culture (2.2.2) which has been divided into six new sub-codes. These sub-codes represent these features individually. In addition, the contents of this culture have also been divided into new sub-codes. Moreover, a new sub-code has been added to the third factor of the change organisational environment. This sub-code is steps for Six Sigma training programs (2.3.3.1.4), which has been divided into nine new sub-codes. Also, a new main sub-code has been added to IT leveragability and knowledge-sharing capability. This sub-code includes the required steps for achieving this factor (2.4.4). Likewise, a new sub-code has been added to the fifth factor of the change organisational environment. This sub-code concerns the methods of network balancing (2.5.3). Generally, the sub-codes that have been added represent the participants' thoughts about the methods of attaining the factors of the change organisational environment and the reasons for applying these methods. These thoughts represent the answer to the theoretical questions of how and why do the factors of change environment within the business process change management theoretical framework are attained in order to successfully implement Six Sigma. Thus, these thoughts fill the gap in this theoretical framework.

In contrast, other codes and sub-codes have been eliminated, especially those which have been anticipated to indicate contradictory opinions such as the participants agreeing or disagreeing with the statement that has been suggested as an answer to the interview questions. However, there are some codes that have been modified in order to suit the extracts that answer the theoretical questions. Therefore, the code that indicates the uniqueness of the factors of the change organisational environment with a vital impact on the success of Six Sigma approach implementation has been deployed in each factor of the change organisational environment. Similarly, although the three other codes that are related to the impact of these factors upon the success of Six Sigma approach implementation have been eliminated from this participant's codes tree, it could be inferred from his answer. Therefore, these codes have also been redeployed in each factor of the change organisational environment.

3.3.1.2 The state of other participants' codes trees compared with the primary one

Likewise, as a result of coding and categorising the interview transcripts of the remaining participants, it enhances the primary codes trees. Although some new sub-codes have been added and some eliminated, most of the codes and sub-codes remain as they are in the primary codes tree. Nevertheless, whilst added sub-codes are secondary, they support the ones that have been mentioned by P1. This means that these interviewees triangulate the participation of P1. In contrast, the codes and sub-codes that have been eliminated could be attributed to the lack of interviewees' knowledge regarding these points. However, they are not contradictory amongst all interviewees. This could be attributed to the features of Six Sigma culture that encourages building common understanding. The following presents the state of each participant's codes tree. In this table, the columns represent the participants' codes trees and the rows represent the series and the states of codes and sub-codes in each codes tree. In addition the letters (S) stand for the same code and (E) for the eliminated code. Moreover, the added codes have been shown as eliminated codes in the primary codes tree.

P1	P2	P3	P4	P5	P6	P7	Remarks
1.	E	E	E	E	E	E	
1.1	E	E	E	E	E	E	
2.	S	S	S	S	S	S	
2.1	S	S	S	S	S	S	
2.1.1	S	S	S	E	S	S	
2.1.1.1	S	S	S	E	S	S	
2.1.1.1.1	S	E	E	E	S	S	
2.1.1.1.1.1	S	E	S	E	S	S	
2.1.1.1.1.1.1	S	S	E	E	E	S	
2.1.1.1.1.1.2	S	S	S	S	S	S	
2.1.1.1.1.1.2.1	S	E	S	E	E	S	
2.1.1.1.1.1.2.2	S	E	S	E	E	S	
2.1.1.1.1.1.2.3	E	E	E	E	S	S	
2.1.1.1.1.1.2.4	S	S	E	E	S	S	
E	E	E	E	E	E	2.1.1.1.1.1.2.5 Focusing on good reputation of Six Sigma	Added sub-code
E	2.1.1.1.1.1.2.6 Working on drawbacks	E	E	S	S	S	Added sub-code
2.1.1.1.2	S	S	S	E	S	S	
2.1.1.1.2.1	E	S	S	E	E	E	
2.1.1.1.2.2	E	S	S	E	S	E	
2.1.1.1.2.3	E	E	S	E	S	E	
2.1.1.1.2.4	S	S	S	E	S	S	
2.1.1.1.2.5	E	S	E	E	S	S	
2.1.2	S	S	S	S	S	S	
2.1.2.1	S	S	S	S	S	S	
2.1.3	S	S	S	S	S	S	
2.1.3.1	S	S	S	S	S	S	
2.1.4	E	E	S	E	S	S	
2.1.4.1	E	E	S	E	S	S	
2.1.5	S	S	S	S	S	S	
2.1.5.1	E	E	S	E	E	E	
2.1.5.2	S	S	S	S	S	S	
2.1.5.3	E	E	S	E	S	S	
2.1.5.4	E	S	S	E	S	S	
2.1.5.5	S	S	E	E	S	S	
2.1.5.6	S	S	S	E	S	S	
E	E	2.1.5.7 The company's objectives	S	E	E	S	Added sub-code
E	E	2.1.5.8 The impact of the business environment	S	E	S	S	Added sub-code
E	E	E	E	2.1.5.9 Limitations of resources	S	E	Added sub-code

Table 13: Participants' codes trees compared with the primary one (continued)

P1	P2	P3	P4	P5	P6	P7	Remarks
2.2	S	S	S	S	S	S	
2.2.1	S	S	S	S	S	S	
2.2.2	S	S	S	S	S	S	
2.2.2.1	E	S	E	E	E	S	
2.2.2.2	E	E	S	E	S	S	
2.2.2.3	S	S	S	S	S	S	
2.2.2.4	S	E	S	E	S	E	
2.2.2.5	E	E	E	E	S	S	
2.2.2.6	S	S	S	S	E	S	
E	E	E	2.2.2.7 Democratic environment	S	E	E	Added sub-code
E	E	2.2.2.8 Time limitations	E	E	E	E	Added sub-code
E	E	E	E	E	2.2.2.9 Balancing between customer expectations and business objectives	S	Added sub-code
2.2.3	S	S	S	E	S	S	
2.2.3.1	S	S	S	E	S	S	
2.2.3.1.1	E	S	E	E	S	S	
2.2.3.1.2	E	E	S	E	S	S	
2.2.3.1.3	S	E	E	E	S	S	
2.2.3.1.4	E	S	E	E	E	E	
2.2.3.1.5	S	S	S	E	S	E	
2.2.3.2	S	S	S	E	S	S	
2.2.3.2.1	E	E	E	E	E	S	
2.2.3.2.2	E	E	E	E	S	S	
2.2.3.2.3	E	E	S	E	E	S	
2.2.3.2.4	S	S	S	E	E	S	
2.2.3.3	E	S	E	E	E	E	
2.3	S	S	S	S	S	S	
2.3.1	S	S	S	S	S	S	
2.3.2	S	S	S	S	S	S	
2.3.3	S	S	S	S	S	S	
2.3.3.1	S	S	S	S	S	S	
2.3.3.1.1	S	S	S	S	S	S	
2.3.3.1.2	S	S	S	S	S	S	
2.3.3.1.2.1	S	S	S	S	S	S	
2.3.3.1.3	S	S	S	S	S	S	
2.3.3.1.3.1	S	S	S	S	S	S	
2.3.3.1.3.2	S	S	S	S	S	S	
2.3.3.1.3.3	S	S	S	E	S	S	
2.3.3.1.4	S	S	S	S	S	S	
2.3.3.1.4.1	S	E	S	S	S	S	
2.3.3.1.4.2	S	S	S	S	S	S	
2.3.3.1.4.3	E	E	E	E	E	E	
2.3.3.1.4.4	E	S	E	S	E	E	
2.3.3.1.4.5	E	E	E	E	E	E	
2.3.3.1.4.6	S	S	S	S	S	S	
2.3.3.1.4.7	S	E	E	E	E	E	
2.3.3.1.4.8	E	S	S	S	S	S	
2.3.3.2	E	E	E	E	E	S	

Table 13: Participants’ codes trees compared with the primary one (continued)

P1	P2	P3	P4	P5	P6	P7	Remarks
2.4	S	S	S	S	S	S	
2.4.1	S	S	S	S	S	S	
2.4.1.1	S	S	S	S	S	S	
2.4.2	S	S	E	S	E	E	
2.4.2.1	S	S	E	S	E	E	
2.4.3	S	S	S	S	S	S	
2.4.3.1	S	S	E	E	E	E	
E	E	E	E	2.4.3.2 Some individuals could look at data	S	S	Added sub-code
2.4.4	S	S	S	S	S	S	
2.4.4.1	E	E	S	E	S	E	
2.4.4.2	E	S	E	E	E	E	
2.4.4.3	E	E	S	E	E	S	
E	2.4.4.4 Monthly meeting for coordinating and information exchanging	E	E	E	E	E	
2.5	S	S	S	S	S	S	
2.5.1	S	S	S	S	S	S	
2.5.1.1	S	S	S	S	S	S	
2.5.2	S	S	S	S	S	S	
2.5.2.1	E	S	E	E	S	E	
2.5.2.2	S	S	S	S	S	S	
2.5.3	S	S	S	S	S	S	
2.5.3.1	S	S	S	S	S	S	
2.5.3.2	S	S	E	S	S	S	

Table 13: The state of participants' codes trees compared with the primary one

Table 13 shows that the participants P2, P3, P4, P6 and P7 have mentioned most of the themes that have been highlighted by P1, whilst P5 has mentioned nearly half of these themes. Despite this fact, their codes trees have not changed significantly. This is because the entire main codes and sub-codes remain the same, with the exception of one main code. This code is the necessity of the change organisational environment that has not been explicitly mentioned by all participants except P1. Although this main code has not been explicitly mentioned by these participants, it could be induced from their participation, as the entire themes lead to this code

In addition, there are some sub-codes that have been eliminated. Some of these sub-codes are eliminated from most of the participants' codes trees. One of these sub-codes (2.1.1.1.1.1.2.3) is manipulating the promotion from a marketing perspective as one of the selling points. This sub-code has been eliminated from the codes trees of P2, P3, P4 and P5. Another sub-code (2.1.1.1.2.1) is organising Six Sigma activities as one of the aspects of top management commitment. This sub-code has been eliminated from the codes trees of P2, P5, P6, and P7. The third sub-code (2.1.1.1.2.3) is determining a proper budget to fulfil the objectives of Six Sigma as one of the aspects of top management commitment. This sub-code has been eliminated from the codes trees of P2, P3, P5 and P7. The fourth sub-code (2.1.5.1) is the impact of international competition as one of the factors that influence strategic decision-making. This sub-code has been eliminated from the codes trees of P2, P3, P5, P6 and P7.

Moreover, the fifth sub-code that has been eliminated from most of the interviewees' codes trees (2.2.2.1), is rigorous discipline as one of the features of Six Sigma culture. This sub-code has been eliminated from the codes trees of P2, P4, P5 and P6. The sixth sub-code (2.2.2.5) is building quality in design as one of the features of Six Sigma culture. This sub-code has been eliminated from the codes trees of P2, P3, P4 and P5. In addition, the seventh sub-code (2.2.3.1.4) is qualified leaders as one of the values and beliefs. This sub-code has been eliminated from the codes trees of P2, P4, P5, P6 and P7. The eighth sub-code (2.2.3.2.1) is flexible management as one of the attitudes and behaviours. This sub-code has been eliminated from the codes trees of P2, P3, P4, P5 and P6.

Furthermore, the ninth sub-code (2.2.3.2.2) is experienced management as one of the attitudes and behaviours. This sub-code has been eliminated from the codes trees of P2, P3, P4 and P5. The tenth sub-code (2.2.3.2.3) is transparent management as one of the attitudes and behaviours. This sub-code has been eliminated from the codes trees of P2, P3, P5 and P6. The eleventh sub-code (2.2.3.3) is language as one of the contents of organisational culture. This sub-code has been eliminated from the codes trees of P2, P4, P5, P6 and P7. The twelfth sub-code (2.3.3.1.4.4) is assigning a Six Sigma coordinator as one of the steps of Six Sigma training programs. This sub-code has been eliminated from the codes trees of P2, P4, P6 and P7. The thirteenth sub-code (2.3.3.1.4.7) is reviewing the progress as one of the steps of Six Sigma training programs. This sub-code has been eliminated from the codes trees of P3, P4, P5, P6 and P7.

Moreover, the fourteenth sub-code that has been eliminated from most of the participants' codes trees (2.3.3.2) is self-education. This sub-code has been eliminated from the codes trees of P2, P3, P4, P5 and P6. The fifteenth sub-code (2.4.4.1) is understanding the uses of statistical tools. This sub-code has been eliminated from the codes trees of P2, P3, P5 and P7. The sixteenth sub-code (2.4.4.2) is facilitating connection to the IT system and providing suitable equipment. This sub-code has been eliminated from the codes trees of P2, P4, P5, P6 and P7. The final sub-code (2.5.2.1) that has been eliminated from most of the participants' codes trees is cross-functional communication. This sub-code has been eliminated from the codes trees of P2, P4, P5 and P7.

The aforementioned demonstration is an elaboration of some sub-codes that have been eliminated from most of the participants' codes trees, whilst the following are the sub-codes that have been eliminated from all participants' codes trees. These sub-codes are establishing a Six Sigma forum (2.3.3.1.4.3) and providing black belts with the right equipment (2.3.3.1.4.5). As a result of the aforementioned demonstration of the state of the participants' codes trees, it is clear, in this researcher's opinion, that the eliminated sub-codes are inessential. This is because most of these sub-codes are divided from several other sub-codes. In addition, this elimination is not contradictory.

In contrast, there are a number of new sub-codes that have been added by the participants. One of these (2.1.1.1.1.2.5) is focusing on the good reputation of Six Sigma. This sub-code has been highlighted by P7. Another sub-code (2.1.1.1.1.1.2.6) is working on trade-offs. This sub-code has been emphasised by P2 P5, P6 and P7. The third sub-code (2.1.5.7) is the company's objectives as one the factors that influences strategic decision-making. This sub-code has been added by P3, P4 and P7. The fourth sub-code (2.1.5.8) is the impact of the business environment on strategic decision- making. This sub-code has been discussed by P3, P4, P6 and P7. The fifth sub-code (2.1.5.9) is limitations of resource as one of the factors that affects strategic decision- making. This sub-code has been raised by P6 and P7.

Moreover, the sixth sub-code (2.2.2.7) that has been added by the participants is democratic environment as one of the features of Six Sigma culture. This sub-code has been highlighted by P4 and P5. The seventh sub-code (2.2.2.8) is time limitation as one of the features of Six Sigma culture. This sub-code has been mentioned by P3 only. The eighth sub-code (2.2.2.9) is balancing between customer expectations and business objectives. This sub-code has been discussed by P6 and P7. The ninth sub-code (2.4.3.2) is some individuals could look at data. This sub-code has been highlighted by P5, P6 and P7. The tenth sub-code (2.4.4.4) is monthly meetings for coordinating and exchanging information, which has been mentioned by P2.

Similarly, these added sub-codes are inessential because they have been divided from several other sub-codes. Moreover, this addition does not contradict other codes. Thus, adding them to the primary codes tree is beneficial. In contrast, eliminating the sub-codes that have not been mentioned by the interviewees is, in this researcher's opinion, unhelpful. This is because they do not affect the results. However, it enriches the data analysis. Therefore, the codes and sub-codes of the primary codes tree will remain the same and be supplemented by the added sub-codes. Furthermore, the participants' statements about each theme will be shown during the demonstration of the findings. Consequently, saturation point will have been reached. Therefore, this researcher is content with this number of participants since the entire interviews and research questions have been answered, and no more essential information is anticipated from other individuals. This is because these participants are the most knowledgeable people about the implementation of the Six Sigma approach in Ducab.

As a result of the major changes that affect the initial codes tree during the progress of preliminary analysis, the second sub-process of data analysis should be conducted. This sub-process involves revisiting propositions. The following part is an elaboration of this sub-process.

3.3.2 Revisiting research propositions

As has been mentioned earlier in this chapter, propositions are grounded in data and developed and explored in interaction with it (Maxwell, 1996; Creswel, 2003). Therefore, as a result of the preliminary data analysis, the propositions of this research will be revisited. Consequently, although these propositions answer most of this study's theoretical questions, they are too specific. Therefore, there are not complete answers for some of these theoretical questions and the central research question in turn. Thus, these propositions have been reformulated into more general wording. This has been done by merging the previous propositions and formulating new statements that reflect the potential findings and conclusions of this research. The following statements are the new propositions:

Proposition 1: Each change organisational environment factor is composed of entities that are led by requirements and stimulated by necessities. These entities should be either attained in order to successfully implement the Six Sigma approach.

Proposition 2: The associated requirements and necessities that represent some of the entities of the change organisational environment factors explain the bi-directional relationship between these factors.

Proposition 3: The change organisational environmental factors in the BPC management theoretical framework are useful to be exploited to explore the success of the implementation of the Six Sigma approach in the case company Ducab (U.A.E).

Looking into these propositions, it could be noted that the previous propositions have been merged into these propositions. The proposition ATQ2 has been merged into proposition 1., whilst the propositions ATQ6.1, ATQ6.2, ATQ6.3, ATQ1, ATQ1.1, ATQ2.1, ATQ3.1 and ATQ4 have been merged into proposition 2. Moreover, . The propositions ATQ6, ATQ3, ATQ4.1 and ATQ5 have been merged into proposition 3. In addition, these new propositions explicitly address the central research question. Moreover, they answer the question of how and why the factors of the change organisational environment are attained in order to successfully implement Six Sigma in the case company Ducab. In answering this question, new knowledge may be added to the existing body of literature. Therefore, the discussion of this study's finding in chapter five will be conducted according to these propositions and its supplements. For this purpose, some tactics that have been suggested by Miles and Huberman (1994) will be exploited in order to draw meaning from a particular configuration of data. The following is a brief demonstration of these tactics.

3.3.3 Tactics for generating meaning

According to Miles and Huberman (1994), there are several tactics for generating meaning from data in a display. This researcher has applied some of these tactics that are necessary for this study, in order to enhance the discussion and contribute to trustworthiness. One of these tactics is noting themes. According to this tactic, this researcher will pull together many separate pieces of data and formulate themes in order to make sense from them. However, it should be possible to see added evidence of the same theme and remain open to disconfirming evidence when such evidence is found. This is because as Ross and Lepper (1980, cited Miles and Huberman, 1994) have pointed out, beliefs are remarkably resistant to new evidence.

Another tactic is clustering. According to Miles and Huberman (1994), it is a general name given to the process of inductively forming categories, and the iterative sorting of things such as events, processes and sites into those categories. This tactic typically relies on aggregation and comparison and is naturally closely interwoven with the creation and use of codes. One way of clustering is to use networks. These networks according to Miles and Huberman (1994) are collections of nodes or points connected by lines (links). They are helpful to focus on more than a few entities at a time. Moreover, clusters must be verified in order to ward off premature closure.

The third tactic is subsuming particulars into generalities. This tactic could be used as a result of using clustering that is intuitive. Thus, this tactic is locating the immediate act, event or activity in a more abstractly defined class. However, moving up a step on the abstraction ladder is not a mechanical or automatic process. It depends on the presence of many other statements. Therefore, according to Miles and Huberman (1994), this tactic is a conceptual and theoretical activity. This activity includes shuttling back and forth between first-level data and more general categories that evolve and develop through successive iterations until the category is saturated.

The fourth tactic is noting relationships between entities. This tactic includes using matrices and networks. According to Miles and Huberman (1994), matrix displays are an especially economical way to see relationships. This is because data bearing on two or more entities can be arrayed for systematic inspection and conclusions subsequently drawn. In addition, network displays help in looking at more complex configurations and show temporal dimensions more clearly. However, although there is a tendency to think in causal terms, there is a risk in trying to understand relationships between two entities. This risk is represented by jumping too rapidly to conclusions. Therefore, there are many ways, according to Miles & Huberman, (1994), that could be used in order to verify conclusions. However, for the purpose of this study this researcher has relied on showing evidence from literature. Thus, for this purpose, matrices suggested by Wengraf (2001) have been used. These matrices include the theoretical questions and the answers from both the interviewees and literature. This is in order to discuss the evidence that verifies the conclusions.

Following the aforementioned discussion of the verification of conclusions, it is also necessary to consider and identify the different ways in which the trustworthiness of the conclusions can be ensured. These strategies include representativeness, checking for researcher effects, triangulating, and evidence weighting. Prior to this discussion, the following is an elaboration regarding the validity of findings.

3.3.4 Trustworthiness of conclusions and validity

Because a reseaech design is supposed to represent a logical set of statements, the quality of any given design can be judged according to certain logical tests. Concepts that have been offeredfor these tests include trustworthiness and other four test namely; construct validity, internal validity, external validity and relliability (Yen, 2009; Gibbert, 2008).

3.3.4.1 Trustworthiness:

In order to guarantee the validity of the conclusions of this study, some elements of trustworthiness have been built into the data collection, display and analysis stages. The following is a brief elaboration of these elements. The first element is representativeness, which concerns the extent to which the findings represent the phenomena (Miles and Huberman, 1994). Due to the agreement between Flick (2002) and this researcher regarding the technique of interviewee selection that has been determined by the level of new insights for developing theory in relation to the state of theory elaboration, the research participants have been selected using a purposive sampling approach. These participants, as has been mentioned earlier, represent more than one fifth of the total top and middle management levels of this case company. In addition, they are from two departments that represent almost one third of the entire departments of this case company. Moreover, they are the most knowledgeable employees about the Six Sigma approach in this case company. This is attributed to their involvement in managing the implementation of this approach. Furthermore, the saturation point has been reached so there is no need for additional interviewees.

The second element involves checking for researcher effects. This researcher has kept his intervention to a minimum. Therefore, he has designed his interview to be conducted over three sessions. The first session has been dedicated to the interviewee to express his thoughts freely without interruptions. For this purpose, the interviewee has been asked an open question. In addition, the questions during the second session have been raised to seek elaboration about what has been said in the first session only. Moreover, rapport has been built between the interviewer and interviewees, so that the former could elicit open and honest responses from the latter. This is shown from the struggling of the interviewees at the beginning to becoming more relaxed at the end of these interviews. Thus, all of the participants are open and cooperative.

The third element is triangulation. This term means, according to Saunders et al (2007), the use of different data collection techniques with one study in order to ensure that the data are saying what the researcher thinks they are saying. Moreover, Easterby-Smith et al (1991) identify data triangulation as data collection at different times or from different sources. For this purpose, two types of method have been used to collect data, namely interviews, and documents and archival records. In addition, data has been collected from a range of interviewees working at different sites. The fourth element of trustworthiness is weighting the evidence. The reflections and information provided by the most knowledgeable interviewee have thus been given more weight than other participants. This is because this participant is the Six Sigma coordinator in the case company. Therefore, the inferred theoretical framework has been built mainly on his thoughts and enhanced by the other participants' thoughts. The final element concerns using some tactics that generate meanings from data in a display such as, noting themes, clustering, subsuming particular issues in general and noting relationships between entities.

3.3.4.2 Validity:

The four tests have been commonly used to establish quality of any empirical social research. Because case studies are one form of such research, the four tests also are relevant to case study (Yin, 2009, Gibbert, 2008). According to Yin (2009), because these tests are common to all social science methods, they have been summarised in numerous books. Thus, there is an agreement among authors regarding the definitions and the measure that enhance the validity. The following part is written depending on Yin, (2009) and Gibbert, (2008).

First, construct validity is defined as identifying correct operational measures for the concepts being studied. There are tactics that could be applied to increase this kind of validity. As explained earlier, two tactics was applied namely multiple sources of evidence and establish chain of evidence. Second, internal validity is defined aas seeking to establish a causal relationship, whereby certain conditions are believed to lead to other condition, as distinguished from spurious relationships. This kind of validity concerns for explanatory case study. For this purpose, this researcher formulates a clear framework that is shown in Figure (7). This is in order to provides a plausible causal argument that is powerful and compelling enough to defend the research conclusions. Third, external validity is defined as defining the domain to which a study's findings can be generalised. According to Yin (2009), case studies are genralisable to theoretical propositions and not to populations or universes. In this sense, the case study does not represent a sample, and in doing a case study, the goal will be to expand and generalise theories (analytic generalisation) and not to enumerate frequencies (statistical generalisation). In this respect, this researcher provides a clear for the case study selection and ample details on the case study context (Gibbert, 2008). Fourth, reliability is defined as demonstrating that the operations of study – such as the data collection procedures – can be repeated with the same results. The objective is to be sure that, if a later investigator followed the same case study all over again, the later investigator should arrive at the same findings and conclusions.

Following to this chapter is the findings.

4 Chapter 4: The findings from the analysis of the factors of change organisational environment of the Ducab company

As a result of the preliminary analysis of each data collection wave, a number of themes have been identified. These themes have been categorised and aligned, as has been shown in section 3.2.4.1, in a number of codes trees. These codes trees reflect the participants' thoughts regarding the answer to the central research question, namely 'Is exploiting the factors of change organisational environment included within the BPC management theoretical framework, in the context of the Six Sigma approach, useful to interpret the success of the implementation of this approach in Ducab in the UAE?'

A final overall codes tree has been concluded from these respective codes trees. This final codes tree informed the structure of this chapter. Accordingly, this chapter is divided into five sections. Each section represents one of the change organisational environment factors. These factors include strategic initiatives, cultural readiness, learning capacity, IT leveragability and knowledge sharing capability as well as network relationship balancing. This is because the aim of this chapter is to interpret the success of the implementation of the Six Sigma approach in Ducab through the participants' experience.

This interpretation begins at the macro levels and then proceeds to the micro levels of these factors in order to address the gap in other studies, as has been shown in section three of the second chapter literature review, by elaborating the ways of attaining these factors. This elaboration focuses on explaining the impact of the upfront entities of these features on the attainment of these factors. Thus, in order to illustrate these relationships, networks have been constructed and provided at the end of each factor analysis. This is because, according to Miles and Huberman (1994), data bearing on two or more entities can be arrayed for systematic inspection and conclusions drawn. As a result of this elaboration, the proposed theoretical framework is developed and included at the close of this chapter. Therefore, the second and third objectives of this study are achieved. Many notes could be demonstrated in the following part via observing the change organisational environment of Ducab. This empirical evidence is supported by evidence from the literature that individually tackles these factors. This is in order to validate the comments gathered from the interviewees. Consequently, the consistency of this evidence is demonstrated according to the theory questions that are resulted from the literature review and recalled below.

TQ1: Is top management commitment necessary to initiate the Six Sigma approach? Why? And how could it be attained?

TQ1.1: What sort of strategic decisions in the context of Six Sigma are made, and what are the factors that affect this process?

TQ2: Should the organisational culture be ready or adjusted for initiating the Six Sigma approach?

TQ2.1: What are the contents of the organisational culture that are associated with the Six Sigma approach?

TQ3: What has been meant by learning capacity, as a factor within the theoretical framework?

TQ3.1: What sort of programmes, schemes and techniques could be conducted to enlarge the learning capacity necessary for the Six Sigma approach?

TQ4: How does data affect the implementation of the Six Sigma approach?

TQ4.1: What is the role of IT in data gathering and decision-making to facilitate Six Sigma implementation?

TQ5: How could network relationships be balanced?

TQ6: Is changing the organisational environment necessary to achieve successful implementation of the Six Sigma approach?

TQ6.1: Are the factors of change organisational environment, which have been mentioned in the theoretical framework, the only ones having a vital effect upon the success of the implementation of the Six Sigma approach?

TQ6.2: How do the factors of change environment influence each other?

TQ6.3: Do the factors of change environment have the same influence upon the implementation of the Six Sigma approach?

4.1 Section 1: Strategic initiatives

Strategic initiatives are considered as one of the factors of change organisational environment. The commitment of top management and strategic decision-making are considered in this company (Ducab) to be the only two components that comprise this factor. By looking into each component, the following points could be made.

4.1.1 Top management commitment

Commitment of top management has been considered in this company as the most important factor to initiate to Six Sigma approach. Almost all participants, who include P1, P2, P3, P4, P6 and P7, have insisted that top management commitment is necessary for the successful implementation of the Six Sigma approach. P1 has justified this, stating that *"without this commitment I don't think Six Sigma will continue in any organisation"* [P1]. In addition, P2 has made the link between top management acceptance and their support. So, he has said *"they need to say yes it is okay ---- and we are going to support people doing this"* [P2]. Similarly, P3 has said *"we need to have top management support"* [P3] and for P4, *"you must have a commitment right from the top of the company, from managing director down to everyone"* [P4]. This reflects Linderman's et al. (2003) claim that implementation of Six Sigma is often driven from the senior leadership of the organisation. Moreover, P6 emphasised that *"any new approach to establish in any company is to have commitment"* [P6]. This also agrees with Linderman's et al. (2003) who assert that organisations not able to secure a mandate from senior leadership will have a difficult time implementing Six Sigma. Likewise, P7 emphasised the importance of getting *"... a champion or a senior level or a group of champions who really want it to happen".* Then he has explained *"if you just throw Six Sigma to the work force and leave it there without reviewing it, then it will be die"* [P7]. These statements are consistent with Srinidhi (1998) who has emphasised that If the top management are not committed, strategic quality management cannot be implemented. In the same vein, Das et al. (2008) have contended that high-product quality does not exist without the strong commitment of top management. Bañuelas and Antony (2004) attribute the significance of top management commitment to the radical nature of Six Sigma initiatives.

However, in order to obtain the commitment of top management, they have to be convinced of the significant role that the Six Sigma approach has to play in improving business and achieving its objectives. In this context, the majority of the participants, who include P1, P2, P6 and P7, asserted this requirement. This is because by convincing senior management, their commitment would be achieved. In this context, P1 outlined that *"convincing top management is very important"* [P1]. In addition, P2 claimed that *"once you get a single senior management buy-in, other top management members are going to be convinced".* Also P6 has asserted that *"---first is top management commitment and buy-in to implement Six Sigma"* [P6]. Moreover, P7 claimed that *"You really have to believe this is going to give you a benefit of business. If you haven't got that belief, then you have got no chance."* These claims agree with Adams' et al. (2003 cited Wessel and Burcher, 2004) who state that an owner of a business needs to be convinced as well as Raisinghani et al. (2005) who clarify that the buy-in of top management is required. On the other hand, the remaining participants who include P3, P4 and P5, did not mention this requirement. Following on from this demonstration are the steps that have been taken to convince top management in Ducab.

4.1.1.1 Factors that affect convincing top management

According to the participants of this study, the convincing of top management is affected by two factors. These factors are the extent of top management's knowledge about the Six Sigma approach and the readiness of their mentality to accept this approach. The majority of the participants, who include P1, P2, P3 and P7, have elaborated the way that the knowledge possessed by top management about Six Sigma has facilitated the implementation of this approach as well as the readiness of their mentality to understand its requirements. In contrast, the remaining participants, who include P4, P5 and P6, did not talk about this point.

In this context, P1 ranked the former as very important and the latter as important factors for convincing top management to adopt Six Sigma because their prior knowledge about the Six Sigma approach saves a lot of effort. For this purpose, he provided an example of two managing directors of Ducab during the change period. One of them has accepted directly the idea of applying the Six Sigma approach because he knew about it whilst the other director came from a marketing background and he has being questioning if there is a certification for achieving the Six Sigma level that could be used for promotion purposes. Since there is no certification, he was disappointed at that time. This example shows how different mentalities and backgrounds affect the decision to implement the Six Sigma approach. Similarly, P2 maintained that "-----*because it is slight change in philosophy, it has to be in the back of the top management"* [P2]. Moreover, P3 justified this importance, stating that *"it all depends on a type of organisation type of people who is the top level people who are running the industry"* [P3].

In the same context, P7 asserted that his knowledge about the Six Sigma approach facilitated his acceptance of its adoption in Ducab. He has reported *"many of us (top management) have previous experience like myself with Six Sigma and other techniques. it depends on the managers' previous experience."* [P7]. These claims are congruent with Green's (1992, cited Buch and Tolentino, 2006, p.30) claim who has pointed to the important role of previous knowledge and training to enhance the belief in the Six Sigma approach to improve the quality of products and in turn the bottom line of an organisation. He identifies experience as *"a means of enhancing expectancy beliefs. Thus, it seems that training and experience are both important mechanisms for the development of success expectancies for Six Sigma, but both must be fully leveraged for maximum impact".*

From the aforementioned demonstration, it could be claimed that there is a real need for top management to have application knowledge related to the Six Sigma approach. Thus, top management's knowledge about the Six Sigma approach is the trigger for attaining their commitment. So, the majority of the participants (P1, P2, P4, P6 and P7) have emphasized *"The managing director himself he didn't need any convincing because he knew about it earlier"* [P1]. In addition, P2 insisted that *"They need to understand what's it's about and they need to say, 'yes' it is okay we believe this is a good idea"* and he added *"top management really has to believe that it is more than a training course for just two weeks. So, really for a new company starting out, top management has to have an overview what's going to be? What the involvement of that personal is going to be? And do they think it's sensible? Once they got that then they can move forward with programme training black belts and green belts"* [P2].

Similarly, P4 emphasised this necessity, stating that *"it is extremely important that they understand the philosophy of Six Sigma"* [P4]. As well, P6 has insisted that *"---- they must understand a basic approach"* [P6]. Moreover, P7 outlined the necessity of possessing basic knowledge stating that *"I think we learned things, I do differently if* *we start again back three years. --- now I got knowledge"* [P7]. Evidence from literature supports these claims. In this context, several authors (Politis, 2005; Byrne, 2003; Savolainen and Haikonen, 2007) have asserted that top management lead the implementation processes. Thus, this needs a sufficient understanding of the Six Sigma approach in order to convey their confidence regarding this approach to their subordinates. Byrne (2003) has reported a number of leaders who have led the learning process, such as Ncreny of 3M, Welch of GE and Holidy of Dupont.

However, in the case of one or more of these factors not being available, the necessity of highlighting selling points in promoting the Six Sigma approach to convince top management is important.

4.1.1.2 Selling points for promoting the Six Sigma approach

According to the participants, a number of selling points were followed within Ducab to convince top management of the reasons for implementing the Six Sigma approach. One such point concerned conducting an introductory Six Sigma approach course. This course and its contents were recommended by the majority of four participants, P1, P2, P4 and P7, whilst P3, P5 and P7 did not highlight such a point. In this context, P1 pinpointed the direction of this course, wherein he claimed that the *"Introductory course about Six Sigma should be conducted from a business point of view which includes implementation and difficulties"* [P1]. In addition, P2 highlighted that *"top management then had training. It's to what is about"* [P2]. Moreover, P4 emphasised the importance of this course saying *"the first thing you have to do is to start training executive managers and managers in the company in understanding Six Sigma. That may be only a two day training course, but it is extremely important that they understand the philosophy of Six Sigma and they buy into the idea of Six Sigma"* [P4]. Furthermore, P7 considered the link between the nature of this course and the experience of management: *"it depends on the managers' previous experience, if they have some experience very quickly I think almost you could do it as an internal meeting"* [P7].

The second selling point that could be emphasised to promote the Six Sigma approach is focusing on good reputation. Although only P7 highlighted this selling point, it could, in this researcher's opinion, be useful. P7 maintained that a *"number of good papers have been written about its successes…it is a high profile scheme"* [P7].

In this respect, Schroeder et al. (2008) have pointed to a number of Six Sigma approach features that make it attractive to top management. Likewise, showing good results from strategic actions is the third selling point suggested by five of the participants (P1, P2, P3, P6 and P7). In this context, P1 proposed that *"Showing evidence and good results by partially initiating Six Sigma in the company"* and he has asserted that *"The other thing to support that decision was the financial result"* [P1]. This result matches Brewer and Bagranoff's (2004) claim, to select a project scope that will enable short-term wins. In addition, P2 asked *"what is the impact on the business of taking them (black and green belts) a part of their time out of routine work to learn this approach?"* and he has answered this question *"Now, if you would obviously be sensible with projects that you've chosen for your green and black belts training are useful to the business"* [P2]. This result is also supported by Buch and Tolentino (2006) who stated that choosing a process which typically involves the completion of at least two projects yields measurable, positive results. Freiesleben (2006) states that the language of management is money. This would greatly facilitate the task of promoting TQM or Six Sigma initiatives.

Moreover, P3 drew attention to the financial benefits of implementation where *"The end benefit of this project was saved or improved the company's bottom line 15.7 million per year…So, this presentation was given to the senior management"* So, *"you will get all support from all senior management because at the end"* [P3]. Moreover, P6 considered these results as motivation, *"when we…start a Six Sigma project we…may get a lot quick wins which will motivate the teams"* [P6]. Furthermore, P7 also highlighted the importance of *"showing some successes"* [P7]. On the other hand, similar to other quality improvement approaches, the Six Sigma approach has certain drawbacks. Thus, working on these drawbacks is another selling point. According to the majority of the participants, there are some drawbacks that should be avoided. According to P2 *"First was not instant solution and second is cost… and taking the people out of their jobs*" [P2]. P5 highlighted the reason for this approach being costly and the way to turn this cost into profit saying *"---- probably it will cost you in terms of training. You have to go to outside agency to get the training. But once you get the people trained, the cost is nothing"* [P5].

In addition, P6 mentioned another drawback. This one concerns applying the Six Sigma approach because it is a fad that should be followed in order to show the company is modernising instead of emphasising the advantages that could be achieved by its application. In this context he said *“I am suspecting that the flavours of the month type attraction doing Six Sigma fade. It may be the top man changed or maybe they didn't succeed, so they just gave up”* [P6]. Moreover, P7 drew attention to other drawbacks and the way of solving them. One of them is this approach’s name *“One thing we've learnt in Ducab is a practical better to call in different name*” he has said and repeated *“I think the only thing I do it different I call it something different”* [P7].

Another drawback concerns the discipline of statistics which according to P7 *“…is very good and necessary but that…title scares people especially non-engineers and people even engineers who didn't like statistics. But Six Sigma tends to put people off and if we would change one thing, probably we will call it Ducab's problem solving methodology or…some better in-house title to get away from all that statistics”* [P7] . The third of these drawbacks is the difficulties that could be faced during consideration of non-manufacturing and non-shop floor engineering problems. In this context P7 has elaborated that *“one of the difficulties that we've faced, is to find ways of applying non-manufacturing non-shop floor engineering problems. The engineers tend to be …quite early adopters where the office staffs were much slower uptake of the ideas there”* [P7]. These drawbacks are common during Six Sigma implementation. Evidence from literature shows that even though Six Sigma has been accepted positively among practitioners as a useful tool to improve business performance, the use of rigorous statistical tools and quality tools creates a fear of Six Sigma. This is especially pertinent in non-manufacturing areas where employees do not have an engineering background and lack mathematical skills (Nonthaleerak and Hendry, 2008).

Furthermore, manipulating promotion from a marketing perspective is another selling point that could be used in order to convince top management regarding Six Sigma approach implementation. According to the minority of participants there are certain features that could be used as promotion points. P1 highlighted the benefit of increased reputation: *“being a leader in the UAE as the first company to implement Six Sigma”* [P1]. Another point was suggested by P6 in that *“just going to the press and saying ‘Okay, Ducab is a Six Sigma company’. So, all what have been done is just* *public relations or a marketing tool. If you do that, it obviously works for the company. Little by little you will get curious as you work for Six Sigma project"* [P6]. However, he has emphasised that *"---but that should not be the aim. The aim must be clearly about making improvements within the company"* [P6]. In this context, P7 emphasised, that *"If you want to do it just to have the Six Sigma batch, you are wasting your time"* [P7]. This result agrees with Antony and Bañuelas's (2002) claim that while the original goal of Six Sigma was to focus on manufacturing processes, today, marketing, purchasing, billing and invoicing functions are also embarked on as Six Sigma strategies with the aim of continuously reducing defects throughout the organisation's processes.

According to the majority of participants, all of the selling points mentioned earlier should be conducted by a good presenter who is a Six Sigma expert. His/her experience should include showing evidence of good results in similar companies and s/he should have the ability to conduct comparisons between different companies implementing the Six Sigma approach. In this context, P1 has insisted upon this necessity saying that a *"Good salesman or presenter who is an expert and can show evidence to promote…Six Sigma and can compare between companies those have implemented Six Sigma in order to show results"* [P1]. Moreover P2 asserted that *"you properly need a presentation to the management from somebody you know what they talking about: either a consultant or one of these training people"* [P2]. In addition, according to P4 the presenter should be chosen from the local area in that the *"Middle East is a very different environment…and they start taking expertise from Europe, they may find that the expertise from Europe is focussing on the wrong area"* [P4]. Accordingly, P7 has mentioned *"we thought that Six Sigma which will support locally by the time by the Motorola University"*. In this context, Wiklund and Wiklund (2002) have asserted that process consultation is the primary strategy of organisational development. The most important qualities of a process consultant are described through four main sets of characteristics: interpersonal competence, theory-based problem-solving capabilities, the ability to create learning experiences and the awareness of one's own assumptions and model.

These are a number of the selling points that have been highlighted in Ducab to promote the Six Sigma approach that will lead to convincing top management and attaining their commitment. In this context, the commitment of top management is characterised by several aspects, as discussed below.

4.1.1.3 Aspects of top management commitment

The commitment of top management in this company is depicted by several managerial aspects. One of these aspects is managing and directing the implementation process, for example by initiating special forums and internal committees and allocating an hour in management meetings to discuss the information coming out of these forums and committees. This aspect was noted by all the participants. However, P1, P3 and P4 talked most explicitly about this aspect. For instance, P3 asked *"who should drive Six Sigma in the company?"* answering *"the top guy"* [P3]. In addition, P4 claimed that *"setting the correct objectives"* is also an aspect of the commitment of top management. Evidence from literature supports this result. In this respect, a number of authors have emphasised the necessity of top management involvement in organising Six Sigma activities. This claim has been supported by Pandey (2007) since he urges deeper involvement beyond sponsorship. Moreover, Byrne (2003) has insisted upon this involvement by eliminating organisational obstacles. In addition, Schroeder et al. (2008), Buch and Tolentino (2006) and Savolainen and Haikonen (2007) have added several tasks that should be the responsibility of top management, namely facilitating project selection, defining project charters, selecting black belts and other project resources.

In addition, taking strategic actions to improve processes is another aspect identified by all the participants. However, P1, P3, P4 and P6 spoke most explicitly about this aspect. In this context, P1 discussed the role of top management in taking this sort of action such as *"defining the bottleneck machine and the main criteria that was the machine should be running all the time"* [P1]. Moreover, P3 asserted that the implementation of the Six Sigma approach *"will happen only when the top management decides"* and he emphasised that *"we need to have the determination of the top management to implement Six Sigma. That's why I said it's not like just deciding overnight"* [P3]. Also, P6 asserted that *"in many cases, --- top management should start to initiate because at that time the initiative started"* [P6]. Furthermore, P4 identified "*defining the policy"* as another strategic action. This result is asserted by Raisinghani et al. (2005) who claim the effective impact of the ability of top management to make tough, strategic decisions affecting the long-term success of their businesses.

Another aspect is allocating a proper budget to fulfil Six Sigma objectives. Like the previous aspect, this was also discussed by all the participants, although P1, P4 and P6 discussed this issue most explicitly. P1 highlighted that *"there is the budget that is made only for Six Sigma expenses"* [P1] as well as P4 who stated that *"the managing director must be committed because he's got to provide the resources"* [P4]. Similarly, P6 has called this aspect *"commitment of resources"* and he repeated that *"there are very much required resources allocation"* [P6]. In this regard, the authors (Buch and Tolentino, 2006; Savolainen and Haikonen, 2007; Raisinghani et al. 2005) have conditioned the success of the improvement projects to the availability of sufficient resources. Thus, they have considered this task as one of the key responsibilities of top management.

Moreover, motivating and showing support to people (including black and green belts) in order to complete their tasks is another aspect of top management's commitment in Ducab. With the exception of P5, almost all of the participants spoke about this aspect. P1 described this support as very important, whilst P3 claimed that *"when you get all the support, then the chance of that team to be successful is also very high"* [P3]. So, top management should promise that they are *"going to support people who are doing this."* P2 has said. This support should include *"encouragement and attention to Six Sigma"* P4 has asserted. Similarly, evidence from literature supports this result. In this context, Kaye and Anderson (1999) have outlined a number of means of motivating people.

Likewise, P6 also repeatedly emphasised this aspect stating that *"there must always be an impression amongst employees at all levels that the top management is always interested in the project"* and repeated *"people must get the impression that the top management support them"* and repeated *"if the top management is not interested, it must at least...pretend to be interested".* And again said *"top management create impression on all of people that they are very much committed to Six Sigma"* [P6]. He has justified his assertion saying *"because if they don't, the general psychology will be that the top guys are not really interested. So I am not going to gain anything by participating. Obviously, whenever people do anything in any organisation, the* *primary motivation is for their own professional or personnel benefits"* and he added *"because they know that the top management is looking at who is doing work in Six Sigma, so people take more open interest in making this a success"* [P6]. These claims agree with several authors (Dayton, 2003; Wessel and Burcher, 2004; Antony et al. 2005; Cheng, 2008) who emphasise the importance of visible support and encouragement of the people.

In addition, participants provided some examples of this support. Arranging monthly meetings and visiting the black belts to discuss the progress of their projects are two ways of showing this support that have been mentioned by P1, P3 and P7. In this context, P7 claimed that *"... in the teamwork the operators involved as well as the engineers and managers, and give them a profile, a high profile into the senior management team".* Also, he explained that *"from a senior management's point view that has another advantage, people who do well we see them. While before, they may be doing a very good job but hidden in the organisation"* [P7]. So, he considered this activity to be an important motivation. Moreover, P6 drew attention to materialistic motivations such as *"increasing the salary or securing their jobs in the company or getting promotions"* [P6].

Furthermore, monitoring and maintaining resolutions are other aspects of top managements' commitment. The majority of the participants spoke about this aspect. In this context, P1 and P6 described the managing director's concern about the bottleneck process that had been improved by keeping the machine in this process running all the time: *"He used to come alone, stand near the machine at odd times in order to make sure that all these up stair did actually taking place on the shop floor"* [P6]. Moreover, P6 asserted that *"...very top management must review and monitor the progress on each and every Six Sigma project"* [P6]. This has been justified by P7 who states that *"if you just throw Six Sigma to the workforce and leave it there without reviewing it there will be……die and people are not really interest… and they will just drift back to the old techniques"* [P7]. This result agrees with Wiklund and Wiklund's (2002) claim that neither individual nor team training will be successful unless reinforced by the regular follow-up of an on-going, systematic change in how work is conducted

For this purpose *"...top management are allocating an hour in the management meeting to discuss the information of Six Sigma forum and internal steering committee* *at the highest level"* P1 has claimed. Usually, this meeting is held *"once a month where top management reviews all the on-going Six Sigma projects"* P6 has emphasised. In this meeting *"the Six Sigma projects team leaders come to report to the senior managers. So, it shows the senior management is following up and interested here what is happening in the teams"* P7 has elaborated. Moreover, P3 has given an example of this sort of presentation saying *"I will show you the project---which we finally presented to management and we have the report also"* [P3]. In this respect, evidence from literature shows that leaders are also involved in the on-going execution of Six Sigma projects. Senior executive champions, typically vice presidents, perform many functions for Six Sigma projects, including facilitating project selection, defining project charters, selecting black belts and other project resources, removing barriers to project completion and conducting progress reviews or tollgate reviews with black belts (Gitlow and Levine, 2005; Snee and Hoerl, 2003 cited Schroeder et al. 2008).

The aforementioned discussions have shown consistence between the evidence from the case study and the literature regarding the answer to the first theory question TQ1, namely, is top management commitment necessary to initiate the Six Sigma approach? Why? And how could it be attained? Thus, it could be suggested that the commitment of top management is so necessary to successfully implement the Six Sigma approach. There are several aspects that top management should practice in order to demonstrate this commitment. However, in order to attain this commitment, top management should be convinced from the outset. In this context, two factors influence their conviction, namely the extent of their knowledge about the Six Sigma approach and the readiness of their mentality to accept this approach. In case of the absence of one or more of these factors, several selling points could be applied to gain a buy-in. Consequently, this suggestion emphasises the relationship between the entities of the first component of the first factor of change organisational environment that have been shown in Figures 2 and 7.

As has been mentioned earlier in this chapter, the commitment of top management and strategic decision-making are the components of strategic initiatives as one of the factors of change organisational environment in Ducab. The following section presents and discusses strategic decision-making.

4.1.2 Strategic decision-making

Strategic decision-making is another component of strategic initiatives in this company. Moreover, there was agreement amongst the participants regarding the nature of strategic decision-making. They claimed that as a result of the top management philosophy of continuous quality improvement, strategic decision-making has an evolutionary nature. Therefore, the Six Sigma approach implementation has been conducted in gradual stages. In this context, P3 has elaborated *"continuous improvement is essential part of any progressing industry…it's a gradual"* [P3]. Moreover, P1 explained that *"first the Six Sigma was as embarking phase and let's…see the benefits…then afterward, the success, it was to train more people and then now is shifting to project selection, and I think in the future I would see it is shifting into the Six Sigma matrix"* [P1]. Also, he insisted that *"remember, when you start Six Sigma, you will not use all the tools at the start,… you use 20% of them. Now I am starting to use 50–60%"* [P1]. Thus, *"we have to realise this is a long term process"* P7 has emphasised.

Accordingly, *"The number of projects this company has tackled at any one time is very few. And they are very much in line with the company's policy"* P4 has contended. In the same context, P2, P5, P6 and P7 provided examples of strategic decision-making that reflect its evolutionary nature. Amongst all the examples cited, none involved radical resolution. For instance, P2 claimed *"we've had instances where we have looked at machine output, the machine has been producing okay, but the… business needs more products. So, how do we get more products out of this machine which has been apparently performing okay? So, that is something the business of identify doesn't need for improvement not necessarily that there is a problem with the machine. So, it's okay, we can improve the output of this bottleneck machine then we get more output, which obviously make the needs of this business at the time"* [P2]. Another example is that, *"…by reducing the setup, I can increase...production"* P5 has reported. These claims confirm the evidence from literature regarding the essential nature of the decisions that are made by top management. This is because the essential nature of the decisions that should be made by top management, as Raisinghani et al. (2005) have described, are tough, unpopular, unusual and affect long-term success. This agrees with all the interviewees' views presented earlier. However, the evidence from the case study disconfirms the evidence from literature regarding the extent of change that occurs as a result of these decisions. According to Bañuelas and Antony, (2004) and Byrne, (2003), these decisions should drastically improve organisational processes. However, this radical change disagrees with the pace of change in the case company. The interviewees highlighted a slower, more gradual way to implementing the Six Sigma approach in the case company. This is because the top management had a long history in applying sustained, long-term and continuous improvements. In the context of the UAE, this more gradual change may be more appropriate.

In addition, the majority of this research's participants (P1, P4, P6 and P7) contended that top and middle management levels had been involved in strategic decision-making in order to ease reluctance surrounding future implementation because they were responsible for daily operations. In this context, P1 claimed that *"It was only restricted to the key decision makers in the company means the managing director and the only the general managers and the potential Six Sigma coordinator"* and he has added *"the middle level which are all the managers in the company."* [P1]. This claim was further emphasised by P6, where *"In our company, it is basically managers and senior managers that have a say about how we will select? What are the criteria of selection of processes to which apply Six Sigma approach?"* [P6]. With this in mind, P7 insisted that *"as a management team you have to decide"* [P7]. These claims are congruent with evidence from literature. In this regard, several authors (Schroeder et al. 2008; Savolainen and Haikonen, 2007; Byrne, 2003) have emphasised the roles of different managerial levels in strategic decision-making. Moreover, they urge top management to empower line managers in order to facilitate the implementation of improvement projects. It is in this context that McAdam and Evans (2004) have attributed the failure of a number of projects to the absence of middle managers during the strategic decision-making process that results in a reluctance to apply these decisions.

Furthermore, those managerial levels in this company have considered several external and internal factors in creating their strategic decision-making processes. The following part is a demonstration of these considerations.

4.1.2.1 *Impact of external and internal factors on strategic decision-making*

Several internal and external factors have been considered when making the strategic decisions associated with the Six Sigma approach. A minority of the participants claimed that the impact of international competition was one of the external factors affecting the future of Ducab: *"They saw the effect of globalisation. They saw that many companies will be coming in, competition will be coming in"* P1 has elaborated. This is because *"In the Middle East, survival is really based on expanding as fast as you can, before someone else expands ahead of you"* P4 has justified.

In addition, all the participants agreed about the suitability of the Six Sigma approach to improve business as another factor that positively affects taking strategic initiatives. In this context, P1 outlined that *"they need extra improvement and they saw this approach as a potential tool for achieving that"* [P1]. Moreover, P2 emphasised that the *"key thing with any Six Sigma project is, it has to make the needs of business"* [P2] whilst P3 asserted that *"one of the advantages of Six Sigma is that the project will not sustain if it is really a key governed of your company or your department"* [P3]. Similarly, P4 has contended that "a typical *Six Sigma project would be to actually improve the output… this… is very relevant to the UAE it's very relevant to the Middle East, because we are in a vastly expanding market where increases output are very meaningful to us"* [P4]. Likewise, P5 stated *"when the problem comes up, I can use Six Sigma approach for my department to solve all the problems"* [p5]. Moreover, P6 has described these problems *"they are not simple"* therefore they need the Six Sigma approach to solve them [P6]. In addition, P7 insisted that the Six Sigma approach *"will be the best scheme for our requirements"*. This is because *"going to give you a benefit of business"* [P7]. The aforementioned claims show that there is agreement by all participants who claim that whenever the case company needs additional improvements, they find Six Sigma to be the potential approach to secure these improvements. Evidence from literature supports this result. In this regard, several authors (Schroeder et al. 2008; Savolainen and Haikonen, 2007) have stated that because of the direct influence of the Six Sigma approach upon organisational performance, this factor has been taken into consideration by top management during the decision-making process.

Furthermore, a minority of participants contended that market forces influence strategic decision-making. P1 and P7 claimed that the Six Sigma approach could not be used as a means of promotion for products such as the ISO 9001\2000 certificate which is a good way of gaining a reputation for product quality. P6 expressed the view that successful Six Sigma project stories could be published as a marketing tool. In this context, P6 reported that *"you can also implement Six Sigma just going to the press and say okay Ducab is a Six Sigma company. So all what has [been] done is just a public relations or marketing tool. If you do that it obviously works for the company. Little by little you will get curious as you work for Six Sigma project but that should not be the aim"* [P6]. Moreover, P4 has pointed to another role of market forces. This role is the impact of market expansion. In this context, he claimed that *"in the Middle East where there is a lot of money coming in that is placing a huge demand and that is in turn placing demand on manufacturing and many other industries."* [P4]. Thus, according to P1 *"Six Sigma is not applied in the Gulf. You will be a pioneer and it will come to your advantage and truly it did"* [P1]. These claims agree with Jacques (1996) who reported that Crosby has answered the question regarding the future of quality by asserting that quality is about reality, not certification. This statement manipulates the negative influence of market forces because of the trend of the Six Sigma approach towards not issuing certificates. This trend could disappoint some top management because there is no certificate that could be shown for promotion purposes. However, the good reputation of high quality products, in this researcher's opinion, is enough to promote these products as well as to satisfy customers and gain their loyalty. For this reason, Linderman et al. 2003; Srinidhi (1998) have urged managers to set goals based on financial or customer satisfaction data.

Additionally, the majority of the participants (P1, P3, P4, P6 and P7) have claimed that manufacturing requirements and quality trends affect strategic decision-making. In this context, P1 provided an example of the managing director of the case company who has been *"well diverse in TQM and Six Sigma. So, I think he was on the positive side"* [P1]. Moreover, P3 described the case company as *"a quality organisation. Since its beginning Ducab is quality trend, always been supporting the quality"* [P3]. Furthermore, P4, P6 and P7 demonstrate their way of thinking with regards to manufacturing requirements and quality trends. For instance, P4 stated *"the emphasis has to be here increasing output. And quality I think is as important here as it* *was in Europe…I prefer to work in an environment where we are trying to sell on quality, delivery short manufacturing cycle times. I don't want to be in an environment where we have to lower our price to try and sell our product, and we have to try and cheapen our product, it's not right"* [P4]. P6 contended that Six Sigma *"for the benefit of the company's performance…the aim must be clearly making improvements within the company…*" [P6]. Also, P7 has given another example *"everyone knows it's a major issue talk about in many meetings, we set up a Six Sigma team on that. They increased production of something like 3 million meter to nearly 5 million meters a week with huge… huge benefits to the business"* [P7]. Accordingly, Srinidhi (1998) has explained the way that manufacturing and quality trends in an organisation could be applied to work in parallel with other factors of strategic decision-making such as customers, suppliers, competitors and other players in the value net.

Most participants (P1, P2, P3, P6 and P7) discussed another factor that influences strategic decision-making, namely the impact of holding previous quality awards such as ISO certification or other quality improvement tools. They stated that traditional quality tools and techniques could have a positive impact on the implementation of the Six Sigma approach. This is because top management have a clear idea about quality and the requirements for implementation. In this context, P2 has claimed *"it will vary from company to company. The company that is already being run well, the benefits of Six Sigma will be different to those in a company which is perhaps struggling where perhaps the management is not following the approach --- if you like best practice"* [P2]. In addition, P3 stated that *"So, a company… practising…continuous improvement which believes in continuous improvement that's what I meant the chances of Six Sigma…success…because you know it's easy to implement Six Sigma in such a kind of organisation where they already understand the quality"* [P3]. Moreover, P6 has emphasised that *"it will be very helpful if you have other system already exist such as ISO 9000…It makes it very easy to identify where large gaps are, because you would already be forced by the system"* [P6]. These claims assert the positive impact of traditional quality tools and techniques on implementing the Six Sigma approach. This is because top management have clear ideas about quality and the implementation requirements. This result agrees with evidence from literature. In this regard, several authors (Srinidhi, 1998; Pfeifer et al. 2004; Nonthaleerak and Hendry, 2008; Caulcut, 2001) have emphasised the need to integrate the efforts of previous quality improvement tools, approaches and philosophies with the efforts of Six Sigma implementation. Thus, the new approach completes the previous efforts and overcomes the former shortcomings.

However, holding a quality award such as ISO 9000 could have a negative effect. This is because of top management's mentality set regarding these tools and techniques. This could make it difficult for them to accept the notion of the Six Sigma approach. Moreover, if they were awarded a quality certificate, it could stop them from adopting another quality approach such as Six Sigma. In this context, P1 stated *"…They would just say we are ISO certified and that's it."* [P1]. This way of thinking has reflected on the way that the case company has made its decision regarding the implementation of the Six Sigma approach. In this context, P7 elaborated *"we look to some alternative techniques and we thought that Six Sigma will be the best scheme for our requirements---we recognised that---it's not the only scheme and it's not necessary to be the best scheme it is one of many"* [P7].

In addition, most of the participants (with the exception of P5) claimed that early, quick and good financial results from the pilot Six Sigma projects positively influenced strategic decision-making. In this context, P2 raised the question *"If there is no financial payback to it for the business, why do you want to be doing it?"* [P2]. In addition, P1 cited an example where *"one of the projects…paid for all training within a year"* [P1] and P3 similarly stated that *"the end benefit of this project was saved or improved the company's bottom line 15.7 million per year which is great improvement on that* phase" and he has concluded *"you will get all support from all senior management because at the end it is going to result at the bottom line of the company"* [P3]. Similarly, P4 asserted that a *"quick win will help to get the people on board, happier with it, this sort of thing"* [P4]. These claims agree with Raisinghani's et al. (2005) who state that the ultimate goal is an enhanced net income. The dollars saved are often the attention-getter for senior executives.

Likewise, P6 contended that *"once you have…basically a system and you demonstrate by using the new system and you achieve success… and the success is quantify let's say one million Dirhams or ten tons or ten days sale. If you can clearly show that, you can convince employees that you applied a new system"* [P6]. This claim is congruent with Linderman et al. (2003) who contend that ultimately, the return on investment for the improvement effort and the strategic importance of the process will determine whether the process should be improved and the appropriate target sigma level is set as a goal. In a similar vein, P7 emphasised that *"So, once people and managers are trained in the concepts then to go through show some successes"* [P7]. This result agrees with Schroeder et al. (2008) who maintain that most mature Six Sigma companies track their financial results and report the impact to all levels of management on a regular basis.

The minority of participants (P3, P4 and P7) have claimed that the company's objectives are another factor that influence strategic decision-making. In this context, P4 repeatedly emphasised that *"Projects will not be successful if they do not relate to the company's objectives, because somebody will try to solve a problem that no-one is interested in"* and he insisted again *"It's much better to get that focus of attention on things which are in line with the company's objectives"* [P4]. Similarly, P3 contended that *"you do a project only when it is required, otherwise just for seek of project and applying Six Sigma will not show any result"* [P3]. Furthermore, P7 asserted that *"you have to…underline business reasons for adopting it"* [P7]. Evidence from literature supports this result. In this context, several authors (Srinidhi, 1998; Nonthaleerak and Hendry, 2008; McAdam and Evans, 2004; Caulcut, 2001) have asserted the existence of a linkage between the company's objectives and improvement project selection. They have suggested that its criteria should be carefully aligned to the company's goals. Moreover, they have considered poor linkage as the reason for project failures.

Furthermore, the majority of participants (P3, P4, P6 and P7) identified several ways in which the business environment affects strategic decision-making, creating a huge number of investment opportunities that affect demand. In this context, P4 clarified the role of oil revenues in forming the UAE business environment: *"in the Middle East where there is a lot of money coming in, that is placing a huge demand and that is in turn placing a demand on manufacturing and many other industries so we are in a situation where the aim is to increase output"* and he has justified *" because all the money is coming in here from the oil revenue and I see the sort of solutions here are very different to that of the UK".* This claim agrees with Elhiraika and Hamed, (on line) Al sayeg, (2004) who claim that the UAE is well-known for its fast-growing economy. Moreover, Shihab (on line) attributes this to large oil revenues, fresh ideas and economic project initiatives (Shihab, on line). Also, the huge oil revenues and open market policies contribute to turn this economy into a mass-consumption economy. In addition P4 has added that "*Certainly in this part of the world, there is a huge amount of construction going on, people are placing a great deal of demand on the infrastructure to supply the materials, supply the cables. And, projects lose a lot of money when they run late, so people are willing to pay to get their materials, their cables delivered on time. So it's worthwhile being the person who can deliver on time"* [P4]. Similarly, P7 emphasised that *"a huge construction in the Middle East requires to increase building wire significantly very clear customer saying lead time is too long, people want more cable it can produce everyone knows it's a major issue"* [P7].

Also, P4 drew attention to another situation that distinguishes the UAE business environment and affects strategic decision-making. This is the role of the expatriate workforce. *"the labour costs, because a lot of the labour is imported from India is relatively low. It's low to the extent that it is maybe about 10% of the labour cost in the UK"*. In this context, Sihab (on line) contends that the UAE workforce depends on expatriates. They represent more than 90 per cent of the workforce in the private sector (Fasano and Goyal, 2004; Wilkins, 2001). This situation reflects on the way Ducab solve its manufacturing problems such as the overtime. According to P4, *"to reduce overtime is not a very clever project. A Six Sigma project to investigate whether we are maximising our labour efficiency is more relevant, and at the end of that project you may decide to increase overtime to get better flexibility. It may be that you've seen well actually, it's cheaper for us, because we are importing all our labour to use less labour and they work more hours. Or you may decide that you are in fact asking them to work far too many hours, they are getting too tired, they are not giving their best effort, you need more people…you should not look at Six Sigma and say because they are doing this in Europe, this is what we do in the Middle East- this is not right, you have to look at your own environment…So you can see projects can be quite different from one area to another"* [P4]. P7 agreed with this perspective: *"…in the UAE, people have not been exposed in the same way as in the western industries. That much younger country, the systems aren't as deep and robust as in other industries of the western countries I have worked in"* [P7].

In the same context, P3 highlighted a similar situation. This relates to the role of the large number of expatriates investing in the UAE on strategic decision-making regarding the Six Sigma approach. P3 explained *"Especially a company that…is not taking a long-term vision, they will not even be going for Six Sigma. I don't know whether they have a long-term interest promoting their business here (UAE). There is a problem of a large number of expatriates here. It could be one of the reasons where why to go for it as soon as…making some quick money and going."* [P3]. However, this situation is changing now as P3 has elaborated *"we have a lot of companies with very strong bases and with long-term vision such companies definitely will go for it (Six Sigma)"* [P3]. So, he has concluded *"really do you want to waste or you want to invest in Six Sigma training and develop a culture? It all depends on the type of organisation and type of people who is the top level people who are running the industry"* [P3].

In addition, P4 suggested the ideal situation for implementing the Six Sigma approach, where *"the best time to go into Six Sigma is actually when you least need it, when you are really buoyant as a company. However, if the market is collapsing, if your sales are diminishing because there is no more demand, Six Sigma will not save your company. So Six Sigma is not the last resort for saving your business, it's something that the business needs to do, probably more importantly when it's healthy because it got the time to actually commit the resources and can become a successful first class world class business"* [P4]. So, according to P6 "it depends on the size and nature of your business".

Likewise, the minority of participants (P5 and P6) considered resource limitations as another factor that influences strategic decision-making. In this context, P5 gave an example *"you might come to a situation to solve the problem. You will say 'yes I have to invest in new machinery. It becomes the company's financial situation"* [P5]. So, P6 has considered the limitation of capital as a barrier in addition to manpower. In this regard, evidence from literature emphasises, amongst other factors, the importance of considering the resources required in order to prioritise projects. This means that resource availability affects strategic decision-making (Savolainen and Haikonen, 2007).

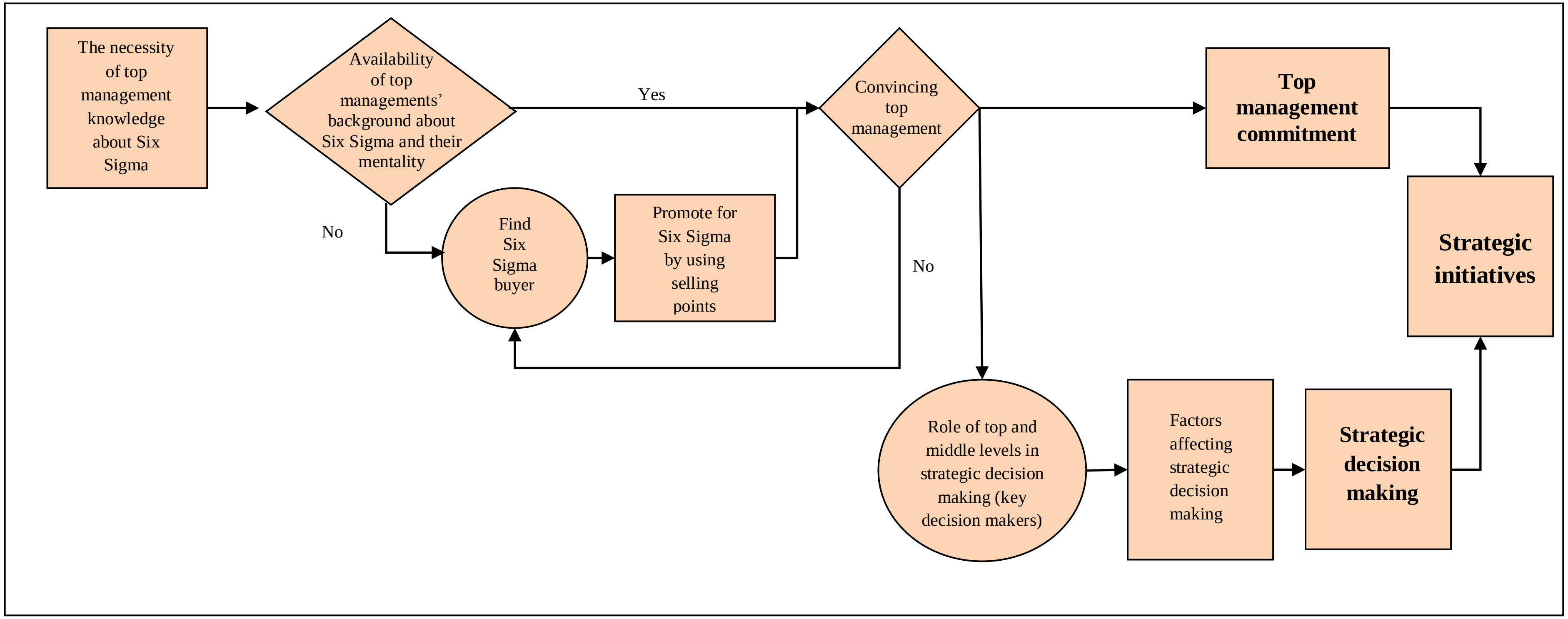
The aforementioned discussions have shown consistency between the evidence from the case study and literature regarding the answer to the sub-theory question TQ

1.1. This question is: What sort of strategic decisions in the context of Six Sigma are made, and what are the factors that affect this process? Therefore, it could be suggested that strategic decisions should be made by top management with an involvement by middle and line managers. This is because these decisions have an essential nature that radically changes the organisation's activities. However, the situation in the case company is slightly different because this company is implementing the Six Sigma approach gradually. However, this situation is understandable due to the novelty of this approach in the UAE. In addition, in order to make comprehensive and effective decisions, a number of factors should be considered by the managerial team whilst they are making these decisions.

As a result of answering the main theoretical question TQ 1 and the sub-question TQ 1.1 theoretically and empirically, it could be suggested that strategic initiatives are one of the factors of change organisational environment that affects the success of the implementation of the Six Sigma approach. Figure 2 depicts the relationship between the entities that construct strategic initiatives as one of the factors of change organisational environment. According to the participants, the commitment from top management and strategic decision-making are the components of this factor. Top management commitment has been ranked as the most important factor to implement the Six Sigma approach because no initiative could succeed without this commitment. However, to achieve this commitment, the necessity of convincing top management has also been raised and ranked as the most important factor.

In the same manner, to achieve this conviction, the necessity of top management's knowledge about the Six Sigma approach has also emerged. However, if there is a lack of knowledge amongst top management about this approach, a promotion program should be conducted in order to find buyers for this approach. The relationship between these entities is unidirectional where there is an initial move from realising the necessity of the knowledge about this approach, towards the commitment of top management. Consequently, strategic decision-making, including the decision to launch Six Sigma, begins only after convincing top management. This therefore involves middle management who are responsible for applying this approach on a daily basis. Moreover, several factors have to be considered when making strategic decisions. The following section is dedicated to showing notes and evidence regarding the second change organisational environment factor, namely cultural readiness.

Figure 2: The relationship between the entities of strategic initiatives.



4.2 Section 2: Cultural readiness

Cultural readiness is another factor of change organisational environment. Culture, according to the context of the Six Sigma approach will later be termed 'Six Sigma culture'. With the exception of P6, all the participants claimed that Six Sigma culture is part of the organisational system in Ducab. In this context, P1 maintained that *"the work system will be based on Six Sigma approach"* [P1] In addition, P5 emphasised that *"the Six Sigma approach becomes a part of the system"* [P5]. Also, P2 contended that Six Sigma *"becomes a part of company culture"* [P2] while P3 asserted that *"it is being applied even in day-to-day life"* [P3]. P7 also insisted that *"we wanted to become adopt it as the way we do the things in our business"* [P7].

According to this factor, organisational culture is assumed to be ready to implement the Six Sigma approach or at least it should be adjusted to suit Six Sigma culture. According to the description of the majority of the participants (P1, P2, P4 and P7), decision-making depends not only on experience but now it is shifting to a more systematic way. P1 claimed that *"there was lots of fire-fighting. I am not saying they still are not taking place but to a…much lesser"* [P1]. P7 emphasised that *"there was too much…fire-fighting…"* [P7]. Also, P2 mentioned that when problems occur, people are *"hitting instant responses need your reaction, but now they are tempted to step back as a matter of habit"* [P2]. P7 also contended that *"we were being very inefficient with use of resources"* [P7].

In addition, P4 provided an example about the way the machines were adjusted: *"very often in the past, we actually required operators to set up a machine, start the machine up, take a reading of the first result and then go and correct the process based on that reading. That is…absolutely disastrous, particularly if the start up results aren't typical of what you are going to get, once you get running the machine, so now we don't require them to do that"* [P4]. Moreover, P7 gave another example: *"When I came here in 2001 we were the engineers who worked on…solving problems that had been solved the year before, and the year before and the year before and keep repeating the same issues kept coming back. We've seen less of that it's not eliminated, but we have seen less of that"* [P7]. Also, he gave another example where, *"sometimes they were solving problems they weren't problems. Sometimes they were solving problems of someone else have already taken some action. So, they are doing it twice,* *and sometimes just it is wrong because they are jumping to a conclusion which was not based on analysis but it was based on experience"* and he has concluded *"so, we want to change this from this fire fighting approach. We want it to retain the dynamic from taking action but we want to put some structure"* [P7].

Therefore, according to these participants, this situation has been changed in the company after implementing the Six Sigma approach. Beside the previous extracts, P1 contended that *"there has been a shift in the culture"* whilst P5 has reported *"we change the way of doing things"* [P5]. However, P3 stated that this change *"is not an overnight job because you have developed a culture within the company"* [P3]. According to him, this is attributed to *"many factors especially in this company, where people have different knowledge levels, different functional departments and very busy environment"*. In a more general manner, he claimed that *"it all depends on the culture in the country, culture within the organisation and whether we really we want to go for Six Sigma"* [P3].

Likewise, evidence from literature supports this result. In this context, a large number of authors (Srinidhi, 1998; Kuei and Madu, 2003; Needle, 2004; Raisinghani et al. 2005; Buch and Tolentino, 2006) have claimed that the success of Six Sigma implementation requires a transformational change in organisational culture. Usually, changes are fundamental and achieved through breakthrough improvements (McAdam and Evans, 2004; Raisinghani et al. 2005; Ehie and Sheu, 2005). Evidence from the case study shows that the company was in a transformation stage. As a result of implementing Six Sigma, a significant change in organisational culture has been achieved. For example, there is shifting in decision-making in this company. Prior to implementing Six Sigma they have relied upon experience to make their decisions. Nowadays, they are depending more upon data outcomes. Previously, the way they solved problems was to fire-fight, but now they are using Six Sigma tools to prevent process errors and making faulty products. Moreover, the interviewees have shown that the case company has made a lot of effort to make Six Sigma culture part of its organisational culture. They have attributed this to differences in people's knowledge and qualifications.

Accordingly, Six Sigma culture in this company has several features. The following part is a demonstration of these features.

4.2.1 Features of Six Sigma culture in Ducab

Several features of characterise Six Sigma culture in this company. First, the minority of the participants (P1, P3 and P7) claimed that this company has rigorous procedures and/or processes. In this context, P1 reported that *"some general managers are subjected to psychometric tests in order to find out to what extent they are fit to lead this organisation"*. Moreover, P3 has described the company as a quality organisation, stating that there is a *"very established system within the company across the entire department. You have quality drive across the company"* [P3]. So, he believes that *"the chances of Six Sigma becoming successful lie there actually because it is easy to implement Six Sigma in such kind of organisations where they already understand the quality"* [P3]. In addition, P7 claimed that *"it brings some discipline into things like problem solving and decision making in organisation"* [P7]. These claims are congruent with claims of a number of authors (Byrne, 2003; Pandey, 2007; Wiklund and Wiklund, 2002) who have described Six Sigma as a robust and highly disciplined approach. This description is attributed to the scientific and statistical nature of this approach, one that has been reflected in its techniques. Likewise, aforementioned participants' claims show that this feature is one of the reasons that motivates the case company to implement the Six Sigma approach. This company, as a result of its long history in pursuing quality, follows rigorous procedures to maintain the discipline.

The majority of the participants (P1, P4, P6 and P7) identified another feature of Six Sigma culture, namely that management should be mature and understand Six Sigma culture before Six Sigma implementation. In this context, P4 contended that *"It is important that the executive management see their role as not solving the problem, but setting the policy objectives"* [P4]. This claim agrees with Marwa and Zairi (2008) who highlighted the influence of leaders upon organisational culture. In addition, Schroeder et al. (2008) have explained the role of the structured method used in the context of the Six Sigma approach to prevent management from jumping to hasty conclusions. In this respect, P6 provided an example of a mature manager. He reported that *"most problems can be solved by allocating large quantities of capital…Throw away old machines and buy new ones. So, you have to identify whether this is included in the scope...Otherwise, there is no point in the advantage gets rid of problem get* *something new"* [P6]. P7 gave another example: *"It depends on your staff and if you have a highly motivated staff. ----any company needs such staff to be successful, and we have"* [P7]. In both examples these managers reflect mature thinking regarding solving problems and trusting staff. This maturity, in this researcher's opinion, has been gained by learning and understanding Six Sigma principles. Moreover, this maturity is characterised by, amongst other things, top management's thinking regarding problem-solving as well as the way they treat their subordinates.

Additionally, all the participants have maintained that being data-oriented is another feature of Six Sigma culture. This means that decision-making depends on data more than experience. In this context P1 contended that *"it is becoming data oriented"* [P1] and P6 emphasised that *"this is now being Six Sigma project it will look at data"* [P6]. Moreover, the language that has been used by all the participants demonstrates this orientation. P3 stated *"then comes out set up data which is reliable"* and he has repeated *"get an accurate data"* [P3]. P4 has reported *"Data collection is one of the very difficult things to do"* [P4]. Similarly, P5 has mentioned *"extracting data from various sources"* and he has repeated *"collect this data you need"* and again he said *"analyse the data that is available with you"* [P5]. Likewise, P7 has reported that *"this is how we press a problem where the data to support that"* and he has repeated *"a lot of use of statistical techniques in data analysis"* [P7]. P2 has said *"knowledge of statistical tools and the methodologies"* [P2]. Consequently, all of the participants' statements indicate the ways that data collection and analysis form part of daily work in the case company and influence decision-making. This is congruent with evidence from literature. In this context, a large number of authors (Caulcut, 2001; Pandey, 2007; Black and Revere, 2006; Wiklund and Wiklund, 2002; Linderman et al. 2003; Savolainen and Haikonen, 2007; Cheng, 2008) have described Six Sigma as a data-oriented or driven culture. This is because management, especially decision-making, is a fact-based process. In other words, data plays an important role in forming peoples' mindsets regarding decision-making.

Furthermore, the majority of the participants (P1, P2, P4 and P6) considered a blame-free environment to be one of the features of Six Sigma culture. In this context, P6 contended that "*nobody now are blaming them…"* and he has repeated *"so there is nobody that blames us which make people take more responsibility"* [P6]. Moreover, P4 provided an example regarding the way that the occurrence of problems is justified stating: *"Again, it's very common if you get a lot of quality problems in the factory. People automatically assume the operator needs more training. It may not be the operator at all; it may be the process capability"* [P4]. Likewise, P2 claimed that *"problems are normal. It's one of these emotive words that 'oh, there is a problem that means something has gone bad'. It may actually be something is working okay, but there is a feeling that it can be done better"* [P2]. These claims indicate that problems are received in an open-minded way and this outlook is considered as a good basis for developing solutions and improvement opportunities. This result agrees with Politis (2005) who suggests that in order to benefit from the maximum participation of employees, the business environment should be relaxed and inspiring. This kind of environment encourages employees to admit to their mistakes but also to be creative.

The minority of the participants (P1, P6 and P7) maintained that building quality into the design and avoiding fire-fighting is another feature of Six Sigma culture. In this context, P1 contended that *"there is lots of fire-fighting. I am not saying they still are not taking place, but to a lesser much extent…we are starting to understand the essence of Six Sigma"* [P1]. Moreover, P6 claimed *"we may find designs need to be changed. So if you need to change the design you can change it"* [P6]. Similarly, P7 outlined problem-solving related to design issues: *"we need to change the design … it is all design faults…it is able to change"* [P7]. These claims are supported by evidence from literature. In this regard, Tannock et al. (2007) have claimed that in order to move from fire-fighting situations to real quality improvements, comprehensive design, built upon manufacturing process information, is required. Furthermore, Stamatis (2000 cited Raisinghani et al. 2005) has clarified the importance of building quality into organisational activities from the early stages, such as planning that includes the design phase.

Furthermore, with the exception of P6, all participants claimed that methodical and structured management is another feature of Six Sigma culture. In this regard, P4 has insisted that *"you --- have to believe in Six Sigma as being a methodology"* [P4]. P7 reported that *"it gives me a structured way to try developing"* and he has repeated *"Six Sigma is very documented scheme. It has a good structure"* [P7]. In addition, P5 asserted that *"it is a methodological systematic method of solving problems"* [P5].

Likewise, P3 emphasised that *"it is so methodical and structured way."* [P3]. P4 observed that *"the tools are methodical…and they should lead you to the correct solution."* [P4]. These claims reflect the way problems are solved in the case company. This result is congruent with evidence from literature. Several authors (de Koning and de Mast, 2006; Linderman et al. 2003; Cheng, 2008) have considered this feature as one of the reasons for the success of Six Sigma implementation. They have attributed their claim to the significant role of the DMAIC cycle in providing management with a methodical and structured approach to organising and maintaining problem-solving processes.

The minority of the participants (P4 and P5) considered working in a democratic environment to be another feature of Six Sigma culture. P5 described this environment: *"discussions will be there, and people will give in their ideas and we will take all the peoples' feedback and ideas…and reach…an agreement…"* [P5]. P4 clarified that the company encourages rival opinions: *"Now it can be useful to have a person who is against the project in the organisation, in fact I think it's healthy…Because they are the people who make you justify more what you are doing."* [P4]. These claims describe the democratic way of discussing problems in order to reach comprehensive solutions. This result agrees with Pandey's (2007) claim who has shown that the Six Sigma approach is moving from a control oriented approach towards people empowerment. Therefore, consistent with this trend, the work should be done in a democratic and blame-free environment. In addition, according to this type of environment, people can contact each other freely and collaborate openly across an organisation. This has been enhanced by the existence of the belts system (Antony, 2004; Caulcut, 2001; Brewer and Bagranoff, 2004).

Moreover, the minority of the participants, including P6 and P7, considered focusing on customers' needs and expectations with regard to business objectives to be another feature of Six Sigma culture. In this context, P6 contended that *"it's a customer focus everything must be the voice of the customer and voice of the business"* [P6]. In addition, P7 insisted that *"we…started looking at customer requirements and talking to the customers and spending a lot of time led by marketing persons. So, give customers demand"* [P7]. These claims agree with Srinidhi (1998) who contends that once the expectations of customers are managed, we need a process which incorporates customer expectations in every decision that the firm makes. In other words, it is important to have a management system which continuously focuses managerial attention on customer needs and expectations. Similarly, many authors (Srinidhi, 1998; de Koning and de Mast, 2006; Caulcut, 2001; Black and Revere, 2006; Wiklund and Wiklund, 2002; Goh and Xie, 2004; Nachtsheim and Jones, 2003; Brewer and Bagranoff, 2004; Antony, 2004) have discussed this relationship between customers' expectations and business objectives. This could be achieved by prioritising improvement projects that satisfy customers and have real impact on the bottom-line. In this regard, critical to quality characteristics are a vital instrument to help measure customer satisfaction.

Finally, only P3 has considered time limitations to be one of the features of Six Sigma culture. He claimed that *"With Six Sigma projects in our company…we…set up…projects which should have time scales and this should be within three months"* [P3]. This claim indicates that the case company undertakes projects that are forecasted to be completed within a maximum of three months. This result is congruent with Lynch et al. (2003) who have contended that timing is vital to project selection. They have attributed this vitality to its relationship with cost. According to this relationship, cost increases with the length of time taken for project completion.

The aforementioned discussions have indicated consistency between the evidence from the case study and the literature regarding the answer to the second theory question. This question is: should the organisational culture be ready or adjusted for initiating the Six Sigma approach? Therefore, it could be suggested that the organisational culture should be ready or adjusted during the implementation stages of the Six Sigma approach. This is attributed to the crucial role of culture in understanding the ability of an organisation to perform and compete (Peters and Waterman, 1982; Cicmil and Keka¨le, 1997; and Deal and Kennedy, 1982 cited Rad, 2006). Moreover, organisational culture is an explanatory factor that distinguishes one organisation from another (Sathe, 1985; Schein, 1985 Prajogo and McDermott, 2005). Accordingly, Six Sigma organisations are distinguished from other organisations in terms of a number of features. These features could be noted in several values, beliefs, attitudes, behaviours and languages that form Six Sigma culture. The following is a discussion of these components.

4.2.2 Components of Six Sigma culture

As has been shown in the literature review, the organisational culture is defined as the values, attitudes, behaviours and language that are common amongst individuals within the organisation (Kuei and Madu, 2003; Motwani et al. 2004). However, because of the similarity between some of these components, they are classified in three groups. The first group is values and beliefs. The second group is attitudes and behaviours. The last component is language. The discussion of the sub-theoretical question TQ2.1 begins with the first entity of the first group (values and beliefs), namely working according to vision.

4.2.2.1 Values and beliefs in the case company

According to the participants, this company works according to many values and beliefs. In this regard, the majority of participants (P1, P4, P6 and P7) have claimed that a key value and belief relates to the company's vision, as developed and communicated by top management. P1 stated that *"the work should be done according to vision"* [P1], whilst P4 emphasised that *"to get to that as a level, you need a strategy of getting there"* [P4]. Thus, P6 contended that *"management must have clear intentions to implement Six Sigma for the benefit of the company's performance"* [P6]. In addition, P7 has asserted that *"senior management have to believe they have business objectives"* [P7]. Aforementioned claims highlight the adherence of top management in the case company to this value. This result agrees with (Caulcut, 2001) who claims that senior management have clear vision, values and objectives. In addition, Byrne (2003) maintains that one of the most common reasons Six Sigma efforts falter, is that companies do not always provide these initiatives with the strong and visionary leadership.

Moreover, the majority of participants (P1, P3, P6 and P7) have maintained that one of this company's values is that applying Six Sigma is a non-stop scheme. In this context, P1 claimed that *"it's like a heritage that each managing director is handing over to the next one"* [P1]. In addition, P3 insisted that *"it is not something which you do once and forget about…It's a constant continuous thinking"* [P3]. Thus, P6 observed that the notion of applying the Six Sigma approach as a fashion is unacceptable in Ducab. Moreover, when P7 was asked about his intention about continuing the implementation of Six Sigma in the company, he answered *"I probably would"* [P7]. These claims show that the Six Sigma approach never stops once it begins in the case company. This result echoes Clifford's (2001 cited McAdam and Evans, 2004) claim who has insisted that the Six Sigma approach should not be seen as a short-term fad.

Additionally, the majority of the participants (P1, P2, P6 and P7) have claimed that the mentality of top management should be ready to accept Six Sigma principles. In this regard, P2 has contended that *"they need to understand what's it's about and they need to say 'yes it is okay, we believe this is a good idea and we are going to support it"* [P2]. These claims are supported by evidence from literature. Several authors (Sinclair and Collins, 1994; Gore Jr, 1999; McAdam et al. 2005) have described the way that the mentality of top management should be ready for implementing the Six Sigma approach. It is here that they should focus on the development and maintenance of the organisational culture. Moreover they will need to rely on specialists to deploy quality through the organisation and give sufficient attention to people in order to involve them in the implementation process and avoid their reluctance.

Only two of the participants (P1 and P3) expressed another belief. According to P1, only professionals lead Ducab. Also, P3 contended that a trained person will be chosen as a team leader, because *"he should have knowledge… about what is Six Sigma, and how to apply it"* [P3]. This result echoes Pandey's (2007) claim which has pointed to the capabilities and abilities of qualified leaders to lead changes and gain employees' buy-in. Furthermore, Caulcut (2001) has defined the qualified leader by their ability to perform most of their subordinates' tasks such as presenting data in charts. In addition, he claims that there is evidence of a readily accepted self-discipline in this style of communication. In Six Sigma companies the person with the loudest voice does not necessarily have the most influence.

In the same context, the participants, including P6 and P7, show the readiness of their mentality as managers, to accept the Six Sigma approach. For instance, P6 stated that *"The time they (the team members) spend on the project. It's if you call it a cost in details but I would not actually call it --- cost, because this is part of the job training andit is almost one or two months will pay back for this project"* [P6]. P7 provided another example, where *"In fact if they do Six Sigma well, they will* *have more free time because we solve our problems better and faster in the long term"* [P7].

As a blame-free environment is one of the features of Six Sigma culture, the majority of the participants (P1, P2, P3 and P6) have considered the importance of blaming the system as opposed to the people, to be another belief of top management in the event of a problem arising. This is because as P1 and P2 have claimed, these problems are improvement opportunities in this company. Moreover, this belief has been considered by P1 to be very important for Ducab. This is because blaming people prevents work improvements. In addition, P4 believes that instead of blaming people, the system should be blamed. This is because this environment encourages people to reveal their mistakes in order that solutions may be identified, which in turn creates good opportunities for improvement. Similarly, Pande et al. (2002) have advised managers not to point to individual employees or departments that have caused problems in order to avoid blame.

4.2.2.2 Attitudes and behaviours in the case company

Another component of Six Sigma culture is attitudes and behaviours. One of these attitudes and behaviours that have been noted in this company include flexibility. P1 and P7 have claimed that managers in different managerial levels are flexible in that they listen to people and discuss matters with them to develop solutions. In this regard, P7 drew attention to the flexible outlook possessed by senior managers: *"there were different conflicting issues… one was the design of the cable was wrong. One was that the tooling was wrong one was the machine was not capable of putting the materials on the right thickness within the tolerance specified. So, there are a number of different ideas and what the team did very simple. It was green belt team but very effective. They pulled out the data. They did serious missions on the diameter under the lead sheet. They end up this the capabilities of machine and amended the tolerance."* [P7]. This result is congruent with Politis (2005) who has explained the negative influence of rigidity upon peoples' participation and acceptance of the Six Sigma approach. Thus, management should be flexible to ensure people involvement.

In addition, the minority of the participants (P1, P6 and P7) highlighted that the managers are experienced and know how to manage change. For instance, P6 has elaborated the way of solving problems in this company: *"You must have clear* *identification what a problem is. For example, machine number five is running too slow that would have been the definition of the problem…If you define a problem like this, then you will go there and look at the gears, look at the drives, look at the motors and so on. However, when we look at like this problem after applying Six Sigma approach we approach everything we went to design, we went to planning we obviously went to the operation"* [P6]. Therefore, P7 emphasised that there should be a *"lot more effort on problem definition before you start the team because it might be a problem you can solve early."* [P7]. These claims show the way these managers deal with problems in the light of their extensive experience. This result agrees with Politis (2005) who has pinpointed the features of the experienced manager that could impact on efficiency, effectiveness, productivity and a competitive position. Thus, experienced managers should have credibility and integrity, clear vision and conscious knowledge strategy.

In addition, the minority of the participants (P1, and P4) have considered the company's managers as transparent and supportive. In this context, P1 claimed that *"top management is clear with people of the company"* [P1]. Moreover, P4 asserted that the role of top management is *"to set the objectives and explain how to achieve those objectives and how to solve problems in the factory…It needs to be taken at the lowest level in the company that can do it because they are the people who are actually going to achieve it"* [P4]. These claims agrees with Caulcut's (2001) claim that senior management objectives are deployed right down to the shop floor and customer contact levels. Wessel and Burcher (2004) and Antony et al. (2005) assert visible top management commitment. (Wessel and Burcher, 2004).

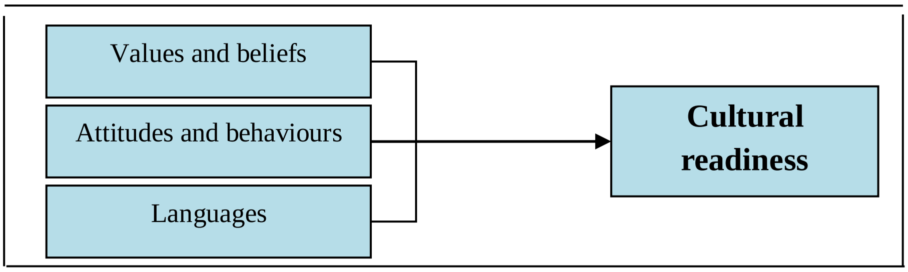
The majority of the participants (P1, P2, P3, P4 and P7) have claimed another attitude of the Six Sigma approach. They have contended that the top management is patient. In this regard, P1 was *"very glad to see the level of patience of the managing director"* [P1]. This is because *"it's very difficult…some projects take a long time, and go out of the time scale"* [P1]. P2 also emphasised that Six Sigma projects are *"not instant solution…not something you can do over night"* [P2]. Likewise, P7 asserted that *"it is a long, long journey and not always as fast as we would like to be"* [P7] and he has repeated *"We have to realise this is a long term process"* [P7]. Similarly, P3 described Six Sigma approach implementation as *"a tough job in any company"* [P3]. This difficulty is associated with two aspects in Ducab.

According to P3 the first difficulty is *"to convince people"* [P3]. P7 explained this as *"the way people are doing things, they perceive that the right way"* [P7]. The second difficulty, as P4 mentioned, is *"Data collection"*. This is because *"you often find that actually people don't fully understand what you want and therefore the data does not come back when you expected it to"* [P4]. The aforementioned claims attest to top management's attitude towards the long journey of Six Sigma approach implementation. In addition, they have clarified the sources of difficulty regarding this implementation. This result agrees with evidence from literature. In this regard, Bañuelas and Antony (2002) have attributed the necessity of management being patient to the difficulty and long term of the implementation of the Six Sigma approach. Therefore, quick wins are helpful to convince top management of the need to continue committing to and supporting this implementation.

4.2.2.3 Language

Shared language is one of the components of organisational culture. The Six Sigma approach has its own language. This language has to be common among people. In this context, the minority of the participants (P1 and P3) claimed that people in the company use Six Sigma language to facilitate understanding. P1 explained *"language is the means of communication…that makes base for understanding this approach among people"* [P1]. This also accords with P3, *"because everybody reads the same language and thus has the same understanding"* [P3]. These claims agree with Motwani et al. (2004) who maintain that as a result of the unity in Six Sigma's culture the common language is spread amongst individuals. Moreover, Scott (2001 cited Schroeder et al. 2008) who contend that the common language serves an integrative function that facilitates diverse team member interaction in exploring system-wide problems. Furthermore, Schroeder et al. (2008) claim that institutionalising Six Sigma creates a common language and method for solving problems. This common language helps overcome barriers created by diverse interpretive schemes. For example, when a financial analyst and an engineer use the term 'process sigma' they have a common understanding of what this term means.

Figure 3: The relationship between the components of Six Sigma culture in the case company



To conclude, the aforementioned discussion has shown consistency between the evidence from both the case study and the literature regarding the answer to the sub-theory question TQ 2.1. This question is: What are the contents of the organisational culture that are associated with the Six Sigma approach? Therefore, it could be suggested that Six Sigma culture is composed of three key components. The first group is values and beliefs which contain a number of entities: working according to vision, a non-stop scheme, the readiness of top management mentality, qualified leaders and a blame-free environment. The second group is attitudes and behaviours which include flexible, experienced, transparent and patient management. The last component is language. Figure 3 summarises the key components of Six Sigma culture.

Figure 3 shows that the above components contributed to cultural readiness for Six Sigma application. There are uni-directional relationships between them. A combination of all of them, according to Six Sigma principles, leads to cultural readiness in Ducab. However, the impact of these components upon the success of the implementation in this company is different. Amongst other values and beliefs, the readiness of the mentality of top management has been ranked by P1 as an important value. This is because *"Six Sigma initiative needs flexible mentality to know how to manage change, otherwise rigidity harms the improvement"* [P1]. Moreover, he ranked a blame–free environment as one of the very important values. This is because as he justified *"blaming people stops them from improving their work"* [P1]. In addition, amongst other attitudes and behaviours, transparency of managers was also highly ranked by P1 and P4 as an important attitude. This is according to P1, in order to *"ensure getting out the stress from the job and no internal politics"* [P1]. P4 attributed this to the role of people, stating *"people who are actually going to achieve it"* [P4]. Furthermore, P1 ranked patient management as another very important attitude that is required for the successful execution of Six Sigma projects.

As a result of answering the main theory question TQ2 and the sub-question TQ2.1 theoretically and empirically, it could be suggested that cultural readiness is one of the factors of change organisational environment that affect the success of the implementation of the Six Sigma approach. To this factor could be attributed the crucial role of understanding the ability of an organisation to perform the implementation of the Six Sigma approach. This is due to the special features of this culture that have been affected by the structured discipline of the Six Sigma approach. Moreover, this culture could be created or adjusted in order to interface with the Six Sigma approach by generating its components that are values, beliefs, attitudes, behaviours and languages. The following section is dedicated to depict notes and evidence regarding the third change organisational factor namely, learning capacity.

4.3 Section 3: Learning capacity

Learning capacity is the third factor of change organisational environment. Due to its vital role in introducing the Six Sigma approach to organisations and convincing top management, it has been considered as one of the important factors. So, according to all the participants, top management have understood this role and it has been taken into consideration during strategic decision-making for initiating this approach in this company. In this context, P1 asserted that *"...you need a level of understanding. We need business knowledge. This is important…there is a learning curve that associated with it. The early part of the learning curve is long and that is the most difficult part…we need to bring more people to know about this approach."* [P1].

Thus, P4 has suggested that *"in order to actually get started, the first thing is to actually understand Six Sigma tools. So, that means going to school and learning about these tools that are in use…*because…*the Managing Director and the workforce have to believe in Six Sigma as…a methodology. Then you need to move into the training phase"* [P4]. In the same context, P2 emphasised that *"the top management need to understand what it is"* [P2]. With this in mind, P7 stated *"once the top management get that, they have to make sure the managers and staff shares that belief. So, our big successes of project here... everyone understands there is an issue"* [P7]. Moreover, P2 has explained the way that this concept has been taken into consideration: *"so, it was I think four or five models spread evenly across a year, a year and quarter. So, we have the first kick-off model where everybody was introduced to it"* [P2]. This helps people, as P5 asserted, to *"understand what we are doing, and they understand why they are doing it, and people appreciate that"* [P5].

Furthermore, P3 emphasised the importance of common understanding: *"the basic purpose of Six Sigma and its success in any organisation comes with equal understanding of it… and there has to be general awareness about Six Sigma. This is essential"*. This is because *"the resistance will be very less…that is why…all people in the company should have a common understanding"* [P3]. Similarly, P4 contended that *"even if you know the solution, implementing it is very difficult. You have got to people trained, educated"* [P4]. P5 emphasised that *"if they (people) don't know why they are doing this, then the purpose is defeated but we keep informing them"* [P5]. P6 claimed that *"mainly the resources required from implementing Six Sigma are training. That* *means people need to be trained and they should be enough number of people trained to take on the Six Sigma projects"* [P6].

These aforementioned claims show that top management have understood the role of learning capacity in introducing the Six Sigma approach to attain employee commitment. Therefore, this factor has been taken into consideration during strategic decision-making regarding the commencement of the Six Sigma approach in the case company. This result is congruent with evidence from literature. In this context, a number of authors (Guha et al. 1997) have identified learning capacity as one of the factors of change organisational environment by the ability of an organisation to adapt and improve internal and external knowledge and to achieve higher levels of learning. This could be attained, according to Linderman et al. (2003), by intentional or explicit learning that employs formal improvement methods. As a result of knowledge creation, there are direct and indirect roles played by this factor in predicting performance in Six Sigma projects (Nonthaleerak and Hendry, 2008). Wiklund and Wiklund (2002) have clarified the impact of proper knowledge upon improvements to goods and services and the costs of rejection deduction. Therefore, Buch and Tolentino (2006) have considered this factor as the primary lever of change. This requires, as has been suggested earlier, top management's commitment to continuously improve and create sustained learning (Savolainen and Haikonen, 2007). Consequently, it requires them to have a firm understanding of the Six Sigma approach (Byrne, 2003).

The aforementioned discussion has demonstrated consistency between the evidence from the case study and the literature regarding the answer to the third theory question TQ3. This question is: what has been meant by learning capacity, as a factor within the theoretical framework? Thus, it could be suggested that learning capacity is one of the factors of change organisational environment. In the context of the Six Sigma approach, learning capacity has been identified as the ability of an organisation to enlarge peoples' knowledge via the application of appropriate learning methods. In addition, learning capacity has a vital role to play in the success of Six Sigma approach implementation. This could be attributed to its role in easing reluctance to change. Consequently, it could be suggested that top management should understand the Six Sigma approach in order to bring more employees at different managerial levels to know it and to apply it in their work. Thus, it could also be suggested that enlarging learning capacity should be taken into consideration during strategic decision-making prior to Six Sigma approach implementation.

Although there are many ways to enlarge learning capacity, according to the participants, the case company has followed, two ways, namely conducting training programmes and self-education. The following part is an elaboration of these ways.

4.3.1 Conducting training programmes

The case company, according to all the participants, has relied mainly on conducting training programmes to enlarge employees' learning capacity. This is because the top management have personally experienced the benefits of participating in training programmes. According to P1, *"first an introductory course was conducted for the top management…"* and he has insisted *"they need to be suitable for the program…so…the training did not stop after that"* [P1]. In addition, P5 emphasised that *"the basic thing is, you have to start with training"* [P5]. Similarly, P6 suggested that *"you need to have the training in the Six Sigma approach"* and he has repeated *"you have to get some training on it"* [P6]. P7 emphasised that *"you need to do some structure training"* [P7]. These claims attest to the necessity of training programmes for the case company from the initial stages of Six Sigma preparation. This result is supported by evidence from literature. In this respect, a large number of authors (Motwani et al. 2004; Das et al. 2008; Buch and Tolentino, 2006; Pandey, 2007; Wiklund and Wiklund, 2002) have asserted the important role that training programmes have played in forming and developing peoples' understanding and skills to facilitate change organisational environment. Accordingly, Buch and Tolentino (2006) have considered training as a lever of change for the Six Sigma approach. Therefore, there is a real need to conduct training programmes in order to enlarge employees' learning capacity (Motwani et al. 2004).

The aim of these training programmes, as the participants have claimed, is to teach people about Six Sigma principles and techniques in order to help them to cope with it. In this context, P2 has clarified that *"one of the big benefits of training black belts and the green belts is the…..knowledge of individuals the statistical tools and the methodologies"* [P2]. Thus according to P6, *"once you train the people, they have a clear understanding"* [P6]. Therefore, according to P3, *"more you make training to all the people in the company then common understanding and the common level of* *thinking are created. And people will understand the advantages of this Six Sigma within the company and the Six Sigma implementation in the company will sustain"* [P3]. P5 has illuminated *"it is not difficult, once you know methodology how to do. Everything depends on the training. ---"* [P5]. Thus, P4 suggested that *"the training must take place and there is no shortcut and no cheap solution to it. It has to be done properly"* [P4].

These claims are congruent with evidence from literature. In this regard, several authors (Motwani et al. 2004; Byrne, 2003; Linderman et al. 2003) have claimed that the main aim of these training programmes is to educate people about the essence, principles and techniques of the Six Sigma approach. Consequently, several objectives could be fulfilled. Removing the ambiguity and complexity of the statistical tools is one of these objectives (Byrne, 2003; Linderman et al. 2003). Another objective of training programmes is to increase employees' confidence in handling challenging problems (Linderman *et al*. 2003). As a result of knowledge spread, employee commitment increases and an atmosphere for teamwork is established to foster a climate that is receptive to Six Sigma culture (Savolainen and Haikonen, 2007).

Consequently, according to all the participants, training programmes have been available for all employees at different managerial levels within the case company. In this context, P1 maintained *"everybody has to have training in Six Sigma"* [P1]. Similarly, P2 stated *"we have the first kick off model where everybody was introduced to it"* [P2]. Following this, as confirmed by P7 *"then, it has gone through a sort of filtering down and doing some training for the senior team and then train the managers and then train the staff"* [P7]. This occurred in phases as P3 elaborated: *"general training to the senior management level then the line manager level then the engineers' level then the technicians' level…across the company, across different departments. So, a large number of people are aware about Six Sigma"* [P3]. Similarly, P6 contended that *"every department or at least most of the departments must be represented in the training program"* [P6].

The aforementioned claims indicate that training programmes are made widely available. This result agrees with evidence from literature. In this context, a large number of authors (Politis, 2003; Das et al. 2008; McAdam and Evans, 2004; Raisinghani et al. 2005; Buch and Tolentino, 2006; Pandey, 2007; Wiklund and

Wiklund, 2002) have suggested that training programmes should be available to all employees working at different managerial levels. It should be available to manufacturing and non-manufacturing groups as well as to managers and workers, leaders and followers. This widespread availability will help to reduce knowledge gaps among the managerial levels.

As training programmes are suggested to be available for all the employees and because there are different levels of understanding, responsibilities and qualifications, there are three types of programmes that are suitable, namely introductory courses, belts programmes and maths and statistics courses. This variety is elaborated further in the following part.

4.3.1.1 Six Sigma training programme contents

There are three types of Six Sigma training programme that have been conducted in the case company. The following is an elaboration of these programmes.

4.3.1.1.1 Introductory course

All participants highlighted that an introductory course is mainly designed for top and middle management. Thus, the aim of this course is to let them understand the principles of this approach. In this regard, P1 pointed out that *"it includes what is Six Sigma and the benefits from a business point of view, as well as the difficulties"* [P1]. Moreover, P2 emphasised *"the top management had training, it is to what is about"* [P2]. In addition, P4 elaborated *"the first thing you have to do is to start training executive managers and managers in the company in understanding Six Sigma. That may be only a two day training course, but it is extremely important that they understand the philosophy of Six Sigma and they buy into the idea of it"* [P4]. These claims agree with Raisinghani et al. (2005) who have described the course content which includes basic training materials. Usually, it is run for one day.

Similarly, P7 clarified that *"we are doing some training for the senior team and then train the managers and then train the staff at least the concepts of overview of Six Sigma"* [P7]. Thus, although this course is designed mainly for top and middle management, it could be conducted and tailored to the needs of employees working at different levels within the company.. In addition, P5 has suggested *"first to train people on the Six Sigma approach"* [P5]. Additionally, P6 has pointed to the benefit of conducting this course for all employees. In this context, P6 stated *"I think you need to* *have the training in…Six Sigma approach. What is this approach because you must have consistency in the approach you are taking to solving the problems"* [P6]. These claims agree with Antony's et al. (2005) who identify the aim of this course is to introduce the Six Sigma approach to a large number of people to create shared understanding of core business processes.

4.3.1.1.2 Belts training programmes

All of the participants have stated that the belts programme is one of the Six Sigma training programmes. This programme is structured. The aim of these programmes is to prepare employees for managing their improvement projects. In this regard, P2 claimed *"parts of the training of being green belt and black belt is practical experience"* [P2], whilst according to P4 "*...training mostly is in…problem solving techniques"* [P4]. With this in mind, P3 highlighted how, *"the training has structure…with practical examples…It may not be required at highest level, like black belt, but at least green belt training has to be done for more people"* [P3]. These claims agree with Motwani et al. (2004) who claim that the belt system provides good opportunities for individuals to expand their learning and skills. In addition, Linderman et al. (2003) maintain that Six Sigma organisations provide extensive training programmes in process improvement methods and tools.

Trainees are classified into two categories, namely black and green belts. This is because, as P3 explained, *"any manufacturing company will have a mix of people with different levels of knowledge. So, Six Sigma itself… has got different levels of training; black belt training and green belt training"* [P3]. Similarly, P7 maintained *"train through to the various levels of black belts or green belts. So, they know the tools and techniques of Six Sigma"* [P7]. In the same context, P3 asserted that black belts are employees who undergo a *"...high level [of] training in all areas and who can understand a bit more like statistical analysis techniques and consultant management"* [P3]. These claims are congruent with Raisinghani's et al. (2005) claim which describes these two types. They state that green belt training is more extensive, including a week of statistical analysis.

However, P4 elaborates that *"these black belts cannot solve the problems on their own and they need to enlist the help of people in the organisation. So, then you have got to train people at a lower level called green belts to understand Six Sigma and* *under the guidance of a black belt to start to solve problems"* [P4]. Moreover, according to P6 *"the green belts…don't need to do all the tools…if he needs more complex tools, then he can of course go and ask for advice from the black belt how to use it...Therefore at least one black belt should be there with the team"* [P6]. This claim agrees with Linderman's et al. (2003) description that training occurs in a hands-on fashion where instructors explain concepts followed by participants applying the concepts to their improvement projects. This training format ensures that participants not only understand the concepts of Six Sigma, but also understand how to apply these concepts.

Belt programmes have been conducted in two stages, where according to P1*"first it has been carried out the black belt training and afterwards the green belt training"* [P1]. In addition, these programmes are conducted, according to P3, in several phases in order to combine theoretical concepts with practice. This type of training could last for five days. However, there are some programmes that are delivered as a series every five days. In one week, trainees learn some Six Sigma techniques and they practise them during the second week, and so on. This program continues until the trainees learn the important techniques for conducting their improvement projects. These claims are congruent with Bertels (2003 cited Buch and Tolentino, 2006) who also contends that training is best conducted in waves, with each wave consisting of one to two weeks of training over a period of two months. The average length of training across organisations seems to be about ten days.

Through these programmes trainees learn many skills that according to P3 help them to *"write and define the status quo or problems or improvement projects"* [P3]. Similarly, P7 stated that *"the important bit to me is the first step; the definition of a problem and making sure people can really define what problem they are trying to solve and most problem solving approaches failed because people do not do that very well"* [P7]. With this in mind P6 emphasised that *"here at least, people will know the basics; how you will go out analysing the effect of input and output and process. It is not purely statistics. They also learn an important thing which I've just said it is customer focus"* [P6].

P1 claimed that some live projects are designed for training purposes. Moreover, P4 explained how to conduct a live project, stating that *"...start with the* *problem. It is called a project definition. And to define the project a team has to be put together and the first thing they have to do is to identify a target, an objective. So the target needs to be quantified"* [P4]. These claims agree with Buch and Tolentino (2006) who maintain that the training content and format require completion of a project and approval of a project report. To maintain green belt certified status, individuals are expected to complete a project each subsequent year.

4.3.1.1.3 Maths and statistics courses

All the participants, with the exception of P5, have claimed that mathematics and statistics courses form one of the Six Sigma training programmes that have been conducted in the case company. In this context, P7 stated that *"in the Six Sigma training there is lot on statistical techniques"* [P7]. Moreover, P2 emphasised that *"individuals' knowledge of the statistical tools and the methodologies should be improve"* [P2]. This is because *"statistics always helps in certain stages of Six Sigma"* [P3]. This stage as P7 clarified, is *"the analysis stage as part of DMAIC"* [P7]. This claim is congruent with Cheng (2008) who contends that DMAIC methodology teaches how to integrate the various tools into an overall approach of process improvement. Each tool is then taught within the context of the DMAIC roadmap, so it is immediately obvious why, when, and where each tool should be used. As employees learn and understand the skills of Six Sigma, they will in turn develop their own new ideas on the concepts of quality management.

Similarly, P6 maintained that *"when people come to the analysis of data they are basically using statistical terms"* [P6]. This claim agrees with Pfeifer et al. (2004) who assert that the development of products and production technologies requires extensive methods of statistical analysis and design of experiments (DoE). Likewise, Motwani et al. (2004) emphasise that individuals should be taught the proper tools and techniques that are necessary to measure their performance, such as team, process and statistical tools.

The main purpose of this course is to teach people how to use different statistical equations and software to improve their work. In this regard, P6 emphasised that *"people don't need to be mathematical and statistical experts, because whatever they are doing…there are software packages available that will take the data and give them whatever the statistical research need from that, such as media, median average... So, they do not need to know the formula or calculate the variance population of* *sample. They do not really need to do that. They have to learn the use of statistical packages"* [P6]. Thus, according to P7 *"applying statistical techniques, if you know what they are… is very, very, very easy. The key in these statistical approaches is to know what data to collect to be meaningful"* [P7]. These claims agree with Byrne (2003) who claims that the Six Sigma quality improvement methodology requires rigorous training in statistical methods, analytical techniques, and various measurement tools that will be helpful to the work of black belts and their Six Sigma project teams.

According to P1, as the case company *"uses probability and capability studies in the analysis stage and in the capability studies, people need to understand the different definitions. The stress should be on understanding statistics, not understanding the equations. Thus, they should understand the meaning of what they are doing, the end results…and…the validities of what they are doing. Not to do too much on the equations because the equations are covered by the programme itself. But you need to understand which tool to use and what is the difference between this one and that one? Therefore, they need to continue their …maths and statistics training"* [P1]. Similarly, P4 maintained that *"The tools are methodical tools and they should lead to the correct solution"* [P4]. Then, he has suggested that *"Pareto analysis, statistical process control, histograms, tick charts, data collection, cause and effect analyses, these tools people have to learn…and…when to use the right tool to the right problem"* [P4].

As Six Sigma is a unique quality improvement approach, the way of conducting training programmes is also unique. The following part is a discussion about these steps.

4.3.1.2 Steps in conducting Six Sigma training programmes

The Six Sigma training programmes, according to the participants, have been conducted through several successive steps at the case company. The first step, as observed by all the participants, with the exception of P3, is contracting with the right consultant who will supervise the training programme. In this regard P1 emphasised that *"it should be done through another party that has implemented Six Sigma or has played the role in training for Six Sigma"* [P1]. Furthermore, P2 asserted *"let us do this properly, let us go to the expert"* [P2]. He has attributed his suggestion to the company's experience with consultants: *"there are a lot of people saying 'we will teach* *you to be a Six Sigma black belt in two weeks, come on a two week training course, and you will be a black belt at the end of it'! That is just not possible"* [P2].

Moreover, P7 elaborated that *"we can do the training in house, but there is often a lot of high credibility when we bring in external trainers"* and he asserted the importance of recruiting an external trainer, *"although if we have someone who is good in training that could train green belts, we choose not to do that because we want another people. This is because some people could be very, very knowledgeable and they know all information, but they cannot teach it to people. So, we need someone who [is] good at appealing ideas across the people as a good trainer"* [P7]. For the same reasons, P4 suggested that *"we need people from outside to do the training"* [P4]. Thus, the consultant should be a *"very confident guy"* [P7] who *"trains people in the methodology and does a presentation to the management"* [P2]. These claims agree with Knowles et al. (2004) who have clarified the role of experienced practitioners to guide others on their way to understanding the Six Sigma approach.

The second step in conducting Six Sigma training programmes in the case company, as highlight by all the participants, is choosing black belt pioneers. In this regard, P5 emphasised that *"we have to identify the potential people who can do Six Sigma"* [P5]. In addition, P2 stated that *"one of the steps is identifying who wants to do the training"* [P2]. Therefore, P1 clarified that *"we choose a group of people as first black belts"* [P1], whilst P3 has elaborated that *"we develop a group of people within the company who are exposed to same level of understanding towards Six Sigma. It is pointless training one guy in an organisation and saying…'you are in charge of Six Sigma,' you do ten different projects"* [P3]. Furthermore, P7 stated that *"we trained some black belts"* [P7] and as observed by P4 they have been considered as *"experts in the company"* [P4]. Similarly, P6 explained *"we start the training with a few black belts to lead the implementation of Six Sigma in order to create a beginner master people who are more or less familiar with Six Sigma approach… we need some black belts to act at least as guides…to first steer the Six Sigma project"* [P6]. These claims are congruent with Raisinghani et al. (2005) who have asserted the necessity of embarking on training programmes with some of the best people to act as pioneers.

Establishing a Six Sigma forum is, according to P1, another step in conducting Six Sigma training programmes. This forum is composed of all the black belts. They meet monthly to present the progress of their projects and to discuss difficulties and find solutions. In addition, the minority of the participants (P1, P3 and P5) have considered assigning a Six Sigma coordinator as another step in conducting Six Sigma training programmes. In this context, P5 emphasised that *"we need to have a dedicated person. He is going to solve peoples' problems through the Six Sigma approach"* [P5]. Likewise, P3 clarified that *"we have one representative who is heading...Six Sigma within the company and also he is aware about what others are doing, and it is done through one umbrella"* [P3]. Thus, according to P1, the role of the coordinator is "*to arrange coordination between the entire black belts and facilitate difficulties that face them*" [P1]. These claims agree with evidence from literature. Several authors (Savolainen and Haikonen, 2007; Cheng, 2008) have emphasised the significant role played by Six Sigma forums. They have attributed this to their role in managing and supporting the continuity of the training programmes. These forums also provide good opportunities for knowledge exchange.

Following this step, according to P1, black belts are provided with the right equipment (such as laptops and statistical software) in order to facilitate their job. Next, according to all the participants, these black belts start to choose their live projects. This is as elaborated by P2 *"part of the training. It is practical experience. It is a sandwich type of training where people got theory application theory application. It has to take time"* [P2]. This claim agrees with Linderman et al. (2003) who contend that most Six Sigma organisations also require employees to work on improvement projects whilst they receive training. Moreover, P2 provided an example: *"let us say, people got the five parts of DMAIC. So, the first training session is the basic introduction to Six Sigma and what the define process actually involves…If they have all the training of how to define a project go and define one. So that involves obviously building a project charter and understanding the nature of problems and one other thing Six Sigma tries to force them to do, is to understand the nature of the problem before they look for a solution"* [P2]. This claim is also congruent with Knowles et al. (2004) who maintain that a training programme followed by a project is an effective way to allow people to practise and refine what they have learnt; Six Sigma training should combine classroom learning with application to real world projects.

In the same context, P4 stated that *"people can then start by looking at some problems and they pick a few projects which are going to be quick win projects. Projects where are definitely seen as an opportunity, definitely in line with the company policy"* [P4]. In addition, P7 suggested *"people have to get a real project the real matter to the business and the people working on the team can see that affects the business"* [P7]. However, P6 suggested an alternative way for practising, where *"if there are no projects where you have to take, people can do it on the practice and they can be provided with hypothetical problems and let them solve it"* [P6]. Also, P3 suggested that *"people can choose any project and…analyse it with the various techniques that they learn and thereafter, they choose the real projects"* [P3]. The aforementioned claims indicate that trainees in the case company have opportunities to execute live projects. In this respect, P1 and P2 have contended that twenty eight projects have been executed during the first two phases of training programmes. (Appendices 3 and 4 provide further details about some of these projects). This result agrees with Buch and Tolentino (2006) who elaborate that employees need organisational support in order to translate the results of training into successful Six Sigma projects. Trainees work on a real-life project and between each week of classroom training they have three to four weeks to work on their projects.

The minority of the participants (P1 and P2) have considered reviewing progress as one of the steps in conducting Six Sigma training programmes. In this regard, P2 clarified *"we are doing this through Motorola Dubai and because of modern electronic e-mail system and everything else, we have sent documents backward and forward and the professor in UK was able to advise the sister how we are gaining. After three months he came back to Dubai and gave us more training, helped us out with and the project progress…"* [P2]. This takes place in a quarterly meeting where according to P1 each project manager reviews the progress of his project. These claims indicate that top management in the case company continuously review progress with the cooperation of the third party. This result agrees with Cheng (2008) who has urged top management to review the training courses in order to assess progress.

According to the majority of the participants (P1, P3, P4, P5, P6 and P6) the training programme has continued with other employees as a result of the progress of the projects that have been achieved. In this regard, P7 maintained repeatedly *"and* *then follow through with detail training of black belt and green belt levels"* and he repeated *"and then go at green belt train"*, and again he stated *"and then we did a large number of training courses for green belts training"* [P7]. This is highlighted by P3 *"may not be required at the highest level like black belts, but at least green belt training has to be done for more people"* [P3]. Thus, as emphasised by P6, the trained black belt *"will subsequently advise and select the people…to be trained as green belts"* [P6]. Likewise, P4 insisted that *"we have got to train people at a lower level that called green belt in order to understand Six Sigma, and under the guidance of a black belt to start to solve…problems"* [P4]. Actually, the case company has followed this way as outlined by P5 where *"P1 has gone for training and now in turn, trains all other people"* [P5]. Finally, according to P1, *"every green and black belt that has not been allocated to projects is targeted in order to find one for them"* [P1]. These claims are congruent with Buch and Tolentino's (2006) description of engaging people in training programmes. They state that training for black belts typically occurs in groups called waves. Only about 5 per cent of an organisation's employees will become black belts; the rest are typically trained to become green belts.

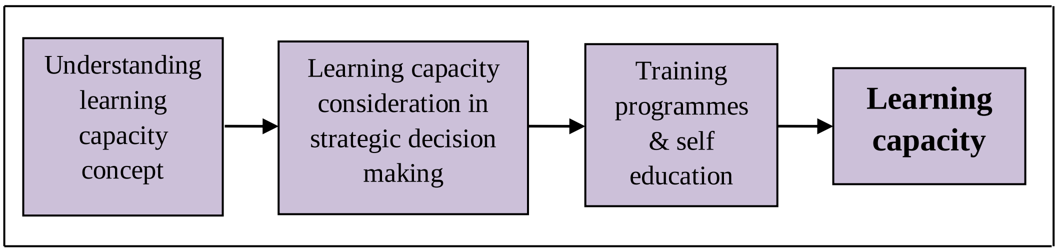
As has been discussed above, two ways have been followed in the case company in order to enlarge peoples' learning capacity. Another way is self-education which is elaborated below.

4.3.2 Self-education

Self-education is another way to enlarge learning capacity in the case company as the minority of the participants (P1 and P7) have claimed. It depends on the motivation of individuals to learn more about the Six Sigma approach. Consequently, a self-educated person more probably does his job in an innovative way, compared to less motivated colleagues. In this context, P1 stated that *"people need to continue their education…I also have other resources that I keep studying from time to time using example and this how I build myself"* [P1]. Furthermore, P7 emphasised *"people could do it in home. They could read the books, they could find some new ideas and they could understand them"* [P7]. Thus, this is an inexpensive option to enlarge peoples' learning capacity that does not cost the company a lot of money. These claims are supported by evidence from literature. In this context, Wiklund and Wiklund (2002) consider increased self-knowledge to be part of the black belt training programme together with themes such as leadership, change management, learning aspects and supervision. In addition, Politis (2005) suggests a number of ways to gain new knowledge that is typically acquired by reading, listening to someone, observing, experiencing events and thinking.

The aforementioned discussion has demonstrated consistency between the evidence from the case study and the literature regarding the answer to sub-theory question TQ 3.1, that is, what sort of programmes, schemes and techniques could be conducted to enlarge learning capacity necessary for the Six Sigma approach? In summary, it could be suggested that there are two main ways for enlarging learning capacity, namely collective training programmes and self-education. In this respect, it could be suggested that conducting training programmes is a crucial approach to educating people about the Six Sigma approach in order to facilitate its implementation. It should be available to all people at different managerial levels in order to reduce the knowledge gaps among them. In addition, since people have varying levels of understanding, responsibilities and qualifications, it could be suggested that different types of training programmes should be designed to suit specific groups. Moreover, several steps could be followed in order to successfully conduct these training programmes. Figure 4 depicts the relationship between learning capacity entities.

Figure 4: The relationship between the entities of learning capacity in the case company



In reference to figure 4, there is a simple uni-directional relationship between the entities of learning capacity. It originates from the extent of top management's understanding of this concept towards achieving this factor. Moreover, the former has been considered by P4 as an important entity because *"there will be people against Six Sigma approach. So, it is important that everybody understands what Six Sigma is about, looking at all the causes and not about jumping to conclusions"* [P4]. In addition, it has been considered by P3 as a very important entity because *"when it* *comes to the improvement phase, the person who is doing the process, he really has to be involved. This is the phase where the project manager has to explain or convince him because it is difficult process to going to somebody else area. So, understanding is very important"* [P3]. Thus, it is essential, as P3 expressed, for top management to take this entity into consideration when they make the strategic decision to implement the Six Sigma approach.

Therefore, two ways have been applied in order to enlarge the learning capacity of the case company's people - conducting training programmes and self-education. The former has been considered by P3 as a very important way to enlarge the learning capacity of all concerned employees working at different levels. This is because *"companywide training of Six Sigma will definitely help to pass through that stage"* [P3]. Moreover, it is extremely important, as P4 expressed, because understanding the philosophy of the Six Sigma approach convinces top management to buy into it. There are three types of training programmes that have been conducted in the case company. Introductory courses are one of these types that have been considered as extremely important, as has been mentioned earlier. The belts training programme is another type of training programme. This type has been considered by P7 as essential work. The third type is maths and statistics courses. They have been considered by P3 and P4 as very important courses because employees should understand when a statistical tool is appropriate for application.

As a result of answering the main theory question TQ3 and the sub-theory question TQ3.1 theoretically and empirically, it could be suggested that learning capacity is one of the factors of change organisational environment that influences the success of Six Sigma approach implementation. This could be attributed to the important role of educating people about this approach that encourages them to contribute positively to its programmes and projects. Therefore, this factor eases peoples' reluctance and convinces them to accept the change.

The following section is dedicated to show notes and evidence regarding the fourth change organisational environment, namely IT leveragability and knowledge-sharing capability.

4.4 Section 4: IT leveragability and knowledge-sharing capability

The fourth factor of change organisational environment is IT leveragability and knowledge-sharing capability. Data lies at the core of this factor. All the participants claimed that employees at different managerial levels were aware of the important role of data in decision-making. This importance has been expressed explicitly by some of the participants (P1, P4, P6 and P7) while other participants (P2, P3 and P5) also spoke about this consideration, although less explicitly.

From the first group, P1 considered the data as an important input because *"it leads to the success of the programme"* [P1]. This claim agrees with Savolainen and Haikonen (2007) who contend that as the ultimate goal is the best possible use of existing information in monitoring and decision-making, the development of information systems is needed for supporting continuous improvement structures and for progressive learning. Moreover, P4 considered it as the most important input, because only from analysing the data could an informed solution be developed: *"data collection is the most important aspect of Six Sigma"* [P4]. This claim is congruent with Paul (1999 cited Henderson and Evans, 2000) who maintains that the significance of the data trace back to the Six Sigma approach supports the adoption of data-driven decision-making. According to this process, the right data should be available at the right time.

In addition, P6 considered data as a very important input because *"without collecting data, people may not be able to define the problem"* [P6]. Furthermore as P7 has considered, it is a critical input because data supports the way of pressing problems: *"people have to be very clear that early getting the right data at upfront stage"* [P7]. These claims agree with Antony and Banuelas (2002 cited McAdam et al. 2005) who conclude that literature suggests that Six Sigma is statistically and operationally based on the premise of long-run quantifiable data being available for analysis and the generation of improvements.

From the second group of participants, P3 repeatedly mentioned the role of accurate data in strategic decision-making: *"then come out setup data which is reliable and which is accurate"* and he repeated *"when it comes to measurement itself, we* *found that we have to get accurate data"* [P3]. Likewise, P5 highlighted that people are *"extracting data from various sources"* [P5] in order to make strategic decisions. These claims indicate that the case company employees rely on data in order to make decisions. Thus, these claims clarify that employees at different managerial levels are aware of the importance of data. This result is congruent with evidence from literature. In this context, a large number of authors (Henderson and Evans, 2000; Politis, 2003; de Koning and de Mast, 2006; Savolainen and Haikonen, 2007; McAdam et al. 2005) have asserted that data plays a significant role in the implementation of the Six Sigma approach. They have attributed this significance to the feature of this approach that is data driven or data oriented. Moreover, these authors have emphasised that such data should be ready at the right time to be exploited for monitoring and decision-making.

Moreover, P2 pointed to sharing data outcomes and/or associated knowledge with other company employees: *"if we find that on the shop floor there is a problem has been solved with a particular machine item and particular way of working, the other factory has to look at it, if they can apply it to their machine"* [P2]. This claim agrees with Politis (2005) who contends that organisations can only strive to provide the best environment for encouraging and fostering expert power and credibility and, by extension, knowledge acquisition and knowledge-sharing. Consequently, this creates an orientation within people of this company to rely on data. So, they are listening to the voice of the data. P1 thus described this situation *"now people are asking for the data and what the data is saying"* [P1]. Aforementioned claims show that the input data and output information are available for all, especially those in charge such as engineers and team members. This result is congruent with evidence from literature. In this regard, Kendall and Fulenwider (2000) have insisted that data should be available and accessible for its users such as internal customers and major suppliers. Moreover, it should be ready in a way that simplifies decision-making. Therefore, they claimed that this needs a truly supported collaborative environment to facilitate knowledge-sharing.

The aforementioned discussion has demonstrated consistency between the evidence from the case study and the literature regarding the answer to the fourth theory question TQ4, that is, how does data affect the implementation of Six Sigma Approach? Therefore, it could be suggested that since one of the features of the Six Sigma approach is being data driven and data oriented, data plays an important role in the implementation of this approach. This could be shown in the decision-making processes that rely more on data than intuition. Therefore, it should be available and accessible to all employees in positions of responsibility.

As a result of greater employee dependence on information than on experience in order to make decisions, the aim of this factor of change organisational environment is to make sense of data, and how, according to P1, *"to transform the data into useful information"* [P1]. Therefore, the case company has leveraged its IT system in order to provide its people with useful information at the right time and place. The following is a brief description of this system.

4.4.1 The way the case company saves and manipulates data

The data are mainly saved and manipulated automatically in this company. For this purpose, a main IT system has been established and loaded with software that facilitates connection to other terminals. For instance, as outlined by P1, one of these terminals is the black belts' laptops that have been loaded with statistical software. Moreover, the IT system facilitates communication between employees via the local intranet. In this regard, P2 described the way of doing Six Sigma. He mentioned long-distance communication with the trainer: *"we are doing this through Motorola Dubai and because of modern electronic e-mail systems…we have sent documents backward and forward"* [P2]. Similarly, P5 maintained *"sometimes if there is something where it doesn't need a meeting, then we can communicate through e-mail"* [P5].

Furthermore, P3 described another data collection technology. This technology has been used in order to obtain accurate measurement data. He has attributed this to the factors that *"are effecting the measurement and certainty people have to find out that, and invest on machinery equipment which helps avoid all the uncertainty parameters"* [P3]. Therefore, the case company has invested *"in good machine equipment. Once this machine process is under control then all these results in a platform where easy to analyse. So within the company, we had quality database with all the results done and then…exported into mini tap to analyse"* [P3].

Thus, P3 has emphasised that a *"Six Sigma company should have some sort of analysis software which is easy…to use"* [P3]. Accordingly, the input data and the output information are generally available for all company employees *"the problems* *are occurring now and people are asking for the data*" [P1]. In addition, both data and information are more specifically available for the people in charge such as engineers and team members. In this regard, P6 has described the situation within the team: *"this is Six Sigma project, it will look at data"* [P6]. Similarly, P7 has maintained that *"the team did very simple green belt team but very effective that pulled out the data"* [P7].

The aforementioned claims indicate that data is managed in two main ways. One of these ways is to establish an effective IT system and another is to use measurement equipment provided with computerised memories for storage of all the necessary data for the completion of the measurement stage. These data should be ready for use in advanced stages. In addition, they highlight the way that the IT system has facilitated communication within the case company as well as with other parties such as Motorola University. This result is supported by evidence from literature. In this context, several authors (Henderson and Evans, 2000; Jacques, 1996; Srinidhi, 1998; Kendall and Fulenwider, 2000; Tannock et al. 2007) have asserted that the main aim of the IT system in an organisation is to effectively store, manage and analyse a huge amount of data, which is a result of hundreds of a complex and high variety of processes and thousands of quality characteristics (Tannock et al. 2007). These data are transformed by this system to useful information that could be used by the decision-makers at different managerial levels. Therefore, in order to construct an integrated and effective IT system, according to the above mentioned authors, it should be featured with connectivity and flexibility. Moreover, it should be structured to sustain the benefits realised from the Six Sigma approach (Kendall and Fulenwider, 2000).

As a result of gathering the important data from different manufacturing processes and manipulating them through an effective IT system, the available information is the material needed to be shared within an organisation (Henderson and Evans, 2000). However, in order to achieve the aim of sharing information throughout the organisation, there are several steps that are applied in the case company. The following is a demonstration of these steps.

4.4.2 Steps for achieving the aim of IT leveragability and knowledge-sharing capability in the case company

As has been mentioned earlier, the aim of this factor in this company is to make sense of data by transforming it into useful information, in order to be exploited by all company employees when making decisions. Thus, this company has applied a number of steps that help in meeting this aim. One of these steps, according to the minority of the participants (P1, P4 and P6), is building the statistical infrastructure in order to help people choose the right statistical tool to make sense of data through training programmes. In this context, P1 claimed that as a result of understanding the statistical tools *"it was easy for us to relate these tools to the data and make sense out of it. So, we actually appreciate the role of statistics"* [P1].

Consequently P4 emphasised that *"people learn to use the right tool for the right problem"* [P4]. In addition, he has clarified that *"data collection is extremely more difficult to achieve than people would expect and so they need to try and keep it simple and focussed on what they want to collect, and don't go round collecting things that are not necessary"* [P4]. Likewise, P6 explained that *"people do not need to be an expert mathematical statistician because whatever they are doing...there are software packages available that will take the data and give them whatever the statistical research from that So, there are certain statistical packages that....they have to learn"* [P6].

These claims emphasise that statistics facilitate problem-solving in the case company because everyone knows how to choose the right statistical tools to make sense of the collected data. Therefore, the solution is going to be acceptable to other parties. This result is congruent with evidence from literature. In this context, the main purpose of mastering statistical tools is to choose the right statistical tools to solve the problem in hand. This accords with the purpose of the maths and statistics programmes and the purpose of the learning of the statistical tools that were shown in section 2.1.6.1.2 of the literature review chapter. Thus, understanding the uses of statistical tools is the first step in achieving the aim of IT leveragability and knowledge-sharing capability. This is because, since there is a common understanding of these tools by people in an organisation, there is agreement about their outcomes.

Providing people with proper equipment to facilitate using the statistical software and connecting them with the main IT system has been considered by a minority of the participants (P1 and P3) as another step in achieving the aim of this factor of change organisational environment. In this regard, P3 has emphasised that *"we need to have...accurate machine equipment and good analysis software"* [P3].

These claims highlight that the case company provides people with the proper equipment to facilitate the connection to the IT system. This result agrees with Kendall and Fulenwider (2000) who have emphasised that IT infrastructure should facilitate communication within organisations. Therefore, this infrastructure should be constructed perfectly to fulfil this task. They have pointed to three levels of preparation. The main one is the availability of hardware and network infrastructure which provide black belts and others with the ability to access data, create information from it and use it intelligently.

Moreover, using some particular statistical tools such as experiment design and team-building is another step in achieving the aim of this factor of change organisational environment, as the minority of the participants (P1, P4 and P7) have considered. This company has followed this step in order to help employees share decision-making procedures and bring them to an agreement without big arguments. This is due to *"the analysis phase is working straight forward on data that apply statistical techniques"* P7 has justified. Moreover, according to P4, *"it is not jumping to the solution. People have to go through the practice and go through it methodically to get there"* [P4]. In this context, he provided an example: *"immediately, jump to a conclusion that the amount of overtime being worked is too much. We do not know that, not until we have actually done our investigations, looked at the figures, seen whether the actual outputs of the machine are satisfactory"* [P4]. Thus, in order to bring people to an agreement, as clarified by P4, *"the next phase after this is to brainstorm the solutions. People think up various solutions and then they test them theoretically to begin with them if they look as if they stand up to a theoretical match, then try implementation"* [P4].

P1 provided an example to demonstrate the role of design experiments as a statistical tool to convince people without big arguments or objections: *"we design experiments. I am starting to see the results of experiments, because the tools that were not used earlier but now there is an application for it, and we have seen the benefits of using this. Really beneficial in the sense that it has eliminated arguments because on this particular one that we have recently used we have used design of experiments a full facts… experiments meaning we have considered all the combined processes, different combinations. It has really reduced my stress. And even now we are taking this and we* *are trying to apply it more into our daily routine work. So, these tools are really important. I see it"* [P1]. In the same context, P1 provided an additional example: *"we have used the team building model…the idea behind that tool is that we need different roles in a team. And those roles are important, and the more roles we have… in a team, the higher the probability of success of that team"* [P1].

P1's claim shows that experiment design is an example of analytical statistical tools, used in the case company to facilitate decision-making, because it gives an actual example of the output of the proposed decision. This claim is supported by the claim of Raisinghani et al. (2005) that the output of a well-defined DOE is a mathematical process model that predicts the response of all the output variables for any combination of inputs. The rigorous treatment of a manufacturing process, including process modelling, is integral to Six Sigma methodology. Each factor's significance is quantified using analysis of variance and the resulting model is used not only to optimise the process, but to troubleshoot the process when deviations occur. Furthermore, P1 and P4 have mentioned other analytical statistical tools such as team-building and brainstorming which similarly influence employees to accept the proposed decisions. These claims agree with Kendall and Fulenwider (2000) who have pointed to the third level of the three levels of IT infrastructure, mentioned in the previous step, which is the decision support layer. The aim of this level is to support business initiatives through combining analytical software and knowledge management systems.

Holding monthly meetings for coordination and information exchange is another step in achieving the aim of this factor of change organisational environment. P2 explained *"we have a monthly meeting with P1 who is the company coordinator for Six Sigma. In this meeting we all get together and update what the projects are up to. So, we call both people from Abu Dhabi and Jabel Ali factory and from the administration areas because you got three areas represented, they know what is going on in other places, so the central meeting to coordinate and exchange the information"* [P2]. This claim indicates that the case company encourages people to hold monthly meetings to share experiences and ideas. This result is congruent with McAdam and Evans (2004) who have asserted the role of communication via meetings to share information. Moreover, they have suggested using the right equipment to facilitate this communication, such as notice boards and awareness presentations on computers.

To conclude, the aforementioned discussion has demonstrated consistency between the evidence from both the case study and the literature regarding the answer to sub-theory question TQ4.1. This question is: What is the role of IT in data gathering and decision-making to facilitate Six Sigma implementation? Thus, it could be suggested that since the Six Sigma approach is considered as a data driven or data oriented approach, decision-making relies more on data than intuition. Moreover, since the process of gathering and managing data is a complex and difficult task, IT systems play an important role in performing this task and contributing to knowledge-sharing capability. Thus, in order to achieve this aim, several steps could be followed. These steps include understanding the uses of statistical tools, facilitating connection to the IT system, providing people with the right equipment, using some particular statistical tools and holding monthly coordination meetings. Figure 5 presents the relationship between the entities of this factor of change organisational environment.

Figure 5: The relationship between the entities of IT leveragability & knowledge-sharing capability in the case company

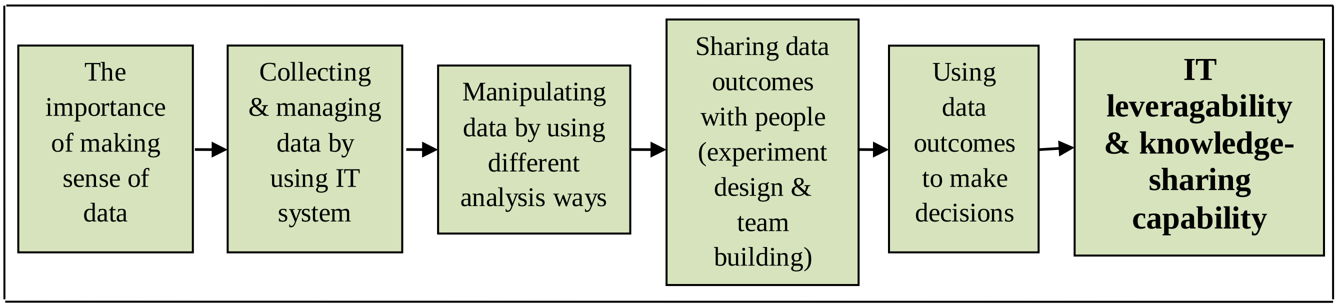


Figure 5 outlines that there is a simple uni-directional relationship between the entities of this factor. It leads from realising the importance of making sense out of data by transforming it into useful information. Then, it leads to going through the process of collecting, managing and manipulating data by using different statistical software provided by the IT system and digital measurement machines. Consequently, these entities of the factor are fulfilled.

As a result of answering the main theory question TQ4 and the sub-theory question TQ4.1 theoretically and empirically, it could be suggested that IT leveragability and knowledge-sharing capability is one of the factors of change organisational environment that influences the success of Six Sigma approach implementation. This could be attributed to the feature of this approach being data driven or data oriented. This means the process of decision-making relies on facts that are supported by data. Therefore, data collection, management and analysis are important tasks facilitated by establishing an effective IT system. This effectiveness could be measured by providing the required data at the right time. The existence of such an IT system helps information to be shared through applying several steps as discussed above. Following this elaboration, the next section shows notes and evidence regarding the fifth change organisational environment, namely network relationship balancing.

4.5 Section 5: Network relationship balancing

Network relationship balancing is the fifth and final factor of change organisational environment. The importance of this factor has risen from the values and beliefs of top management in the case company. As was mentioned earlier, top management believe that improvement takes place in a transparent organisational environment by linking the achievements of all branches and departments of this company to the bottom line. These values and beliefs, as all the participants claimed, have led to balanced network relationships among employees working in different departments. In this context, P1 maintained *"I think now more and more, realising the link between the different departments that what one department does, affects the others. So…now we are thinking in terms of system thinking not every department in isolation……it will be every action, which somebody is taking, linked to the bottom line of the organisation or it will affect the organisation somehow, no matter where individuals are in the organisation"* [P1]. Moreover, P2 provided an example for this linkage between departments: *"because we are running the company with Jeble Ali as the central of the operation and Abu Dhabi factory essentially a lean satellite. Some of the overall approaches as we spot this in the system, there is an improvement in the system then it is automatically have to the other side"* [P2].

Similarly, P3 has explained *"in an organisation has multi-sites like us, now we have different sites but we do not have Six Sigma, which is separately running. We have one representative who is heading Six Sigma, within the company and then he is aware about what others are doing, and it is done through one umbrella"* [P3]. These claims highlight that the network relationship is balanced in the case company. This is because of the vital role that has been played by the top management to create a cooperative environment. The real motivation for playing this role is attributed to top management's values and beliefs. According to the participants' claims, the top management believe that improvement takes place in a transparent and integral organisational environment. This transparency encourages people to be clear about the organisation's vision and objectives. Therefore, every individual in the organisation knows that there is no hidden agenda so they have a clear idea about their situation in the organisation. This result agrees with evidence from literature. The literature has attributed conflicts and stress within an organisation to two main sources. Conflicts may be created by process owners, especially if they operate in isolation from each other or because of political and 'turf' issues (Byrne,2003).

Moreover, Sinclair and Collins (1994) have pointed to the jealousy that could be expected from managers in the event of any incursions into their decision-making role. However, since the Six Sigma approach is characterised, as has been discussed in section 2.1.5 of the second chapter, by its democratic environment and integration of human with process elements, the process improvement should be created through inter-functional relationships between individuals in different departments (Kotter,1995). Thus, conflicts are expected in this type of environment because of employees' involvement. Therefore, top management should play a vital role to mediate conflicts and other sources of stress between different process owners, or between business units or operating divisions of an organisation (Byrne,2003)

The network relationship balancing has some aspects in this company. The following part discusses these aspects.

4.5.1 Aspects of network relationship balancing in the case company

According to all participants, the entire company is managed by the same system. They have considered it as an essential aspect of this factor of change organisational environment. This is because, according to them, it ensures doing tasks throughout the company in the same way, which leads to balanced network relationships amongst company employees working in different departments. In this regard, P1 reported that *"we are developing more than one factory- one in Abu Dhabi and one here. We want to have the same system…Six Sigma approach is the way to do that"* [P1]. With this in mind, P5 stated that *"Six Sigma approach becomes a part of the system"* [P5]. Moreover, P4 emphasised that *"we first of all have to find out if people are all using the same system"* [P4]. This is because, as P7 observed, *"it gives me as a senior manager, a very useful reference point to try to get people to think in a structured way"* [P7].

Moreover, according to this system, tasks are deployed between employees working at different managerial levels. P4 thus confirmed *"as the total commitment and setting the correct objectives from the top, at the bottom level you have got to employ all the people who have an interest in that area"* [P4]. Thus, *"the executive* *managers set the policy, set the strategy but the method of achieving it is always down at the bottom layer"* [P4]. Likewise, P6 asserted that *"you must know which others' boundaries are"* [P6].

These claims indicate that the case company works according to the same management system (i.e. the Six Sigma approach) and becomes a part of this system. According to this system, top management set policy, whilst tasks are deployed between people at different managerial levels. This result is supported by evidence from literature. In this context, by reviewing underlying sections of the previous and current chapters, it is again noted that Six Sigma is a rigorous and structured approach. This is created from a highly disciplined approach (Byrne, 2003; Pandey, 2007; Wiklund and Wiklund, 2002). In this respect, the DMAIC improvement cycle plays an important role in encouraging individuals at different managerial levels to apply the same system to improve processes (Goh and Xie, 2004; Bañuelas and Antony, 2002; Kuei and Madu, 2003; Antony and Bañuelas, 2002; Folaron et al. 2003; Schroeder et al. 2008; McAdam and Evans, 2004; Tannock et al. 2007; de Koning and de Mast, 2006; Sekhar and Mahanti, 2006; Brewer and Bagranoff, 2004; Ehie and Sheu, 2005; Linderman et al. 2003; Savolainen and Haikonen, 2007; Cheng, 2008). Thus, the Six Sigma approach is considered as part of an organisational system. This is because Six Sigma is a top-down approach (Goh and Xie, 2004; Antony and Bañuelas, 2002; Buch and Tolentino, 2006). This kind of structure creates network relationship balancing within the case company.

In addition, people involvement in decision-making is another aspect of this factor of change organisational environment, where P5 stated *"when we do the study, we involve the people because they are asking what you are doing. And we make them understand and we commit on progress and in each stage what we are doing, what is the result, what are our findings and we tell them and like that they are involved"* [P5]. For this purpose, *"periodical meetings are held…when it comes to the action plan, we call them in a meeting and tell them this is what we want to do, and sometimes where it does not need a meeting then we can communicate through e-mail. So, we can go ahead."* [P5]. These claims highlight that the top management of the case company encourage people to be involved in improvement processes via several ways such as periodic meetings and/or electronically by e-mails. This result is congruent with evidence from literature. In this regards, several authors (Abdullah et al. 2002, p. 16 cited Politis,2005) have attributed the necessity of people involvement in decision-making processes to the tacit knowledge that is in people's memory. Moreover, others (Sinclair and Collins, 1994) have emphasised the role played by employees in achieving organisational success, since employees provide the service and deal with problems. Thus, people at different managerial levels have an important role in the decision-making process. Moreover, there is a vital role for top management to involve people in this process.

Furthermore, one of the aspects of network relationship balancing in this company is that individuals are assisting and training each other. In this context, P7 has provided an example: *"some good black belts who are good at training could train green belts"* [P7]. P6 also provided an example "*when an individual has a lunch break at that time, another individual from another machine comes and stands there and watches that this going okay"* [P6]. Thus, in order to facilitate this cooperation as P6 has highlighted, all departmental heads sign cooperation agreements: *"when an individual is needed for a Six Sigma project and his manager does not sign the cooperation agreement for different uncompleted stages. So, it is the project manager's job to run the project and he has to go to the manager or team member and get them to sign the agreement. However, he may have to negotiate. Then, the project manger has to use his negation skills to get him to sign"* [P6].

These claims show that there is a cooperative relationship between employees in the case company. This relationship is organised by signing agreements between managers in order to organise the assistance and temporary replacement of people in cases of emergency. Evidence from literature supports this result. In this context, as has been mentioned earlier in section 2.1.6.2, one of the responsibilities of the higher level belts is to mentor and train the lower belts (Henderson and Evans, 2000). This responsibility includes teaching them statistical and other problem-solving tools (Wiklund and Wiklund,2002). Thus, Byrne (2003) has considered training sessions as an appropriate opportunity to develop bonds and build group morale.

In order to facilitate this cooperation, communication within this company has two features. The following part discusses these features.

4.5.2 Features of communication within the case company

Communication within this company, according to all the participants, is characterised by open and honest interactions where employees from different departments and branches contact each other freely regarding their projects. This result agrees with evidence from literature. In this regard, Ulrich et al. (2002 cited Schroeder et al. 2008) claim that structural exploration helps Six Sigma teams to be open and flexible regarding new and different perspectives. This is because communication challenges can occur between diverse organisational members who may have different interpretative schemes that can obstruct understanding (Dougherty, 1992 cited Schroeder et al. 2008). Therefore, in order to achieve this freedom and honesty, many means have been adopted.

In this context and as has been mentioned earlier, many of the participants have pointed to the coordination meetings such as *"black belt meetings"* [P1, P2] and *"periodical meetings"* [P5]. In addition, P4 has mentioned some tools that have been exploited and which need enough transparency and openness among people in different departments. P4 cites tools such as *"brainstorming and team working are exploited in order to…think up possible solutions of problems and then testing out these theories"* [P4]. This claim is congruent with Pandey (2007) who claims that on the basis of the findings of these techniques, brainstorming sessions were conducted within the team. Fishbone analysis was conducted to understand the cause and effect relationship of the defect in the process.

Moreover, P3 pointed to the transparency of communicating Six Sigma projects to people who are involved in them and P7 has stated that *"everyone understands there is an issue"* [P7]. These claims agree with Bañuelas and Antony (2002) who maintain that after implementation of Six Sigma projects, it is best to publish results. These should not be restricted to success stories but also admit to and communicate setbacks. This will help other projects in the pipeline to avoid the same mistakes and learn from them. Also, P6 drew attention to a simple communication channel: *"they can of course go and ask for advice from the black belt about how to use it"* [P6]. This claim agrees with Schroeder et al. (2008) who contend that in Six Sigma, the black belt serves as a heavyweight project manager who reports to senior management. This structure promotes boundary-spanning activities that help employees understand and solve problems that feature in cross-functional domains. Moreover, P5 gave an example of the friendly atmosphere in discussions amongst employees during meetings: *"people will give in their ideas and we will take all the peoples' feedback and ideas. Then we come to an agreement"* [P5]. This is all happening with the aid of an IT system that is facilitating communication between people and includes providing managers with the right equipment to connect them with the main system.

From the aforementioned elaboration and according to the minority of participants (P1, P3 and P6), the communication channels that link people in different departments and branches of this company are interactive and cross-functional. In this regard, P1 contended that *"black belts are coming from different areas"* [P1]. Likewise, P3 stated *"it is always the best way to choose the team members from the relative departments where this overall project will pass through"* [P3]. This claim agrees with Knowles et al. (2004) who contend that cross-functional and multi-level representation in teams leads to faster progress and smoother changes in working practices. Furthermore, Manev and Stevenson (2001 cited Schroeder et al. 2008) who maintain that communication can also facilitate exploration and boundary-spanning activities.

Moreover, P6 elaborated that *"there are some problems which may require a number of interactions between different departments, especially when you cannot identify what one department or one manager is responsible for that particular process. There are many interventions between the departments then you may need to solve the problem permanently via the use the Six Sigma techniques"* [P6]. This claim is congruent with Daft (2001 cited Schroeder et al. 2008) who claims that boundary-spanning roles can help break down barriers that get in the way of understanding problems. In addition, research indicates that individuals who are strongly linked to external and internal environments are more effective at boundary spanning (Druskat and Wheeler, 2003; Tushman and Scanlan, 1981 cited Schroeder et al. 2008).

Thus, in order to achieve network relationship balancing, P3 has stated that *"the company identify common procedures according to Six Sigma"* [P3]. The following part is a demonstration of these procedures.

4.5.3 Two procedures to perform network relationship balancing in the case company

There are two procedures that have been applied in this company which are considered as major procedures to achieve this factor of change organisational environment; namely forming teams and integrating the actions of different departments.

4.5.3.1 Forming teamwork

The first major procedure, according to all the participants, is gathering employees from different departments and branches to form teams such as the black belts team that has been mentioned by P1. The aim of teamwork includes fostering an organisational atmosphere for people to share and discuss ideas in order to solve problems and improve products. P5 stated that *"the team is formed to come up with a solution to increase the production"* [P5] and P2 clarified that *"it is only the really big projects, when we go to the efforts of putting…the project charters together and then resource teams according it"* [P2]. Likewise, P7 has emphasised *"when there is a major issue, which we talk about in many meetings, we set up a Six Sigma team on that. It should be a real business issue and is structured enough to require the team to solve it"* [P7]. This is because, as P7 justified, *"when data is collected, the company needs somebody who says 'what about that data as well as what about comparing this data with that data?' And that is the power of the team"* [P7]. Thus according to P3, *"the company identifies the team, and everybody who understands the same problem, is included"* [P3]. These claims agree with evidence from literature. In this regard, Byrne (2003) claims that no one person, not even a powerful CEO, can successfully launch and sustain a Six Sigma initiative alone. It requires a significant amount of teamwork among many people at all levels in the organisation. In addition, Cheng (2008) describes Six Sigma as intra-organisation of cross-function teamwork.

P6 asserted that *"the team should be composed of at least one black belt who should be there with the team. He may be the lead person in the team"* [P6]. This claim agrees with Wiklund and Wiklund, (2002) who contend that implementation is the responsibility of project team members. They receive green belt training from the master black belts or the black belts. Similarly, P4 suggested that *"in order to define a project we have to put a team together. So, we identify the people, this is known as the 'processes owners', or 'stakeholders'"* [P4]. In this regard he provided an example: *"if* *we are looking to improve in a machine and the process, we need to get on board the operators from that machine; we need the manufacturing engineers, the supervisors, to buy into this, so all the people who have a stake in it, must buy into it"* [P4]. He has attributed this choice to avoid conflicts: *"If somebody has an interest in the problem, and we leave them out of the team, then they will work against the problem"* [P4]. These claims agree with Schroeder et al. (2008) who state that an improvement team was formed, consisting of employees who had substantial knowledge of the process. The team leader was a full-time black belt specialist. The black belt usually reported to the team's sponsor, the champion, a member of senior management trained in Six Sigma basics. The champion provided a holistic view of the organisation, helped establish project buy-in, and ensured the availability of critical resources to the team.

Likewise, P3 justified *"we can do a lot of analysis and suggestions of improvements, but the implementation phase needs the process owner, because we go down further. For example, I can measure a production process without knowledge of the operator. I can do the measurement phase because he is not greatly involved, he is producing. But when comes to the improve phase, the person who is doing the process should really get in involved"* [P3]. This claim is congruent with Schroeder et al. (2008) who claim that DMAIC also involves different organisational members at different steps in the process. Champions play an active role in the define step but a supporting role in the remaining steps. On the other hand, process owners take a much more active role in the control step but a supporting role in the other steps. Green belts tend to take a more active role in the measure, analyse, and improve steps. Finally, black belts serve as project leaders and are active in all steps of the process.

Similarly, P7 claimed *"we do the definition phase. This is the issue we got, now we need a team for these reasons"* [P7] and he emphasised that *"the team work helps senior management to bridge between and to get the operators involved as well as the engineers and managers. This gives them a high profile into the senior management team"* [P7]. Therefore according to P6, *"since the whole team is acting on it, they are more likely to show responsibility"* [P6]. These claims are congruent with Pandey (2007) who claims that the Six Sigma team, with the use of improvement tools, implemented the desired changes and deployed the control mechanism to make the changes sustainable. All team members should have a common approach to management of the project. Each team member should be provided with a clear definition of the project, project scope and deliverables and his or her role.

Thus, P3 emphasised *that "it is very important to form the team from the process owner to the team leader to the team members of the process and include the people who are in the team"* [P3]. This is because each member plays his role in the team. For example P3 stated that *"the company needs to have...project owners…and sponsors. Generally, the sponsor will be the person who has got an interest in the results. He should be a top management representative who really wants that to be done. So he will give all the blessings to the team saying that 'yes I am behind you and I am sponsoring this because I know that it is going to be a good result [of benefit] to the company'. So, a process sponsor and a process owner if you run a project without the knowledge of the process owner, then he will also not cooperate. A person who is running a process needs to be involved in this otherwise he will not support your team. So, a process owner should be an important element in the team"* [P3].

4.5.3.2 Integrating actions of different departments and branches of the case company

The majority of the participants (P1, P2, P3, P5, P6 and P7) considered integrating actions of different departments and branches in order to achieve the company's objectives as the second major procedure of performing network relationship balancing in this company. In this regard, P1 described it as a critical procedure and justified this whereby *"sometimes you may find a problem in one area that is not being addressed. So, the management should address these issues in a professional manner"* [P1].

In the same context, P6 described this problem where *"some problems may require a number of interactions between different departments"* [P6]. In addition, this problem could be caused by a conflict of interests, where P3 observed that *"we have a process owner who will be the beneficiary of the project. So, everybody in that structure itself has got an interest in the project because he wants to be beneficiary"* [P3]. Thus, P6 suggested Six Sigma techniques to be a professional approach in order to solve this problem and P3 argued *"there is no point- I am doing the same project and he is doing the same project in two different ways. So, the benefit of each project has to be shared between the two persons"* [P3].

In the same context, P5 gave an example of how the coordination was organised: *"a team was formed to come up with a solution to increase the production. It was done by P1 and the team members. Although P1 is from another department, I got benefit out of that solution. Thus, they did the study for me and they were able to suggest an improvement in interest of production in my particular area"* [P5]. Similarly, P7 maintained that *"when some departments have a problem, the management choose the right people who could contribute in a valid, agreed and incremented solution. And we felt that would have a better chance of being successful, which has proven to be effective"* [P7]. Furthermore, as mentioned earlier P2 gave an example of the integration between different branches of this company in Dubai and Abu Dhabi. These claims indicate that the case company integrates actions of different departments and branches in order to achieve the company's objectives. This helps balancing network relationships amongst individuals working at different managerial levels. This result is supported by evidence from literature. In this regard, Srinidhi (1998) has attributed the conflicts among departmental managers to the lack of the coordination efforts during process improvements. Moreover, Schroeder et al. (2008) has emphasised the importance of integrating improvement projects, since the Six Sigma approach encourages various mechanisms to help achieve multilevel integration such as strategic project selection and leadership engagement.

To conclude, the aforementioned discussion has demonstrated consistency between the evidence from both the case study and the literature regarding the theoretical and empirical answer to theory question TQ5. This question is: how could network relationships be balanced? Therefore, it could be suggested that network relationship balancing is one of the factors of change organisational environment that affect the success of Six Sigma approach implementation. As the Six Sigma approach encourages inter-functional relationships between individuals of different departments in order to improve processes, conflicts could be associated with these types of relationships. These conflicts could be created as a result of process owners or managers feeling threatened by political and 'turf' issues. Thus, top management should play a vital role to ease these conflicts and mediate stress between different parties in order to balance network relationships. According to the aforementioned discussion, there are three aspects of balanced network relationships. First, the entire company is managed by the same system. Second, people working at different managerial levels are involved in decision-making processes. Third, individuals assist and train each other. Moreover, in order to facilitate network relationship balancing, communication channels should be open, interactive and cross-functional in order to facilitate common understanding and promote new and different perspectives amongst diverse departments within an organisation. In addition, in order to attain this factor of change organisational environment, two main procedures could be applied. One procedure is to form teams. Another is to integrate the actions of different departments and branches. Figure 6 illustrates the relationship between the entities of network relationship balancing.

Figure 6: The relationship between the entities of network relationship balancing in the case company

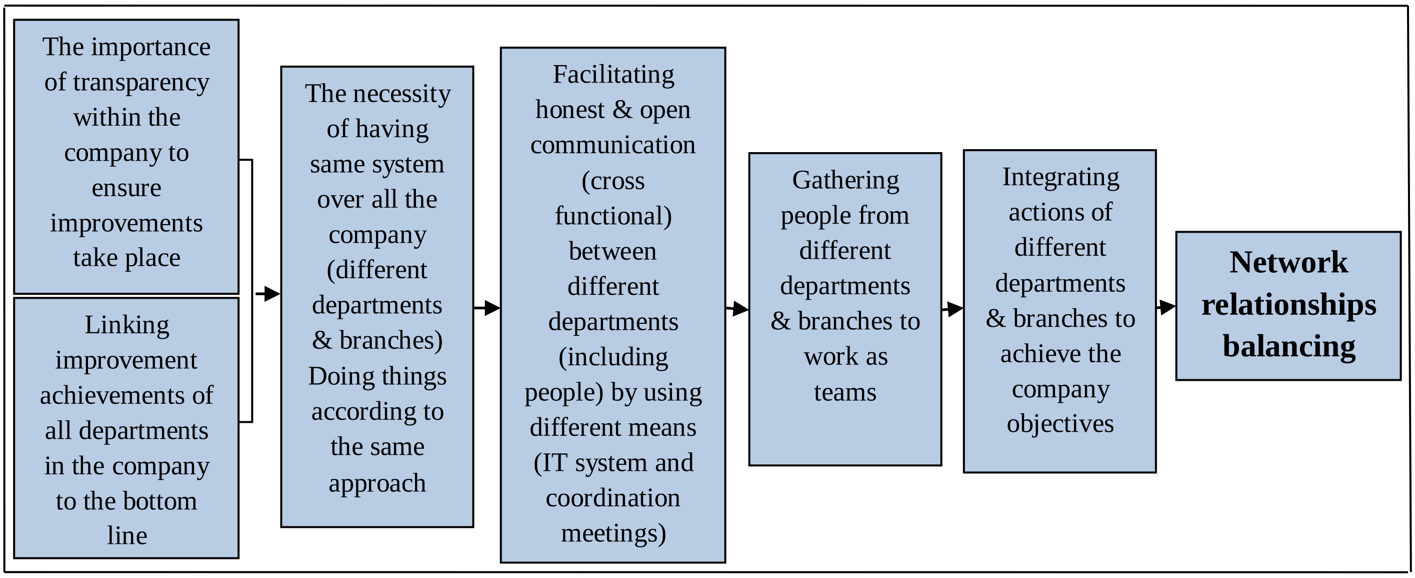


Figure 6 illustrates that there is a uni-directional relationship between the entities of this factor of change organisational environment. The direction of this relationship begins with the impact of two values and beliefs. One of these values and beliefs is transparency within the case company in order to make improvements. Another is linking achievements to the company's bottom line. From these values and beliefs, there is a need to have the same system in this company. Thus, in order to perform this factor, some procedures need to be followed. These procedures include gathering people from different departments in order to work as teams and integrating the actions of these departments to achieve objectives.

Comprehensive overview

This comprehensive overview has been conducted in order to look at the impact of each of the factors of change organisational environment upon others. For this purpose, figure 7 illustrates the relationship between these factors. By exploring this figure, there are many indicators that show this relationship.

Figure 7: Theoretical framework of the factors of Change organisational environment within the BPC management theoretical framework in the context of Six Sigma approach in the case company

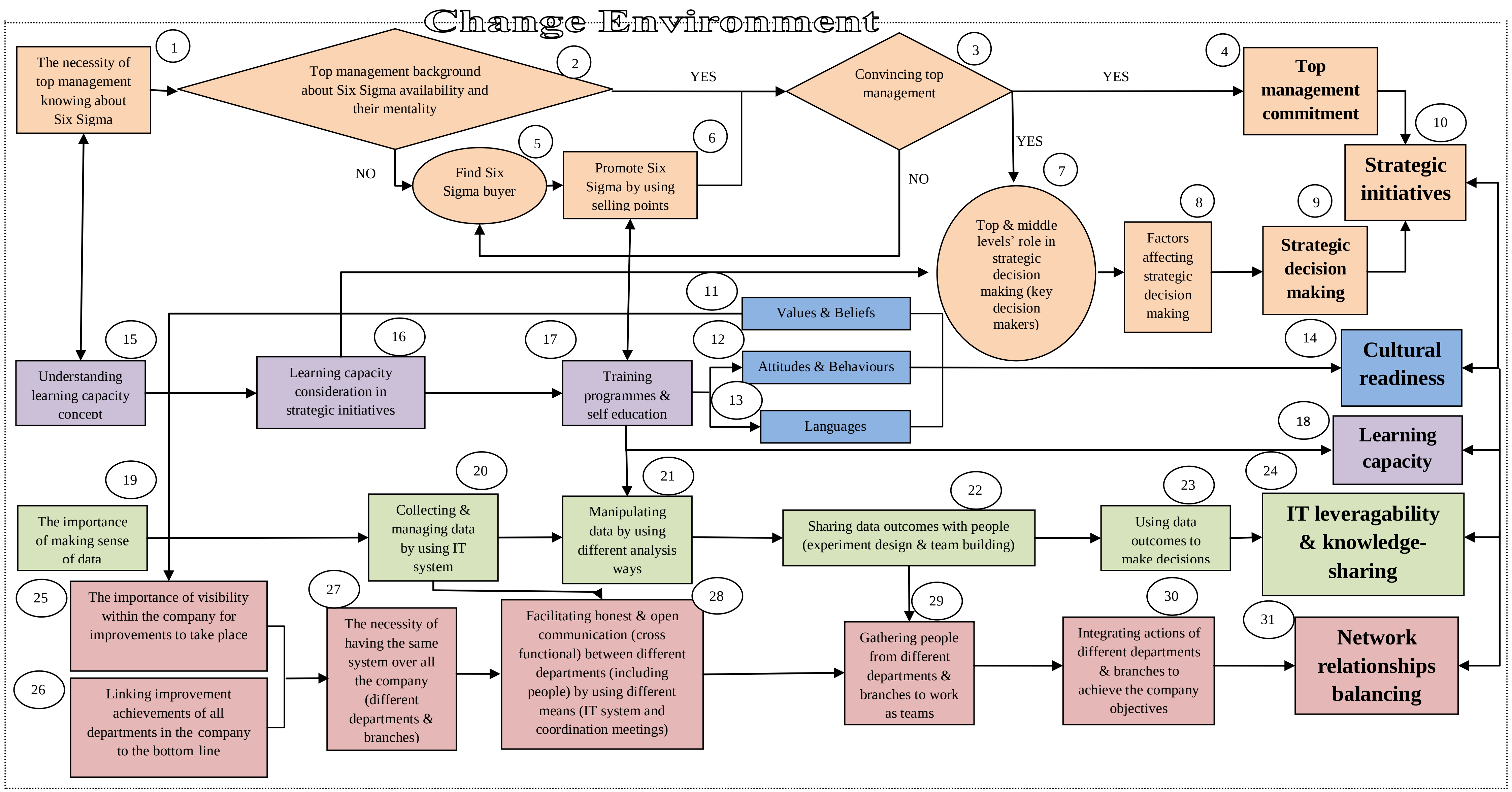


Figure 7 shows the five factors of change organisational environment at the far right hand of this figure whilst the other nodes are the required entities to attain these five factors. Accordingly, the nodes from 1 to 9 are the required entities to attain the first factor of change organisational environment node 10 (strategic initiative). These nodes show that this factor in the case company is composed of two components. These components are top management commitment (node 4) and strategic decision-making (node 9). The former, as has been elaborated earlier, is considered as the most important component that affects the success of the implementation of the Six Sigma approach. Furthermore, it has been claimed that no improvement scheme continues without the support of top management. This commitment has several aspects that have been shown in sections 4.3.1.1.3. However, in order to attain this entity, top management should be convinced (node 3). Top management persuasion is easier if they have sufficient background knowledge of the Six Sigma approach (node 2). Thus, this factor is stimulated by the extent of top management's knowledge about this approach (node 1). Consequently, in case of a lack of knowledge, a buyer from top management should be found in order to initiate this approach (node 5). Finding a buyer could be achieved through a number of selling points (node 6) that have been discussed in sections 4.3.1.1.2.

In addition, after embarking on Six Sigma, the approach needs strategic decisions to be made by top management. The process of making these decisions (node 9) is the second component of the first factor of change organisational environment. Several factors that have been shown in section 4.1.2. 1 affect these strategic decisions (node 8). Thus, these factors should be taken into consideration when these decisions are made. Moreover, as the Six Sigma approach is characterised by people's involvement, the managers at different levels are involved in the process of strategic decision-making (node 7).

Moreover, nodes 11 to 13 are the required components of the second factor of change organisational environment, namely node 14 (cultural readiness). Since Six Sigma is distinguished by its rigorous discipline, the features of its culture that have been shown in section 4.2.1 reflect this nature. Furthermore, Six Sigma culture has a number of components, namely values, beliefs, attitudes, behaviours and languages. For the purpose of the demonstration of this study, these components have been classified in three categories that have been shown in section 4.2.2. Values and beliefs are represented by the first category (node 11). Attitudes and behaviours represent another category (node 12) and language (node 13) a third category. As has been discussed earlier, some of the values and beliefs stimulate the attainment of other factors. Furthermore, the components of Six Sigma culture are influenced by entities of other factors such as training programmes within learning capacity.

In addition, nodes 15 to 17 are the required entities of attaining the third factor of change organisational environment node 18 (learning capacity). This factor is stimulated by the extent of top management's understanding of this concept (node 15). Thus, the incentive of this factor is similar to one of the first factors highlighted earlier. This motivation attributes the bi-directional relationship between these entities. Therefore, as the majority of top management understand this concept and its importance to facilitate the implementation of the Six Sigma approach, they are going to enlarge people's leaning capacity from the outset. Thus, they are going to take it into consideration during the process of decision-making regarding the execution of this approach (node 16). The earlier this step is performed, the sooner the sharing of responsibility for strategic decisions will be enhanced between top and middle management. Thus, performing this step also interprets the relationship between this factor and the first factor of change organisational environment.

According to this study, self-education and training programmes are two ways of enlarging learning capacity and knowledge acquisition (node 17). In addition to the important role of conducting training programmes to promote Six Sigma within top management and find a buyer to support the implementation, it plays an important role in teaching people about Six Sigma principles and techniques to help them cope with its requirements. Thus, since the Six Sigma approach has an extraordinary nature, the training programmes as discussed in section 4.3.1.1 are designed to match this nature and are conducted through several steps as shown in section 4.3.1.2. The role of conducting training programmes shows the bi-directional relationship between this factor and the first and fourth factors of change organisational environment. Moreover, conducting training programmes has an important role in modifying attitudes, behaviours and languages in order to agree with Six Sigma culture. This influence shows the relationship between this factor and the third factor of change organisational environment.

Furthermore, the nodes 19 to 23 are the required entities of attaining the fourth factor of change organisational environment node 24 (IT leveragability and knowledge-sharing capability). This factor is motivated by top management's recognition that the Six Sigma approach is directed by data (node 19). Thus, decision-making relies more on fact than intuition. Accordingly, as decision-makers need to manage a huge amount of data, the need to collect and manage data by exploiting IT systems has been enhanced (node 20). In order to fulfil this task, there are several methods available for data collection and analysis. Thus, there is a need to understand the aim of each analysis in order to choose the right way for the right data (node 21). In this respect, there are several software programmes that facilitate this task. However, in order to understand these ways to analysis and the software that is related to them, decision-makers should attend training programmes that explain the usage of these ways and the software programmes involved. This step shows the relationship between this factor and the third factor of change organisational environment. Moreover, as a result of the existence of a vital IT system as has been shown in section 4.4.1, knowledge could be shared amongst decision-makers within an organisation by applying several steps that have been shown in section 4.4.2 (nodes 22 and 23).

In addition, nodes 25 to 30 are the required entities of the fifth factor of change organisational environment node 31 (network relationship balancing). This factor is stimulated by two incentives that are raised from the values and beliefs of top management. These incentives, as has been mentioned earlier, are the recognition of the role of transparency within an organisation in order for improvements to take place (node 25) and linking the achievements of all departments in an organisation to the bottom line (node 26). This motivation attributes the relationship between this factor and the second factor of change organisational environment. Moreover, applying the same system within the entire organisation (node 27), is one of several aspects of network relationship balancing that has been highlighted in section 4.5.1. Furthermore, in order to enhance network relationship balancing, communication within an organisation should be free, open and honest (node 28). Besides the aforementioned requirement, two procedures could assist an organisation in performing network relationship balancing, namely forming teams from different departments and branches in an organisation (node 29) and integrating their actions (node 30).

Figure 7 also depicts the relationship between the change organisational environment factors. Firstly, it shows that values and beliefs (node 11) of top management and individuals at different managerial levels are the inspiration of other factors. For instance, the importance of transparency within the company to make improvements takes place (node 25) and leads to balanced network relationships (node 14).

Secondly, training programmes (node 17) have very important roles in many factors. They have a role in promoting the Six Sigma approach and in finding buyers. In order to find buyers (node 6), top management need to be convinced and consequently offer their commitment and vice versa. Moreover, they have a role in changing people’s attitudes, behaviours and languages (nodes 12 and 13). In addition, training programmes are important means to teach people about statistical tools and data manipulation (node 21). This role is important to attain IT leveragability and knowledge-sharing capability (node 24).

Thirdly, there is a vital relationship between the need for top management to know about the Six Sigma approach (node 1) and understanding the concept of learning capacity (node 15). Fourthly, the role of top and middle management levels in the process of making strategic decisions (node 7) is under the influence of learning capacity consideration in strategic initiatives (node 16). Clearly, without this influence, top management will not involve middle management in decision-making.

Fifthly, there is a bi-directional relationship between collecting and managing data by using IT systems (node 20) and facilitating honest and open cross-functional communication between different departments via different channels (IT system and coordination meeting) (node 28). Obviously, this relationship occurs because honest and open communication helps to collect and manage data from different departments and people, freely and easily, and vice versa. Sixthly, the same relationship is between sharing data outcomes to make decisions (node 22) and gathering people from different departments and branches to work as teams (node 29) and vice versa. Finally, using data outcomes to make decisions (node 23) is an important factor for those who affect strategic decision-making (node 8). For this reason, there is a bi-directional relationship between these entities.

According to the aforementioned discussion, this figure has suggested that there are bi-directional relationships between the factors of change organisational environment of Ducab. In addition, it could be claimed that the success of the implementation of the Six Sigma approach in Ducab could be interpreted by exploiting the factors of change organisation environment within the BPC management theoretical framework. This interpretation begins with the macro level and moves toward the micro level of these factors.

Overall, there is strong evidence that the theory questions (1-5) have been answered. Consequently, the central research question is answered. This means that the exploitation of the factors of change organisational environment that are included within BPC management theoretical framework in the context of the Six Sigma approach is useful to interpret the success of the implementation of this approach at Ducab in the UAE. Therefore, it could be claimed that the third research proposition is verified. These theory questions have been explored in depth through moving from macro to micro levels of each factor of change organisational environment in order to answer successive questions of how and why these factors affect the success of the implementation of Six Sigma approach at Ducab. Thus, there is strong evidence that each factor is composed of a number of entities. These entities are led by requirements and stimulated by necessities. For example, in order to attain the first factor (strategic initiative), top management commitment is required. However, in order to attain this commitment, they should be convinced. In addition, the fifth factor (network relationship balancing) is stimulated by the values of top management regarding transparency within the company and their beliefs regarding sharing the results of all departments and linking them to the bottom line. Accordingly, these requirements and necessities create a web of linkages between the entities of different factors of change organisational environment. These linkages explain the bi-directional relationship between these factors within the theoretical framework. Therefore, it could be claimed that the second proposition is verified.

In addition, there is, according to the aforementioned discussion, strong evidence that attaining or meeting these entities plays an important role in maximising the impact of the factor of change organisational environment on the success of Six Sigma approach implementation. In this respect, the commitment of top management as one of the entities of the first factor of change organisational environment (strategic initiatives) has an important role to maximise the impact of this factor on the success of the implementation, since it has been claimed that no initiative could succeed without this commitment. Moreover, the readiness of top management's mentality as one of the entities of the second factor of change organisational environment (cultural readiness) has an important role to maximise the impact of this factor on the success of the implementation. This is attributed to the needs of this implementation for a flexible mentality that could manage the associated resistance to change. In addition, conducting training programmes as one of the entities of the third factor of change organisational environment (learning capacity) has an important role to maximise the impact of this factor on the success of the implementation of the Six Sigma approach. This is because these training programmes are the way of enlarging the learning capacity of employees working at different managerial levels in order to buy-in to the implementation of the Six Sigma approach. Additionally, data collection as one of the entities of the fourth factor of change organisational environment (IT leveragability and knowledge-sharing capability) plays an important role in maximising the impact of this factor on the success of the implementation, since Six Sigma relies heavily on the analysis of data in making strategic decisions. Consequently, as a result of the aforementioned elaboration, it could be claimed that the first proposition is verified.

As a result of the aforementioned discussion the research propositions are verified. Therefore, it could be claimed that the third objective of this study has been fulfilled. Therefore, the theoretical framework that has been presented in Figure 7 could be suggested as a means to explain the way that the factors of change organisational environment affect the success of the implementation of the Six Sigma approach at Ducab in the UAE. This includes the answers of how and why these factors affect this success. Thus, it could be claimed that the gap in other studies is addressed by elaborating the way of attaining these factors. However, since there is a risk of jumping too rapidly to conclusions in trying to understand the relationships between two entities, as Miles and Huberman (1994) have suggested, there are many ways to verify these conclusions. One way is to present and consider evidence from literature via discussing the proposed theoretical framework against other change theories, which will be the focus of the following chapter.

5 Chapter 5: Discussion, contribution to knowledge and research reflections, limitations, implications and future researches

This chapter is initiated in order to discuss the results that are presented in the previous chapter as compared to other organisational change theories. This is in order to discuss the contribution to the knowledge and research reflections. Moreover, this chapter presents the limitation of this research and ends with the direction of future research.

5.1 Discussion

As a result of the previous chapter, the three research propositions are verified. Thus, it could be claimed that:

1: Each change organisational environment factor is composed of entities that are led by requirements and stimulated by necessities. These entities should be either attained or met in order to maximise the impact of the change organisational environment factors on the success of the implementation of the Six Sigma approach.
2: The associated requirements and necessities that represent some of the entities of the change organisational environment factors explain the bi-directional relationship between these factors.
3: The change organisational environmental factors in the BPC management theoretical framework are useful to be exploited to explore the success of the implementation of the Six Sigma approach in the case company Ducab (U.A.E).

Moreover, as a result of verifying these propositions, a resultant theoretical framework is developed. This resultant framework that is shown in Figure 7 addresses the gaps in knowledge. These gaps are identified following the critical review of the BPC management theoretical framework that is conducted the second chapter. In their study, Motwani et al (2004) have not answered a main question. This question is: how and why do the factors of the change organisational environment within the BPC management theoretical framework affect the success of the Six Sigma approach implementation. However, presenting evidence from the literature is one way of verifying the conclusions of the previous chapter through discussing the resultant framework in the light of its theoretical bases and other change theories.

5.1.1 The resultant theoretical framework against its theoretical base

As has been discussed in the third chapter, although the BPC management theoretical framework is applied in this study, it does not prohibit this researcher from adapting it. Thus, this resultant theoretical framework is a result of this adaptation. Essentially, the BPC management theoretical framework has been suggested by Motwani et al. (2004) for examining the implementation of Six Sigma in Dow Chemicals. As has been elaborated in the third section of the literature review, they adapted this theoretical framework from the one suggested by Kittenger and Grover (1995) that has been built on the notions of Rockart and Scott Morton (1984) and Nadler and Tushman (1980). Generally, these notions have been constructed on the nature of an organisation as a dynamic socioeconomic system composed of inputs, outputs and transformation processes. The latter represents an organisation that comprises several components. These components are in a congruent state until it is disturbed by one of the external environmental forces that affect one or more of the organisation's components. Consequently, these components react positively or negatively to each other in order to return to the congruent state.

Similarly, the resultant theoretical framework is initiated on the congruent state of the five change organisational environment factors. Kittenger and Grover (1995) and Motwani et al (2004) proposed these factors, namely, strategic initiatives, cultural readiness, learning capacity, IT leveragability and knowledge-sharing capability, and network balancing. These factors represent the socioeconomic forces that affect the strategic initiatives. In this study, these initiatives are improving quality through implementing the Six Sigma approach. Therefore, in order to maximise the opportunities of the success, the positive effects of these factors should also be maximised. However, although these five factors, as has been elaborated in the third section of the literature review, are induced from the models and the notions of Rockart and Scott Morton (1984) and Nadler and Tushman (1980), there are several differences between them.

As has been discussed in the second chapter, Nadler and Tushman (1980) suggested that an organisation's components include task, individual, formal organisational arrangements and the informal organisation. On the other hand, according to Rockart and Scott Morton (1984) the components of an organisation include not only organisation strategy and structure, individuals and technology, but also they have added to the structure the corporate culture, and they considered management process as a core component that links all components together. Accordingly, the previous models were limited compared to the five factors that are suggested by Kittenger and Grover (1995) and adopted by Motwani et al (2004). This is because, as has been shown in the third section of the second chapter, they take account of these components and several inputs of the socioeconomic environment.

Because of this comprehensiveness of the suggestion of Kittenger and Grover (1995) and Motwani et al (2004), this researcher adopted these five factors in the resultant theoretical framework. However, this adoption does not prohibit this researcher from improving this suggestion. This could be noted from the critical review that is conducted in the second chapter. According to this review, Motwani et al (2004) provided a minimal account of the theoretical background underpinning the strategic initiative. This was observed in several issues. For example, they state that top management only play an important role in initiating the strategic initiatives without providing sufficient explanation about the way this role should be played. In addition, they have not demonstrated how strategic decision-making takes place in the context of Six Sigma. Moreover, they were too brief in explaining the common organisational culture. Thus, they left the way of attaining this common culture unexplained. Moreover, the organisational culture status during Six Sigma implementation has not been clarified as well as the contents of this organisational culture. Furthermore, in their discussion of the third factor of the change organisational environment (learning capacity), Motwani et al (2004) limited their discussion to a generic identification of the major goal of learning to provide positive outcomes, without specifying these outcomes. Therefore, they overlooked providing a further explanation about how and why the means of enlarging learning capacity work. In addition, they again do not explain how data affects Six Sigma implementation. In this respect, they limited the identification of leveraging to the effective multiple implementation of demonstrated best practices whilst the leveragability of IT involved more than this role. Thus, in this researcher’s opinion, the role of IT has not been sufficiently explored. Additionally, Motwani et al (2004) do not explain the way of balancing the network relationship in the context of Six Sigma. Furthermore, they have not explored in depth the relationship between the change organisational environment factors.

As a result of the aforementioned critical review, a number of theory questions are raised in order to address the gaps in knowledge. As a result of answering these theory questions through in-depth exploration of the Ducab experience of the successful implementation of the Six Sigma approach, the resultant theoretical framework (Figure 7) is proposed as has been elaborated in the previous chapter. This resultant framework addresses the gaps in knowledge through answering the question and provides a better understanding of how and why the factors of the change organisational environment within the BPC management theoretical framework affect the success of Six Sigma approach implementation in Ducab. According to this investigation, the entities of the change organisational environment factors are identified. In addition, the relationship between these entities provides an explanation of the bi-directional relationship between the change organisational environment factors.

Briefly, in order to attain the first change organisational environment factor (strategic initiatives), two components should be attained. These components are top management commitment and strategic decision-making. Top management commitment is considered as the most important entity that affects the success of Six Sigma implementation. In addition, it is clarified that without this commitment any quality improvement effort will fail. Moreover, in order to gain top management commitment, they should believe that Six Sigma is a vital approach to improve organisational performance and positively affect the business's bottom line. As has been elaborated in the previous chapter, convincing top management needs to apply several selling points. Furthermore, according to the result of empirical investigation, several factors affect the process of the strategic decision-making. These factors should be taken into consideration when these decisions are made by the managers of different levels.

The second change organisational environment factor (cultural readiness), according to the resultant framework, comprises a number of components. These components are values, beliefs, attitudes, behaviours and languages. Top management values and beliefs play a vital role in executing Six Sigma schemes. Thus, these values and beliefs stimulate the attainment of other factors. However, these components are influenced by entities of other factors such as training programs within the third factor (learning capacity). According to the results of empirical investigation that are shown in the previous chapter, there are two ways to enlarge learning capacity - self-education and training programs. In order to achieve the expected result of conducting a training program, several steps should be followed. Moreover, the resultant framework enhances the role of IT (the fourth factor) in organising and analysing the data that are gathered from different processes. Additionally, it proposed several ways that facilitate knowledge-sharing across different units of the organisation. Furthermore, this resultant framework proposed two procedures that could assist an organisation performing network relationship balancing (the fifth factor) namely, forming teams from different departments and branches of an organisation and integrating their actions.

The aforementioned discussion is an independent verification through a comparative analysis with the theoretical base of the resultant theoretical framework. Next, this discussion proceeds with a comparative analysis of other change theories.

5.1.2 The resultant theoretical framework against other change theories

The resultant theoretical framework is an attempt to implement and manage organisational change, since there is, according to Burnes (2004 cited By, 2005, a fundamental lack of a valid framework of how to implement and manage organisational change. This is because, in Burnes's (2004 cited By, 2005) opinion, a wide range of change organisational theories and approaches, currently available to academics and practitioners, are contradictory and confusing. Moreover, this resultant theoretical framework provides empirical evidence of organisational change, since very little empirical evidence has been provided in support of the different theories and approaches suggested, despite ever-growing generic literature emphasising the importance of change and suggesting ways to approach it (Guimaraes and Armstrong, 1998 cited By, 2005).

In addition, this resultant theoretical framework considers the wide-scale recognition that effective organisational change practice is inextricably associated with organisational performance (Meyer and Stensaker 2006 cited Rees, 2008). This recognition has created a hunger for theories, models, training and, arguably, answers how best to manage organisational change processes in different settings. They also claim that, paradoxically, these advances in the body of knowledge on organisational change have unearthed numerous contradictions surrounding issues such as: the aims of organisational change; power and the ownership of change interventions; the ethics of organisational change; value clashes across national cultures; the transfer of organisational change theories and practices across national boundaries; the role of internal and external change management consultants; and the evaluation of organisational change and development interventions from multi-stakeholder perspectives.

Furthermore, this resultant theoretical framework asserts the role of leaders in the implementation process. This could be seen in the aspects of top management commitment. These aspects agree with a number of leadership styles that are suggested by Nadler and

Tushman (1990). This is because a variety of leadership styles may be appropriate, depending upon how the organisation is normally managed and led. In strategic changes, however, the management process and structure itself is the subject of change; therefore, it cannot be relied upon to manage the change. Thus, the resultant theoretical framework urges leaders to be charismatic. According to Nadler and Tushman (1990), charismatic leadership is a particular type of leadership that successfully brings about changes in an individual's values, goals, needs, or aspirations.

Charismatic leadership is characterised by three major types of behaviour and some illustrative kinds of actions. The first component of charismatic leadership is envisioning. This involves the creation of a picture of the future, or of a desired future state with which people can identify and which can generate excitement. By creating vision, the leader provides a vehicle for people to develop commitment, a common goal around which people can rally, and a way for people to feel successful. Envisioning is accomplished through a range of different actions. Clearly, the simplest form is through articulation of a compelling vision in clear and dramatic terms. The vision needs to be challenging, meaningful and worthy of pursuit, but it also needs to be credible. People must believe that it is possible to succeed in the pursuit of the vision. Vision is also communicated in other ways, such as through expectations that the leader expresses and through the leader personally demonstrating behaviours and activities that symbolise and further that vision.

The second component is energising. Here the role of the leader is the direct generation of energy-motivation to act among members of the organisation. Different leaders engage in energising in different ways, but some of the most common include a demonstration of their own personal excitement and energy, combined with leveraging that excitement through direct personal contact with large numbers of people in the organisation. They express confidence in their own ability to succeed. They find, and use, successes to celebrate progress towards the vision.

The third component is enabling. The leader psychologically helps people act or perform in the face of challenging goals. Assuming the individuals are directed through a vision and motivated by the creation, they then may need emotional assistance in accomplishing their tasks. This enabling is achieved in several ways. Charismatic leaders demonstrate empathy - the ability to listen, understand, and share the feelings of those in the organisation. They express support for individuals. Perhaps most importantly, the charismatic leader tends to express his/her confidence in people's ability to perform effectively and to meet challenges.

In contrast, reviewing the aspects of top management commitment that are induced in the resultant theoretical framework, it could be claimed that motivating people to complete their tasks represents the second component of charismatic leadership (energising). In addition, this framework identified working according to vision as one of the values of Six Sigma culture. This value represents the first component of charismatic leadership (envisioning). Moreover, other attitudes and behaviours that are identified through the resultant theoretical framework, such as flexible and patient management, indicate the third component of charismatic leadership (enabling).

Furthermore, instrumental leadership, suggested by Nadler and Tushman (1990), agrees with the aspects of top management commitment that are identified by the resultant theoretical framework. Nadler and Tushman (1990) call this style instrumental because it focuses on the management of teams, structures, and managerial processes to create individual instrumentalities. The basis of this approach is in expectancy theories of motivation, which propose that individuals will perform those behaviours that they perceive as instrumental in acquiring valued outcomes. Leadership, in this context, involves managing environments to create conditions that motivate desired behaviour. In practice, instrumental leadership of change involves three elements of behaviour. The first is structuring. The leader invests time in building teams that have the required competence to execute and implement re-orientation and create structures that make it clear what types of behaviour are required throughout the organisation. This may involve setting goals, establishing standards, and defining roles and responsibilities. Re-orientations seem to require detailed planning about what people will need to do and how they will be required to act during different phases of the change. The second element of instrumental leadership is controlling. This involves the creation of systems and processes to measure, monitor, and assess both behaviour and results and to administer corrective action. The third element is rewarding, which includes the administration of both rewards and punishments contingent upon the degree to which behaviour is consistent with the requirement of the change.

Looking into the aspects of top management commitment that are proposed by the resultant theoretical framework, it could be claimed that there is a similarity between these aspects and the aforementioned leadership style. Organising Six Sigma activities as one of top management aspects is similar to the first element of instrumental style (structuring) whilst monitoring and maintaining resolutions agree with the second element of this style (controlling). The third element (rewarding) of this leadership style agrees with motivating people to complete their tasks, also an aspect of top management commitment. Moreover, because the challenge is to broaden the range of individuals who can perform the critical leadership functions during periods of significant organisational change, Nadler and Tushman (1990) recommend institutionalising the leadership of change. They suggest three potential leverage points for the extension of leadership namely, the senior team, broader senior management, and the development of leadership throughout the organisation.

According to (Nadler and Tushman 1990), several actions appear to be important in enhancing the effectiveness of the senior team. These actions are: visible empowerment of the team, individual development of team members, composition of the senior team, and the inducement of strategic anticipation. In contrast, the entire actions are similar to the actions of conducting a Six Sigma training program as they are suggested in the resultant theoretical framework. Moreover, Nadler and Tushman (1990) consider the senior team as a learning system. Therefore, they urge a senior team to benefit from its involvement in leading change. It must become an effective system for learning about business, the nature of change, and the task of managing change. There are several ways to enhance a senior team's ability to learn over time. One approach is to work to keep the team an open system, receptive to outside ideas and information. This can be accomplished by creating a constant stream of events that expose people to new ideas and/or situations. For example, creating simulations, using critical incident techniques and creating near histories, are all ways of exposing senior teams to novel situations and sharpening problem-solving skills. Similarly, senior teams can open themselves to new ideas via speakers or visitors brought in to meet the team, visits by the team to other organisations, frequent contact with customers, and planned informal data-collection through personal contact (breakfasts, focus groups, etc.) throughout the organisation. A second approach involves the shaping and management of the internal group process of the team itself. This involves working on effective group leadership, building effective team membership skills, creating meeting management discipline, acquiring group problem-solving and information-processing skills, and ultimately creating norms that promote effective learning, innovation, and problem-solving. This is, again, similar to the resultant theoretical urge through enlarging the learning capacity of people in different levels and different departments.

Furthermore, the resultant theoretical framework agrees with the general theory of change proposed by Lewin. This basic change model of unfreezing, changing, and refreezing is considered as a theoretical foundation upon which change theory could be solidly built (Schein 1996). Lewin (1946 in Burnes, 2004 cited By, 2005) proposed that before change and new behaviour can be adopted successfully, the previous behaviour has to be discarded. According to Lewin (1952 in Eldrod II and Tippett, 2002 cited By, 2005) a successful change project must therefore involve the three steps of unfreezing the present level, moving to the new level and refreezing this new level. This model of change recognises the need to discard old behaviour, structures, processes and culture before successfully adopting new approaches (Bamford and Forrester, 2003 cited By, 2005). The agreement between the resultant theoretical framework and Lewin's general theory of change is attributed to the transformation process that Ducab was going through. This could be known from P1's claim *"it was a transition time for the company. Top management had a vision they saw the future … they saw the effect of globalisation … many companies will be coming in. …So you need that extra edge, the extra skill and extra improvement. And they saw Six Sigma as a potential tool for achieving that".* It is clear that there was a period of transition in this company. This agrees completely with what has been mentioned in Lewin's general theory of change. Moreover, it agrees with Kettinger and Grover (1995) who claim that successful implementation of the Six Sigma approach should involve the creation (or change) of an organisational environment.

The aforementioned discussion suggests that changing the organisational environment is necessary to achieve successful implementation of the Six Sigma approach. This suggestion shows that the first theory question (TQ6) is answered. In addition, the answer related to TQ6.1 could be found in the findings chapter. By considering the informants' extracts, they are the only factors that form change organisational environment. This conclusion is also supported by the literature, namely that the factors of changing the organisational environment, which have been mentioned in the theoretical framework, are the critical factors to implement the Six Sigma approach successfully (Motwani et al. 2004).

Moreover, the answer concerning TQ6.2 could also be found in the findings chapter. It has been observed that there is a close relationship between the factors. This conclusion is supported by the answer in the literature, in that the factors of change organisational environment have a bi-directional influence upon each other that represents a correlation bond (Kettinger and Grover, 1995). Furthermore, the answer of TQ6.3 has not been considered in the reviewed literature. Therefore, this researcher has proposed that all factors of changing the organisational environment have the same influence upon the implementation of the Six Sigma approach. From the findings chapter, it has been noted that each of the factors exert different impacts upon others (such as values and beliefs, and training programs). This researcher supports the assertion that the factors have different impacts upon the implementation.

As a result of the aforementioned discussion, it could be suggested that there is consistency between the resultant theoretical framework and other change theories as well as its theoretical base. Therefore this resultant theoretical framework is consistent with the body knowledge in the context of organisational change. Therefore, it addresses the gap in the knowledge that has been discussed and in the research positioning in the literature review chapter that follows.

5.2 Contribution to Knowledge

As has been mentioned in section 2.3.3.2., the proposed theoretical framework is suggested in order to fill the knowledge gap in the original theoretical framework proposed by Motwani et al (2004). This gap in knowledge has been caused by constraining the interpretation of the success of the implementation of the Six Sigma approach in Dow Chemicals in the USA to the macro level of analysis. Thus, this study depends on a description of the basic foundation for Six Sigma approach implementation, the cultural change within an organisation when adopting this approach, and the challenges or barriers that can be expected along the way. In contrast, the proposed theoretical framework interprets the success of the implementation of the Six Sigma approach at Ducab by exploring the micro level of each factor of the change organisational environment. As a result of the in-depth interpretation, this study focuses merely on one part of the original theoretical framework that consists of the five factors of the change organisational environment. Consequently, this study attempts to answer several questions. These questions are how and why the factors of the change organisational environment within the BPC theoretical framework could be attained. In addition, what are the real motivations to attain these factors in these ways, and how do they lead to a successful implementation of the Six Sigma approach? In order to answer these questions, Ducab’s experience of implementing the Six Sigma approach will merge with available knowledge regarding the impact of these factors on this implementation.

According to the aforementioned description, the resultant theoretical framework (Figure 7) is proposed. This framework includes two parts. The first part is located at the right end of this framework and represents the original factors of the change organisational environment of the BPC theoretical framework according to Motwani et al (2004), whilst the other part is located to the left of the first part and represents the required entities that have been suggested by this study. This part shows the upfront entities of each of the change organisational environment factors and the way of motivating the attainment of these factors. In addition, it shows the way these entities of all the factors motivate each other to create the integration between them to prepare the business environment for potential implementation of the Six Sigma approach. Thus, this part interprets the bi-directional relationship among the change organisational environment factors within the original theoretical framework.

Moreover, whilst the study of Motwani et al. (2004) was the first to examine the success of Six Sigma approach implementation in the USA, this study is the first to investigate the success of the adoption of the Six Sigma approach by exploiting the factors of the change organisational environment within the BPC theoretical framework in the UAE. This means that this study shows that the BPC theoretical framework could be useful to interpret the success of Six Sigma approach implementation in the UAE. Therefore, the proposed theoretical framework is suggested as a guide for potential implementation of the Six Sigma approach in other UAE manufacturing companies.

5.3 Research reflections

Generally, this researcher agrees with almost all of the findings presented in the previous chapter and discussed in this current chapter, such as the commitment of the top management of the case company to the implementation of the Six Sigma approach, as well as considering Six Sigma culture as part of the system of the case company. This is because top management realise that the Six Sigma approach is a complete methodology of improving the quality of every organisation's aspects. In addition, although there are several ways to enlarge learning capacity, as has been mentioned in section 4.3 and discussed in section 5.1.4, this researcher emphasises self-education as a significant way to continue learning about this approach. In contrast, this researcher disagrees with the gradual implementation that has been highlighted in section 4.1.2. This disagreement is attributed to inconsistency between this finding and the supporting literature. According to the literature, the nature of the Six Sigma approach is revolutionary (Kotter, 1995). Accordingly, a number of authors (Bañuelas and Antony, 2004; Byrne, 2003) have claimed that the strategic decisions made according to this approach should change the improved processes dramatically. However, the novelty of this approach in the UAE makes this way of establishment justified.

The researcher admits that there is no full agreement amongst the interviewees regarding a number of the findings as has been mentioned in the fourth chapter. However, this does not weaken the evidence of these findings, because, as has been mentioned in section 3.3.1.2, not all of the opinions are contradictory. However, evidence is attributed to the extent of knowledge that each interviewee has because there are some interviewees that are more knowledgeable than others (such as P1 who is the Six Sigma coordinator and P7 and P2 who are senior managers). Consequently, the secondary data such as documents and archival records have been used in order to enhance the robustness of the findings and conclusions. For instance, several interviewees cited evidence from company records regarding the number and progress of Six Sigma projects initiated by these interviewees. Moreover, P1 presented evidence from the budget statement regarding the amount of funds dedicated to Six Sigma programs. Moreover, the plan and the success indicators of the Six Sigma approach implementation in the case company have been enhanced by the evidence from the company's published magazine and website.

Furthermore, bearing in mind that the result of this study is limited, the proposed theoretical framework could be suggested as guidance to the companies within the manufacturing sector in the UAE intending to adopt the Six Sigma approach to improve product quality. Prior to discussing further research implications, the following section addresses the research limitations of the current study.

5.4 Research limitations

Bearing in mind that there are other ways that could be exploited in order to investigate the effectiveness of organisations, such as the criteria of the quality awards as has been discussed in the third section of the literature review, the proposed theoretical framework is one way to investigate the success of the implementation of the Six Sigma approach as well as to guide the companies that intend to adopt this approach. The results from this study however could not be generalised, since it is not one of the aims of the qualitative research strategy (Saunders et al. 2003). Moreover, the limitation of the result of this study is attributed to the limitation of the cases that are looked into as well as the number of the participants who have been interviewed. This limitation does not weaken the result of this study. This is because, as has been mentioned in section 3.1.3.1 and 3.2.1.2, the case company, according to the pilot survey that was conducted in 2005 and updated in 2008, is the only one that implements the Six Sigma approach within the UAE manufacturing sector. In addition, the participants are the most knowledgeable individuals within the case company regarding the implementation of this approach. Furthermore, they represent one fifth of the top and middle management levels in this company. This agrees with the claim of Glesne and Peshkin (1992) that for the purpose of in-depth studies over extended periods, time should be spent with a few participants who are revisited repeatedly. However, this process should finish once the point of data saturation has been reached (Flick, 2002; Wengraf, 2001).

Furthermore, choosing the single case-study in order to conduct this study is similar to a large number of studies that have been conducted to investigate the success of Six Sigma approach implementation. According to a result of a recent study (Nonthaleerak and Hendry, 2008) that has reviewed a large number of studies about Six Sigma approach implementation, it shows that all of them are single case-studies. This could be attributed to the novelty of the Six Sigma approach, as is the case in the UAE, as well as the reticence of Six Sigma companies to reveal their experience. This is similar to the attempt of this researcher to find some companies within the UK in order to conduct part of this study about them.

Accordingly, this study has the usual limitations associated with a single case-study. Pandy (2007) claims that since research is a continuous journey, the limitations serve as learning triggers. Thus, the limitation of the number of companies it covers and the generic tackling of the factors of change organisational environment, despite many high level and complex concepts such as cultural readiness and learning capacity, are triggers for further replication of such studies. These studies may be useful for drawing lessons for greater generalisation. Therefore, some directions for future studies are suggested in the following section, after elaborating the research implications and proposing some recommendations for the case company in particular, and to companies of the wider UAE manufacturing sector.

5.5 Research implications

According to the aforementioned elaboration, the proposed theoretical framework that has been illustrated in Figure 7 is an attempt to explore the success of the Six Sigma approach implementation in Ducab. As this theoretical framework has been verified, it could be suggested as a means to investigate the success of the same implementation in other companies and the readiness of other change organisational environment companies that intend to adopt the Six Sigma approach within the UAE manufacturing sector.

In order to achieve the first task, the change organisational environment of an organisation should first be explored via reviewing the entities of its factors. This step could be achieved by interviewing the top, middle and line managers involved in the implementation. The interview question that could be asked in this context is similar to the one that has been posed in this study. This question could be: ‘could you please explain your perception regarding Six Sigma schemes and the way of establishing it in your company/department’? Moreover, ‘what is the impact of these schemes on different aspects of the organisation’? Analysing the answers of different participants according to the entities of the proposed theoretical framework leads to the identification of the gaps in the implementation. These gaps are improvement opportunities that could be pursued to reach Six Sigma level.

On other hand, in order to achieve the second task, a Six Sigma approach proponent should first be found within the top management of the company that intend to adopt the Six Sigma approach. This could be achieved through applying the selling points for promoting this approach highlighted in section 4.1.1.2 and discussed. Secondly, a good consultant should be retained in order to introduce the Six Sigma approach to the rest of top management to convince them of the significant role of this approach in improving quality, satisfying customers and ultimately, impacting positively on the bottom-line. In addition, the consultant’s mission includes planning the implementation of this approach and training people to cope with this implementation.

As a result of these steps, the commitment of top management is attained and the consultant begins to explore the organisational environment of the company in order to investigate the readiness of this company to implement the Six Sigma approach. Interviewing the management members at different levels assists the consultant to identify how business practices are conducted in this company. This could be attained by asking them an interview question such as: ‘what are you doing to ensure the quality of your products meets standards’? Furthermore, ‘do you think that you need to improve the quality of your products? Why? How do you improve it? What do you need to achieve this improvement’?

Next, the consultant should analyse the interviews through comparing the participants’ claims with the entities of the factor of the change organisational environment mentioned in the proposed theoretical framework. This is in order to find out the gaps of the company’s change organisational environment that should be modified or rebuilt to suit the adoption of the Six Sigma approach. As a result of performing this step, these gaps should be discussed with the steering committee in order to make the required strategic decisions to commence the Six Sigma programs. Amongst others, the prioritisation of process improvement and allocation of sufficient funds are two of these strategic decisions.

The introductory training programs are the next step that should be conducted in order to raise employees’ awareness regarding the Six Sigma approach within the company and to choose the black belt pioneers. These black belts will then select their first projects to be improved from the processes that have been prioritised from the last step. As much as the results of the process improvements are impressive, the top management are enthusiasts for continuing Six Sigma programs. Thus, the training programs continue to involve other people that will reflect the number of Six Sigma projects. Moreover, the business culture is modified to meet the features of Six Sigma culture and reflect its values, beliefs, attitudes, behaviours and languages.

As the Six Sigma programs are progressing and the number of the projects increases, the necessity of integrating these efforts and working via teams is enhanced. Free and honest open communication channels maintain this coordination among teams working with special attention to leverage the IT system. Consequently, the network relationship is balanced and knowledge-sharing is enabled. All these steps should be performed followed by a review by the direct support of top management, characterised by facilitating the implementation and easing resistance by managing change.

5.6 Recommendations

The results of this study suggest some specific recommendations for Ducab and more generally, for other manufacturing companies in the UAE. First, on the case company level, although the result of this study shows that Ducab has succeeded in the implementation of the Six Sigma approach, this success should be maintained in order to reach the level of perfection. In this respect, top management should continue visibly supporting Six Sigma programs to encourage people at different managerial levels to maintain the impressive results that have been achieved thus far. This includes dedicating sufficient funds to Six Sigma schemes, linking promotion schemes to the progress of Six Sigma projects and showing interest in associated activities.

In addition, they should move to a more revolutionary as opposed to evolutionary implementation. This means involving more people from different departments in Six Sigma activities to work on more improvement projects. As a result of this expansion of Six Sigma activities, the need for more coordination is growing. This need entails continuing training programs to create common understanding and language to facilitate communication among people, as well as ease the reluctance to change. Moreover, this need entails encouraging people to work through teams and leads to integral results that positively affect the bottom-line as well as leveraging the IT system to facilitate data analysis and knowledge exchange which enhance transparency within the company. This transparency saves the company resources through avoiding the repetition of improvement efforts.

Second on the national level, as has been mentioned in the introductory chapter, the UAE government expends a lot of effort in order to encourage manufacturers to improve the quality of their products through quality excellence awards. However, the quality of the local products has yet to reach the desired level. Therefore, since the Six Sigma approach has a positive influence on customer satisfaction and the business performance of a large number of USA companies, this study recommends the Six Sigma approach as a vital way to improve the quality of local products in the UAE. In this respect, the responsible national bodies for improving the quality of local products (such as the Standardisation and Specification Authorities), and the municipalities with the cooperation of unprofitable quality organisations (such as Dubai Quality Group and Total Quality Electronic University) should organise a national campaign to introduce the Six Sigma approach to local manufacturers.

For this purpose, a steering committee is formed from the aforementioned bodies in order to organise the activities of this campaign. This includes conducting a number of free introductory courses for the top management of local manufacturers. The aim of these courses, as has been mentioned, will be to encourage the top management to establish this approach in their companies. These courses could be presented by consultants from the Dubai Quality Group, Total Quality Electronic University and/or from private consultants. In addition, the government could encourage the local manufacturers by offering free consultancy services in order to guide them to a successful implementation of the Six Sigma approach. Governmental support could include providing special facilities for Six Sigma companies in governmental enterprises. This support could also include a special award for these companies to enhance the desirability of implementing the Six Sigma approach.

5.7 Direction for future research

Since this research proposes a theoretical framework for exploring the success of the implementation of Six Sigma in Ducab in the UAE, it could be considered as a step forward in the long process of developing a body of empirically verifiable generalisations and an explanation of Six Sigma implementation assessment phenomenon. This is because this research is at an early stage in understanding the entities of the change organisational environment factors that affect the success of Six Sigma implementation.

Potentially, a useful area for future research lies in expanding the application of the resultant framework to other industries in different geographical locations. This is because the context of the business and organisational environment differs from industry to industry and from country to country. Moreover, it is fruitful to operationalise the framework in order to examine it according to other research methods such as survey research.

In addition, there is an opportunity for future investigation, having relaxed the constraints imposed on the research design such as the generic tackling of the factors of the change organisational environment, despite many high level and complex concepts (cultural readiness and learning capacity). Thus, these limitations are triggers for further replication of such studies.

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Appendices

Appendix 1: Acronyms used for typical quality tools

3K	Kangae, kodo, kaizen	JIT	Just-in-time
4M	Man, machine, material, method	LTPD	Lot tolerance percent defective
5S	Sort, set, shine, standard, strict; or seiri, seiton, seiso, seiketsu, shitsuki	M/PCpS	Machine/process capability study
		MRB	Material review board
7 new QC Tools	Relational diagram, KJ method, PDPC method Systematic diagram, matrix diagram Arrow diagram, matrix data analysis	MSA	Measurement system analysis
		MTBA	Mean time between access
		MTBF	Mean time between failure
		MTTR	Mean time to repair
7 old QC Tools	Pareto analysis, histogram, Ishikawa diagram Control chart, stratification, scatter plot Checklist	OC	Operating characteristic
		OCAP	Out-of-control action plan
		PDCA	Plan-do-check-act
		PM	Preventive maintenance
ANOVA	Analysis of variance	QA	Quality assurance
AOQ	Average outgoing quality	QC	Quality control
AOQL	Average outgoing quality limit	QCC	Quality control circle
AQL	Acceptable quality level	QFD	Quality function deployment
COQ	Cost of quality	QIS	Quality information system
Cpk	Capability index (centre-adjusted)	QM	Quality management
CQI	Continuous quality improvement	R&QA	Reliability and quality assurance
CWQC	Company-wide quality control	RQL	Rejectable quality level
DFM	Design for manufacture ability	SDCA	Standardise-do-check-act
DOE	Design of experiments	SOP	Standard operating procedure
EVOP	Evolutionary operations	SPC	Statistical process control
FMEA	Failure mode and effect analysis	SQC	Statistical quality control
FMECA	Failure mode, effect and criticality analysis	SS	Sampling size
		TQC	Total quality control
FRACAS	Failure reporting and corrective action System	TQM	Total quality management
		WIT	Work improvement team
ISO	International organisation for standardisation	ZD	Zero defect
		ZIPS	Zero inventory production system

Source: (Kwok and Tummala, 1998)

Appendix 2: names of the consultants and organisations that concern about quality in the UAE

No.	Name of certification body	Tel.	Fax.	email	contact
1.	SGS Gulf Ltd	+971 4 339 5344	+971 4 338 0772/3	sgsgcc@sgsgroup.com	Mr. Don Roberts Mr. Stephen Seddon
2.	RWTUV Middle East	+971 2 671 5225	+971 2 676 1236	rwtuvgis@emirates.net.ae	Mr. Akef D. Sibai
3.	ICL (Dubai) – BM TRADA Middle East	+971 4 268 0130	+971 4 262 7278	icldxb@emirates.net.ae	Mr. Sami Elemara Mr. Ali Yawer
4.	Germanischer Lloyd Branch office Dhabi	+971 4 332 8842	+971 4 321 819		Mr. El Sherbiny
5.	Det Norske Veritas (DNV)	+971 4 352 6626	+971 4 352 0524	dub@dnv.com	
6.	Bureau Veritas Quality International	+971 4 345 3560	+971 4 345 2391	marian.paruszewski@ae.bureauveritas.com bveritas@emirates.net.ae	Ms Meral Marion Paruszewski
7.	AOQC Moody International	+971 4 228 4808	+971 4 228 3843	moodydxb@emirates.net.ae	
8.	AIB-Vinçotte International	+971 4 297 5085	+971 4 297 5086	aibvin@emirates.net.ae	Mr. Ishtiaq Ahmed
9.	ABS Group Incorporated	+971 4 355 6541	+971 2 351 7188	akhussaim@consulting.com	Mr. Ali Kadhim
10.	ICS	+971 4 393 3343		icsasian@emirates.net.ae	Mr. Qureshi

Source: Authority of Standardisations and Specifications

Appendix3: A descriptive questionnaire for collecting data regarding the quality level and quality tools approaches in use for quality management in the manufacturing sector in the UAE

Factory Name (optional): ....

Activity: ....

Invested Capital: DH.................................... Number of Labour:.............................

Name (optional):...

Job:...

Q1: from the following list, tick in the circle the tool (s) or approach (s) that is in use for quality management of your product (s):

Short name	The tool or approach full name	Short name	The tool or approach full name
○3K	Kangae, kodo, kaizen	○ JIT	Just-in-time
○4M	Man, machine, material, method	○ LTPD	Lot tolerance percent defective
○5S	Sort, set, shine, standard, strict; or	○ M/PCpS	Machine/process capability study
	seiri, seiton, seiso, seiketsu, shitsuki	○ MRB	Material review board
○7 new	Relational diagram, KJ method,	○ MSA	Measurement system analysis
	PDPC method	○ MTBA	Mean time between access
○QC	Systematic diagram, matrix diagram	○ MTBF	Mean time between failure
Tools	Arrow diagram, matrix data analysis	○ MTTR	Mean time to repair
○7 old	Pareto analysis, histogram, Ishikawa	○ OC	Operating characteristic
	diagram	○ OCAP	Out-of-control action plan
○QC	Control chart, stratification, scatter plot	○ PDCA	Plan-do-check-act
Tools	Checklist	○ PM	Preventive maintenance
○ANOVA	Analysis of variance	○ QA	Quality assurance
○AOQ	Average outgoing quality	○ QC	Quality control
○AOQL	Average outgoing quality limit	○ QCC	Quality control circle
○AQL	Acceptable quality level	○ QFD	Quality function deployment
○COQ	Cost of quality	○ QIS	Quality information system
○Cpk	Capability index (centre-adjusted)	○ QM	Quality management
○CQI	Continuous quality improvement	○ R&QA	Reliability and quality assurance
○CWQC	Company-wide quality control	○ RQL	Rejectable quality level
○DFM	Design for manufacture ability	○ SDCA	Standardise-do-check-act
○DOE	Design of experiments	○ SOP	Standard operating procedure
○EVOP	Evolutionary operations	○ SPC	Statistical process control
○FMEA	Failure mode and effect analysis	○ SQC	Statistical quality control
○FMECA	Failure mode, effect and criticality	○ SS	Sampling size
	analysis	○ TQC	Total quality control
○FRACA	Failure reporting and corrective action	○ TQM	Total quality management
○S	System	○ WIT	Work improvement team
○ISO	International organisation for	○ ZD	Zero defect
	standardisation	○ ZIPS	Zero inventory production system

If the quality management tool (s) or approach (s) did not appear above, please mention it down and give some details about how and why it is used:

....

....

....

....

....

....

(If the space not enough, please use extra papers)

Q2: from factory's records, please list in the following table the quantities and kinds of the prime products that are produced in year 2008 as well as the number of (If any) defective, reworked items and scraps.

Details Products	Unit	Production quantity	defects	Reworked products	scraps

Appendix 4: The questionnaire letter:

20th of April 2010

Dear NAMED PERSON

Subject: Describing the quality management tool (s) or approach (s) in use within the manufacturing sector in the UAE

I am Ahmed Al Sharif from United Arab Emirates studying for my PhD at Bournemouth University supervised by Dr Sid Ghosh and Professor Colin Armistead in the Business School. My research topic is on the use of the quality management tool (s) approach (s) in companies within the UAE.

In my research, I am seeking to describe the quality management tool (s) or approach (s) in use within the manufacturing sector in the UAE.

I know that *NAME the COMPANY* has considerable experience in this area and I would be very grateful if you could arrange for me someone who would be able to answer the attached questionnaire in order to name the tool (s) or approach (s) have adopted in order to manage the quality of your product (s) and the outcomes. The questionnaire includes only two questions that hopefully will not take long time to be answered. Any data I gather will only used for the purpose of my research and not used in any other way without further permission.

I appreciate you if you could retain the questionnaire within 30 days to my following address:

To: Ahmed AlSharif

Po. Box: 5406 Sharjah

The UAE

I hope you will be able to help me and I look forward to hearing from you.

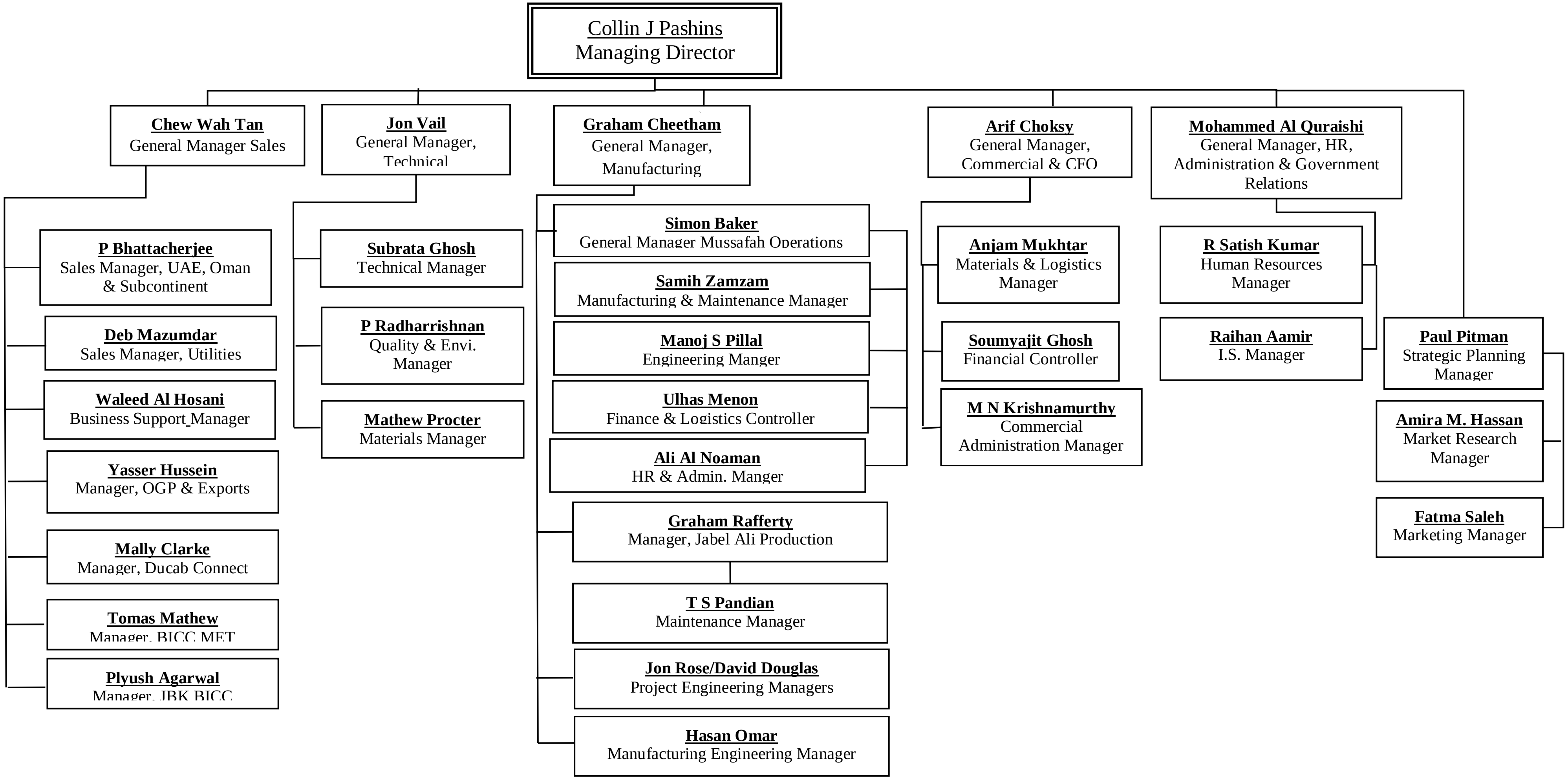
Yours sincerely,

Ahmed Al Sharif

Research Student

Appendix 5: the organisational hierarchy of this company

Ducab Organisation
November 2006



Source: Ducab' document

Appendix 6: first five projects that have been conducted in phase one in Ducab

1. Project aims to examine the way of this company to generating enquiries from potential customers.
2. Project looks into the way of this company turns enquiries into orders.
3. Project looks investigates the of this company progresses the orders through to the point of invoicing.
4. Project to look into improving the throughput on the bottleneck machined.
5. Project examines ways to reduce scrap and rework in the factory.

Source: Baker (2002)

Appendix 7: some of the twenty eight project that have been conducted in phase two in Ducab

1. Project to improving the reliability and cost defectiveness of purchasing of sundry raw material which are not common.
2. Project to reduce over usage of high voltage material,
3. Project to increase an output for different kind of materials because it is a functional demand increasing output of building wire.
4. Project examines delivery performance improvement.
5. Project on increasing the factory scheduling appearance or factory schedule appearance
6. Several projects to improve material saving.
7. Project looks into scrap monitoring system.
8. Project investigates cost comparison.
9. Project looks into overtime.
10. Project to design for six sigma approach.

Source: Six Sigma coordinator in this company interview (2006)

Appendix 8: an example of the adoption of some national quality awards to one or more of these famous awards

Models adopted by the various NQAs

NQA	Country	Year established	DP	Model adopted MBNQA	EQA
ArgNQA	Argentina	1996	Features	Features	Features
AruQA	Aruba	2000		Basic	
ABEA	Australia	2000			
CNQA	Chile	1997	Features	Features	Features
EgyQA	Egypt	1997		Basic	
HKMAQA	Hong Kong	2001		Basic	
JQA	Japan	2000		Basic	Features
MNQA	Mauritius	2001		Full	
NIQA	Israel	2000		Basic	
PMQA	Malaysia	2000			
SQA	Singapore	2001	Features	Basic	Features
SABEA	South Africa	2000		Features	Basic
SLNQA	Sri Lanka	2001		Full	

Notes: Basic model of similar construction and concept; Full=full adoption (with little or no modification of criteria); Feature= only selected feature adopted

Source: Tan (2002)

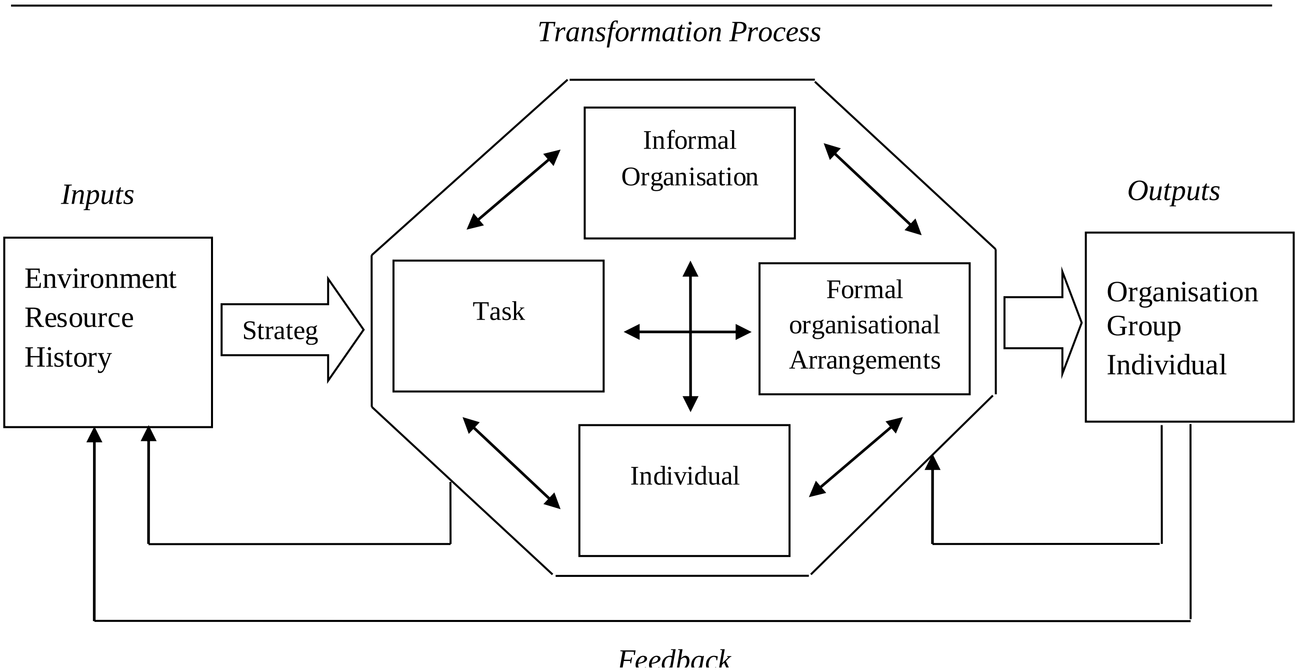
Appendix 9: a summary of the description of the assessment criteria through Quality Awards

A summary of the comparative framework

Criterion	Description of criterion
Leadership system	Examines how the company can achieve continuous quality and performance excellence through the driving forces of the senior executives and the involvement of all levels of the organisation
Impact on society	Examines how the company addresses its responsibilities to the public in three major areas: social responsibility; community involvement; and environmental conservation
Information and analysis	Examines the selection, analysis, and utilisation of information and data in the organisation itself and within and outside the organisation's industry and markets
Strategy and policy planning	Examines how the company develops, communicates, implements, and improves its strategy and policy of achieve company performance excellence and strong competitive position
Resources	Examines the management of various resources in the organisation; namely financial, materials technology, intellectual property, and assets
Customer management and satisfaction	Examines the ability of the company in satisfying the needs and expectations of the customers through gain in customer and market knowledge and enhancement in customer relationship
People management	Examines how the company plans and develops its human resources to achieve the maximum potential of its workforce
Process management	Examines the design, management, evaluation, and improvement of the various key processes to achieve product and service excellence
Performance and management of suppliers/partners	Examines how the company selects and manages its suppliers/partners to ensure that they attain the expected quality requirements
Business results	**Examines the company's performance in two areas: financial and market results, and operational and productivity results**

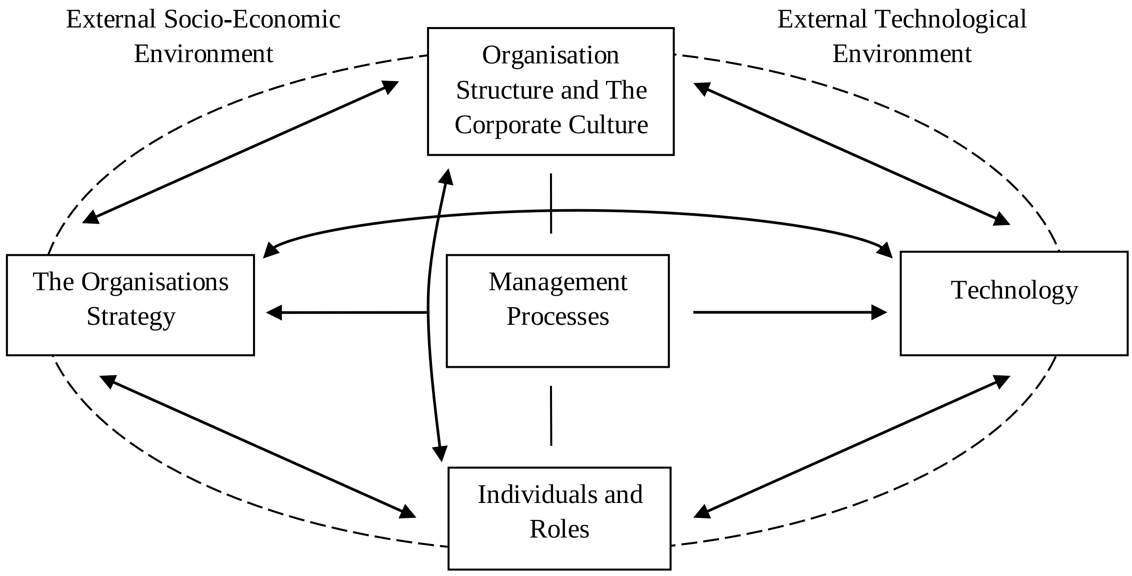
Source: Tan (2002)

Appendix 10: A Congruence Model for Organisation Analysis



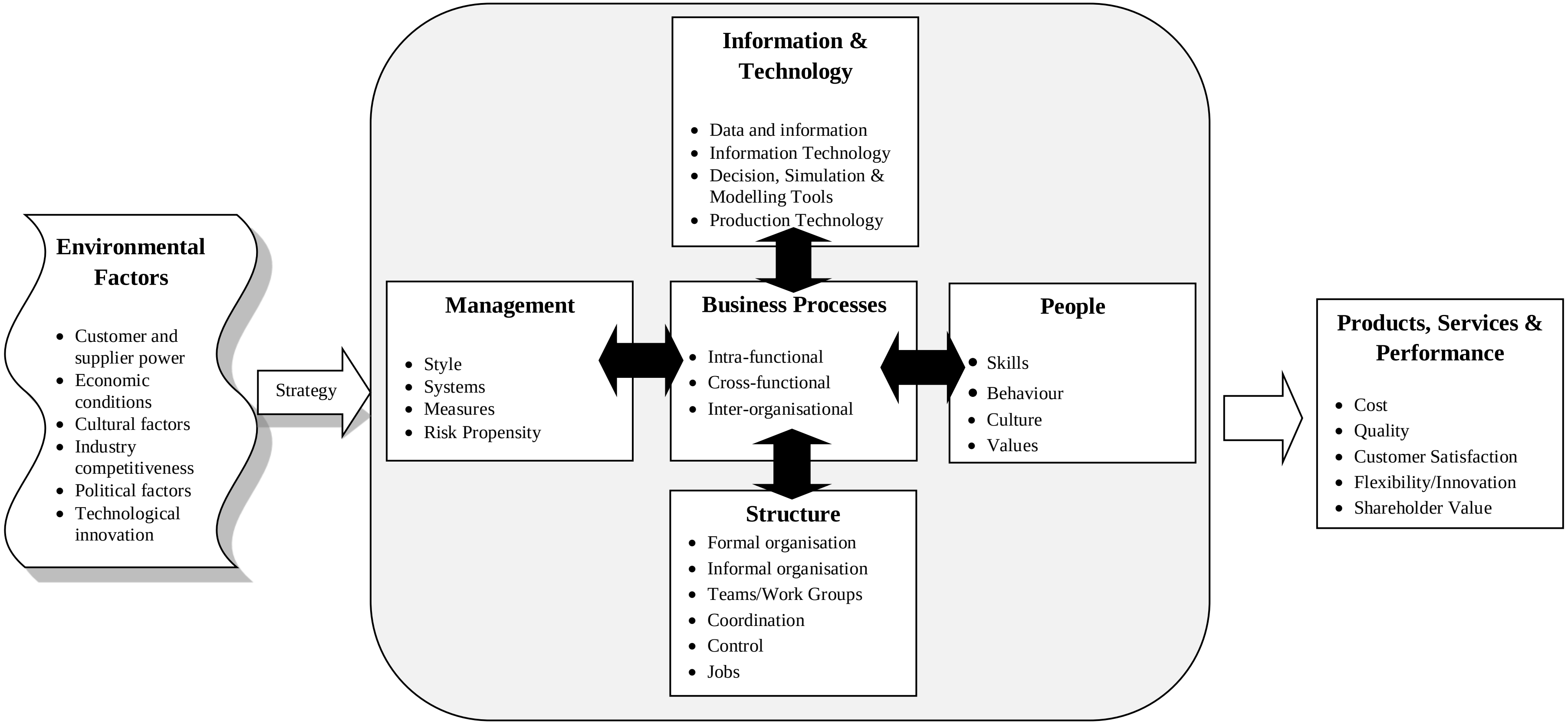
Source: Nadler and Tushman (1980)

Appendix 11: A conceptual model of technology impact



Source: Rockart and Scott Morton (1984)

Appendix 12: Business process change model



Source: Ketinger and Grover (1995)

Appendix 13: Principles of Business Process Change/business process reengineering

Principle 1: PBC should be strategy-led with visionary leadership from senior management but, should also recognise the value of bottom-up participation of line workers and middle managers in design, implementation and continuous improvement.

Principle 2: BPC should take care to ensure that resistance to change is minimised through an assessment of cultural readiness and effective change management

Principle 3: BPC should challenge existing assumptions concerning organisational systems and their learning capacity

Principle 4: BPC should leverage information technology's process, storage and communication abilities to facilitate knowledge- sharing capability

Principle 5: BPC should manage relationships both intra- and inter- organisationally. This requires deliberate design decisions related to the degree of cooperation and competition in network relationship balancing.

Principle 6: Business process change should use well developed methods, techniques and tools of process management to steward business processes through their life-cycles. These processes may be intra-functional, but are typically cross-functional and/or inter-organisational.

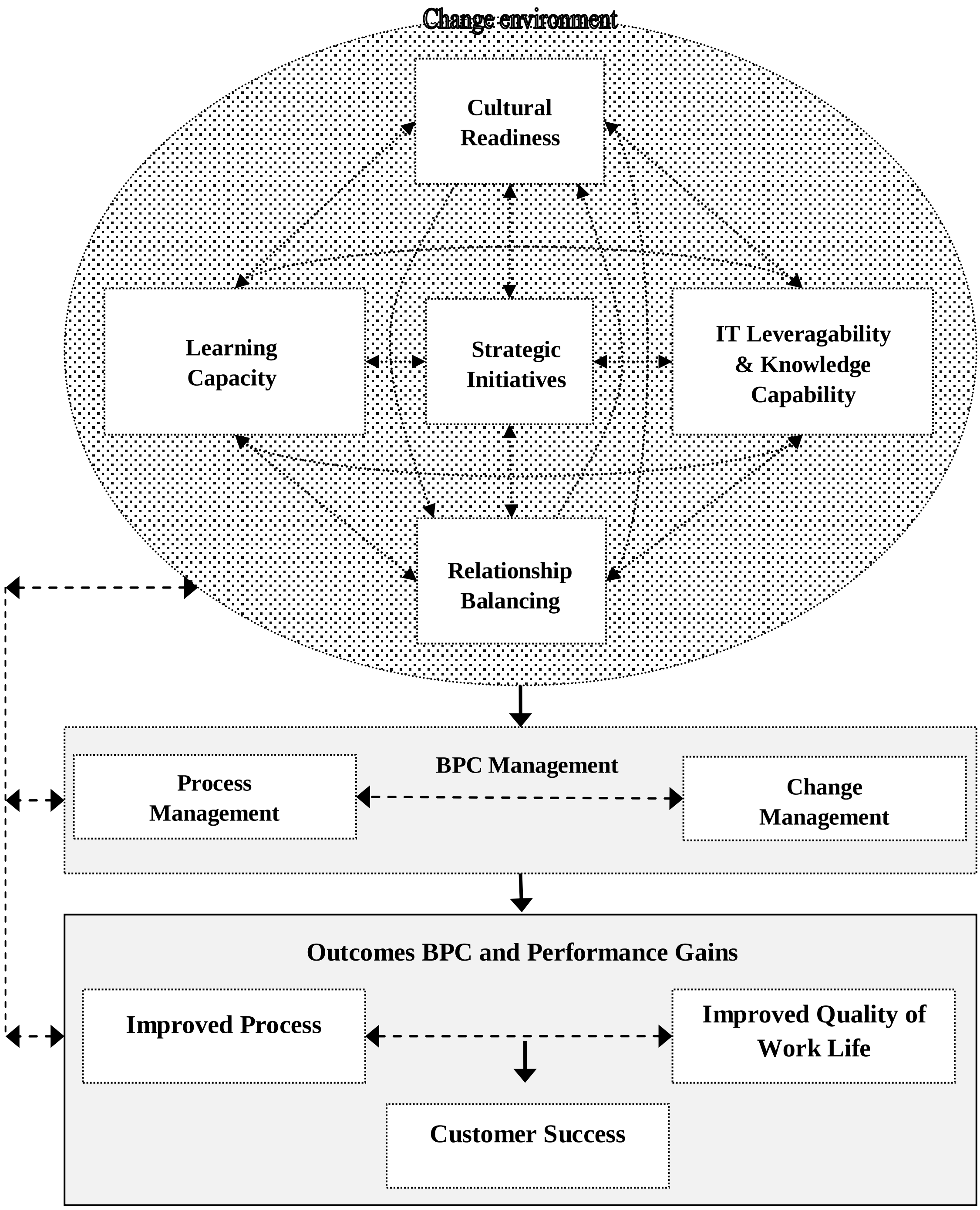
Principle 7: Business process change should range on a continuum of change outcomes from radical new process design to continuous process improvement depending on the contingencies at work.

Principle 8: BPC should empower individuals and teams and generally, improve the quality of work- life.

Principle 9: BPC should be customer-driven, with value defined as satisfaction and, where possible, success.

Principle 10: BPC should result in significant measurable performance gains with direct effects on market share and/or profitability

Appendix 14: BPC management theoretical framework



Source: Ketinger and Grover (1995)

Appendix 15: Wengraf's matrix of preparing questions for second session of the interviews

			ILLUMINATION ONLY by MORE STORY
Themes in the order mentioned and in the terms used by the interviewee	Relatively General terms about Situation, Time and phase	More Particular terms about Incident, Happening Occasion Event 'How it all came about' 'How all of that happened'	e.g. You said 'XXXX' - can you tell more about how all that happened? Or - Do you remember any particular incident or occasion when XXX?
Their keywords for your eventual return-to-narrative questions			*Full* versions of your eventual return-to-narrative questions
An actual notepad would have 2-3 pages of blanks under the heading above			
It would just have two columns like this row and that above			

Source: Wengraf (2001)

Appendix 16: the full transcripts of P1 interview

Mr. Hassan (P1)

A: hello Mr. Omar Hassan Omar I appreciate your acceptance to be one of my interviewee and I'd like to tell you this is you know this is a research for PhD research and all the information you'll tell me in this meeting will a top confidential and only it will be use for education matter and research matter it will be not transfer for anybody only by your permission.

H: thank you very much Mr. Ahmed

A: Mr. Omar I have a question and it will be like an opened question: I'd like you to put yourself in the position of my advisor

H: yes

A: I'm a manager of a company that has no idea about six sigma scheme and never heard about it. What would you advise me about this scheme and how does it work what do I need to do to get establish this scheme in my company?

H: that is very interested question and I think it's one of the most common questions that asked for industries that don't know about six sigma and they may want to know embark in this scheme. Well, I explain it from the point view of from the way we done it here in Ducab Dubai Cable Company. The way started over here those a person that heard about six sigma during when he visited Canada

A: m

H: he was an X general manager

A: m

H: he was general manager of finance and IT

A: m

H: emm he introduce this idea to the top management

A: m

H: which is the managing director plus the origin manager the executive manager of the company.

Aaaaaaaam then a person was brought in which was a consultant from Motorola University he gave about two days introductory training about six sigma basically answering question that you've asked

A: hm

H: early mentioned early which is what is six sigma? What is the benefit? Not from details point view from business point of view from the benefits for business

A: hm

H: from difficulties in the implementation from the expectations from the differences to other available schemes or methodologies

A: hm

H: aaam and also an implementation so all that was explained to general executive ….. excuse me ………

So that was coming back to the subject that was an introductory course to them so this was mainly to have the top management buy into six sigma

A: hm

H: so that was selling point basically and of course giving the case with any project aaa I think finance general manager he was very clever in the way he has selected the Motorola University to an and of course the aa looking back ground of the presenter himself to present the study and measurement and it was the same presenter or the person who introduce six sigma to the top management was the same person who emmm carried out the training the black belt training and afterwards the green belt training for the company so I think this is the most important factor the top management needs to know six sigma what it is and it should be done through another party that has implemented six sigma or has played the role in training for six sigma and he has and the advantage over there with that particular person is that he has lots of examples industrial examples behind him to show the benefits and to compare and to compare companies that have implemented six sigma

A: ehhm yes

H: emmm so I would this one of the most important things because the top management has to be convinced

A: ehm

H: especially if it is something new. They need examples

A: ehm

H: they need evidence. And the person who has to show evidence has to be credible first of all

A: ehm

H: and also he has to show the examples from the industry. And this is I think what was done.

A: ehm

H: Unfortunately, I was not involve in that introductory

A: ehm

H: course. It was only restricted to the key decision makers in the company means the managing director and the only the general managers

A: ehm

H: and the potential aa six sigma coordinator at that time that could to be a manager.

A: ehm did you hear about how they take the decision about…

H: obviously they accepted because otherwise you won't be aaaaa 5 years down the line with six sigma but amm I think having some later conversation with six sigma coordinator at that time he said ammm that amm the session took place in two separate days it wasn't one full session was made in two separate days. The first day was general introduction and I think this was deliberate there was a break in between and then it was taken over to the second day over to the second day….. which over discussion and to give time for the management to absorb and to and to well and to what ever had in the first time. So the second time was mainly clarification. I think because It was done like this then afterwards I think the management they give them time to ask question. actually And to absorb the first session then I think they took some time and then the decision took place I think that also was done at the executive but I think the managing director himself after that he was very keen for introducing six sigma sorry emmm because at that time it was a transaction in the company there were two managing directors the managing director first he's main because he was mainly coming from the business Function. Because He was earlier the Marketing General manager then became the managing director his main question or issue was that will the company be certified will they get certification for having being six sigma implementer or holder so I think he was disappointed at the time that amm it's not a company certification, he thought it is like an ISO certificate that you hang being from the marketing sight but I think ammm seeing the result I think he was convinced. Ammm the thing is that was a transition time for the company also so the other the new managing director because that was transition time I think was involved and being also an ex trainer from quality or on management. He was a management training he was retired and come back again to the company. At the retirement time he had opened his own business in Management training. So I am sure he was diverse in TQM and six sigma. aaa I think he accepted he was on the positive side. And I think actually he was the person who make sure that aaam that there would be a forum special forum that would take care of six sigma and that also the training would seeing the affect the result of the training with the executive manager. That he would that training needs to be taken over to the middle level management. So he also proposed training for because from that point view considered to be ok. The top management, was on board, what about the middle management so there was another session that was also prepared for the middle level which are all the managers in the company. And then a collective decision or I think that supported earlier decision seeing the feedback.

A: for me I am a manger a new manager, how can I persuade my top management you think?
H... I'm sorry I didn't understand the question.

A… as my question was I am a new manager I would like to know about the six sigma

H… you would like to know ……..

A…and want persuade my top management about six sigma…..

H... oh --- ok you want to persuade them about six sigma

A: Yes

H: I think one way was as I explained you we have done it by showing evidence and results aaaaa we did something the way we have done it is that ok aaaaaaaaaaaa one factor one of the argument also was that will it's, it's a different culture because you are applying it in dubai that was one of the arguments. So all the examples that were shown or examples of international companies that implemented six sigma like General Electric or Motorola. But there were no examples of companies in the UAE. From the marketing point of view aaammmm it helps us because if we were to go in boarded ….it would be the first company so that was from the marketing point of view that was also one of the decision being a leader, a market leader. That was put for and that was support to be marketing. The other thing to support that decision was that financial and basically it was agreed at that time is that the training would take place on group of people a first black belts they could be given a project

Excuse me ………..
Ok we started the training one of the acceptance factor another one or the persuading factor the persuading factor was that we liked the acceptance of the six sigma to the success of the

pilot projects. So there were 4 black 5 black belts that were given five projects live projects. And the success of the training of future acceptance of the training was put on the success of those projects was based on the success of those projects. So those projects took about a year the time frame was given the chapter was develop and the trainer used to come aaaa about every three months. Complete a phase and then to review the project and then come again after three months to give time to implement for implementation of the earlier phase. And eventually aaaaaa one of the projects which was improving the bottle nick the company bottle nick paid for all training within a year and aaa that was the main success factor financial result the pilot project proves itself during the training so you made the training you train 4 black belts the project was successful. And the projects were selected in such a way that the distribution of the projects were in such way that they would cover the whole business. One project was in the order selection another was in manufacturing cycle time another one was in reducing …and rework and another was in the testing. So all these projects were the project were covering aspect in business. This is also I think was done to be sure that six sigma is not on limited to manufacturing although the company is mainly manufacturing entity but selecting project in such away I think was a clever idea essential that six sigma is valid in different aspects and that what happen. That was the main criteria for moving on six sigma and following the plan at that stage so but and again I mean this was actor pilot but in earlier stage of course this depends on the management this depends on the driver out still have to see was the believe of the managing director and one of the GM’s in six sigma. In the benefits of six sigma.

Sorry for disturbance……..

Aaaaaam yea... what I were saying is the managing director had background had some background knowledge about six sigma so there was no further need to convince him. Although I said there were two at that time and it was transition between the new managing director and the older managing director and the older managing director was mainly coming from business point of view he was stressing from the business point of view because of his background in marketing and sales. So he was concerned about the certificate that would be hang on the wall. The new one he was coming from the different perspective. He was a trainer because he was retired and then he coming back to the business. And during his retirement he was managing training company firm. So he had background knowledge he didn’t…… he was not really need further convincing but as I said both came true because the first criteria was from on the ground that well if it takes six sigma, six sigma is not apply in the Gulf. You will be find year and it will come to advantage and truly it did. We have won the Dubai Quality Award ==== category and six sigma was one of the factors, contributes at least. And the managing director himself he did not need any convincing because he knew about it earlier. But I mean that was also contributing factor previous prior knowledge about six sigma and the mentality of the management was also important at aaannnnn hmmmmm their commitment is very important their commitment for continuous improvement is important and their philosophy of continuous improvement is important. if I think the management were in the ===== they would aaannnnn I mean see the results of continuous improvement they would have ground for six sigma. They would just say ISO certify and that's it. They had a vision they saw the future of all about they saw the affect of globalization they saw that many companies will be coming in, competition will be coming in. You will know the only cable company in UAE. So you need that extra edge you need the extra skill and they need extra improvement and they saw six sigma as a potential tall for achieving that. So aaamm but their mentality was important their attitude was important at that time. They had they were lucky actually to have that. aaaammm it's also comes on selection in the general manager extra extra extra…. I mean it's also at Ducab always has a rigorous procedure process. I think even its confidential even some the general manager goes to the psychometric test. This is to see how fit they are in total. But only by profession to lead the origination. And the top level you need that type of mentality otherwise not only with this six sigma for any other improvement or any other initiative you need people who know how to manage change and were not rigid because you in the situation were cold rigidity takes place. Basically that you're so good at some thing that it becomes you downfall in future because you can't change you've been doing it, and you perfect did it and that shown the result but you can't change for it, this the problem but I do not think the management here have that. They weren't so rigid they always flexible and always and knew how to manage change and they had different outlook on on … improvements that this is very important. But I think it was all about because it was taken care from marketing point of view meaning being a leader in that and it was also taking care of financial point of view meaning the result to show the results ==== and also from the change a man point of view meaning that the training of the lower levels and the information of forum for six sigma and internal steering committee for six sigma and also it was put at the highest level because it was allocated an hour in the management interview and then monthly management interview which is only attending by the executives this is to show the importance of six sigma to the company. So that… and they were all the thinking was allaying in this sense they aaaaaa... Their appreciative of visibility that six sigma bring to the company, they were at time would aaannnn who would aannnn appreciate visibility because they knew that if things visible improvements would take place there would be involvement from different sides and eventually it will be for product development. I think I heard stories of other organisations who were looking at six sigma the same question was asked to those companies weather to go ahead or not with six sigma and one of the leading companies in the UAE. Almost a monopoly and say aaam monopoly type of company, the top management after seeing that six sigma after seeing that implementing six sigma with entail visibility people comply. So it's you can't convince everybody they has to be it's like communication the sending is one part but the receiving is another part so I… the things have to be already in the receiving party. They have to be base, have to be some understanding otherwise maybe no matter what you do is not conveying massage the communication process would they was something in that which explain to aannnn

A: Maybe the second part of the question, OK. How does it work and how can I establish this scheme in my company

H: it's not easy, it's difficult, it requires lot of patient. And there is learning curve that associated with it. The early part of learning curve is long and that the most difficult part. First you need to train people =====who would be the references of six sigma. They need to be there is they need to be aaaam suitable for the program aaannnn during the training program aaaam those people giving full time support from their management, lower management not only from the general managers. Because although the drive coming from the top the middle management has to be convinced. We did that by showing it by bringing them inside the program to give them honour-ship otherwise there will be nonbelievers aannn then you have some area were the management may be will not fully converted so there is a level of management that needs take place from the executive management to the middle management, they need there… they has to be that level of management. Because those black belt will be coming from different areas the managers of those areas need to be fully convince about those black belts are doing they need to be giving support in terms of time because many of the black belts they have main functions and responsibilities, so they need to be scheme of diverting that those tasks to.. to.. others in that area otherwise it would be just lip service. You would say the react that black belt is fully dedicate but in the reality is not, this what happen. Again this come from the structure of the company. They should not be always one person doing everything they need to be some sort of.. of.. jobs distribution within the unit this is very important. Aannnn another is those black belts selective black belts they needs to be selected carefully in a such a way that not only having some.. some… professional knowledge or scientific knowledge but also business knowledge they need to be well diverse in the business experience in the business, not extensive experience but at least aware of how the business clicks, and how aaa interactions general occur in the business. They need to be because part of six sigma project is driving and managing projects. The person does not have that knowledge is very difficult if he does not know who is who is in the organisation it will be very difficult part of it takes holder the management he needs to know who those people are so if he is not experience he will not do that. aaaaaa this is very important. The other aspect is he needs to have some knowledge in math and statistics, I mean most of the… people holding bachelor degrees nowadays they have taken sometimes courses in statistics. So that is covered there. And here the person who is teaching who is training was conducting the black belt training needs to be an experience person and a practical person and pragmatic person. Aaaaaaaaaaaa statistics can be a boring subject and can be difficult subject. The way the instructor conducted statistics training was very interesting. He did not well that much in the numbers and the equation he was trying to making common sense of the tools, he was trying to make sense of the statistical tools on the main differences between different statistical tools. And on what the… what is the main outcome of these statistical tools, what is the indication of these statistical tools, not how to drive these statistical tools. And in case there was an overlap between two tools he will not stress that much on the adequacy of that tall. He would.. his perspective was different, he would take that both are valid so only that one case you might be more confident your confidence is more by maybe five or ten percent. But he will not stress that aannnnn you will only use this tall for this situation so he is perspective was different. He would not stress on 100% on this issue. he was more… his perspective was broader, it was on how to make sense of the data, how to transform the data into useful information. From that perspective I think.. he was.. that was the success of the program. He would use lots of examples from the current industry not from other industries he was able.. he was very capable of tracking this examples within the cable industry, not only giving example from other places he had worked, this is very important. So I even remember because I was in the black belts in some of the examples in some of the.. in the course of the training if he would talk to me he would give me ideas or examples from manufacturing, if he would talk to the other black belt because they dealing with something in the testing would give them examples from the testing, and then from the marketing or from the sales also examples from the sales. And it was easy for us then to relate the tools to the data and make sense out of it. And then hence have an understanding of this.. and appreciate the statistics actually. So he broke the fear barrier factor. aannnn and also the car.. as I said the character of trainers is very important it's…aaaam experience practice and not a taking from academic.. pure academic point of view that is very important, otherwise I think a lot of us have been turned… turned off from the statistic. Aannnn another thing is the forum that the top management made. They made aaaaaaaaa…six sigma was allocated aannnnn ---------- in managing meeting. All the black belts once in a month they would come and they would present the cases and there was one who was made the coordinating between the black belts. He was basically dealing with the some of the issue that mark may they face because remember all of them they weren't at… black belts were not at the management level they were at… they were engineers and they were the staff level, sometimes in they were have some they were facing some difficulties. So the job of the coordinator who was a manager who was a black belt at the same time trainee black belt was to facilitate those differences, and of course talk to the sponsor who was a general manager. In the management meeting were meeting once in the month discussing all of these issues presenting. And also that was very important because the black belt felt the importance of the program and also they were given full support. Aaaa.. another factor was that a lot of black belts they were award for it. Two of them got managerial positions and one of them moves to Canada he got.. aaaan… and the certificate itself was.. aaaa.. passport, yes. Aaannnnn another the other manager the other black belt also he became an executive manager he was a manger and he promoted as an executive manager, the last one he got promotions but not so much as other two aa.. and I think the reason is the lack of support that he was given from his manager at that time. He was very negative about six sigma.. in fact he was negative about any improvement. Aaaam.. but the other black belts they felt very good about the program. They were look at as heroes in the company. As aaa.. and one of the project after one of the black belt did some work after the analysis and in the improvement stage he came up and put some potential solutions in the pilot aannnnn and he defined the bottle nick machine and the main criteria that was the machine should be running all the time, the managing director was frequently seen at odd times and walking into to the shop floor, and then just looking at that machine, if it is running he was happy if it wasn't he would just aaa.. shoot off to the production and he said this is the bottle nick why is not running. So that support was very.. very… important it gives support to the black belt, well you see my work result is something I have found out where the problem is and even the managing director does not have to observe all line just this line which is as a result of my the project. So that was real motivation factor and also in the newspaper that the on the auditing the company produces over the success stories were reflected and written and there were pictures they can of the managing director standing with the machine with that black belt, and also it was more than one issue. After was the training did not stop after that black belt was helped the result that six sigma --- is important and we need to bring more people of worry. So then the company started the green belts training. Different staff members were selected and put to this training for a week aaa the company have so far about four different batches had granted for training and the management have insured they would be projects generated after the training give in fact that was one the aaaaam… one of the aannnn… the indicators or… one of the… the things have they were been targeted all the time, the number of black belt who don't have projects. That was monitored all the time and reported even in the management meeting, so… aannnn and still the forum did not stop those green belts were.. their project was also is continued to be reviewed at that management meeting, that six sigma forum that is.. that has been growing on for the last five years or four years in the company ----- six sigma it has not seized even with the changes of structures. It's like a heritage that each managing director is handing over to the next one. And I am glad to see that it's still being ----. The other thing is the patience. Patience is very important. I've mentioned that in the early stage, it's very difficult as I said and I am very glad to see the level of patience with the managing director. The first is some of them the project is not as successful as the others but it was never viewed negatively, it was always viewed as an opportunity for improvement. That perspective is very important no project was scrutinized in this manner. It was always the stress was what are the learning from that project that view aannn is.. this view is essential in the success of any project, again this comes from the nature of the managing director. This is an important factor. I think this is the most important factor in the successes of any six sigma initiative. It is the commitment of the top management, this is the most important factor, without this commitment I don't think six sigma will continue in any organisation. Another is the selection of the projects I think this is an area where we are facing some problems, it is how to select the projects sometimes very successful because some of the projects are linked to the major issues in the company. I noticed that those are the most successful project. Others maybe because they come from the wings and believes of management. It's.. they are not so successful the results are…are.. are humble aannnn but never the less the management looks again the view on those projects as it's a training for the green belts. So maybe they understand the difference between the black belt projects and the green belts projects, maybe some projects are driven at the start I mean just for the seek of training. But however now it’s becoming more and more rigorous more and the importance is shifting to the selection of the projects so it’s taking place and phases. First the six sigma was the -- as ok and embarking phase and let’s embarking six sigma and see the benefits there are the drives come from the top management and the black belt trainer himself and then afterward the success it was train more people and then now is shifting to project selection and I think in the future at soon I would see it now is shifting into the six sigma matrix because so far we are not using the matrix yet we not using the sigma levels meaning a variation, but I see it happening now soon we are going into not only attaining the results but achieving the results but attaining them at the same time, so now I think the next phase is that -- I see it already happening which is ..as I said I’m repeating myself which is the selection and I see the attaining the result also---… I think these are the main things that I have to say about success of six sigma.

A: ----and would you like to summarize the steps how can I establish my six sigma scheme in my company?

H: yes the first I would say is you have to is… introduction to top management, convincing top management and I give some examples aannnn the third one is introduction to middle level of management and convincing them also, aannnnn following that would be the training of black belts selection and training of black belts aannn projects and results and then I would say aaaa selection of the green belt projects result and then improvement which is the feedback you have to feed the system I think six sigma itself starting six sigma initiative is the six sigma process itself.

A: Do you think you give me all the information what I need or what you want to add something?

H: aaaaaaaaa change is not easy, change is difficult. I mean of course there are issues but I think it’s… but these issues are mainly linked to change management. So I would not eliminate any issue that you would face with change. I would expect it may be I forgot it in this particular moment but I would not exclude it. It’s ---- shift. It would be difficult.. in many different ways, maybe we have not covered but it will be difficult, but you need to concentrate on.. on… how to keep the momentum, keeping momentum is.. you need to concentrate on that aspect I think. If you succeed in that those factors will contribute, because they would be eliminated as long as you keep the momentum, you have to keep the momentum you have to ensure that the momentum is there. You need leadership you need lots of leadership from different levels from the top from the middle even from the black belts level. You need leadership. You are changing there is ---- shift you need momentum and you need also commitment and stress from the top. You have these two I think it would be successful it is bound.. it is.. it has to result in success, otherwise it would be too difficult. I mean.. what are you thinking what are the difficulties you thinking of? Any specific difficulty anything you think or my think is possible. Many difficulties. There are lots of nonbelievers but at the same time there are believer. How do we get over those, I mean how do we convince them? By showing result. How do you do that? Put a lot of effort it, it’s a lot of hard work. How do you do that, how do demonstrate from the other party convert other people other team members you demonstrate leadership. How do you co-ordinate between different teams this is very difficult, there are marketing there is a project that.. that.. involves design and manufacturing and… that it is critical because sometimes you may find a problem in one area that is not being addressed. Well the management has to be matured. it needs to address these issues in a professional manner. They should not blame… they should not blame those people where the problems are in their areas. No, they should take that as an opportunity for improvement. If a project finds some negativity there is it should not be taken as negativity it should be taken as an opportunity for improvement. People should not be blamed. It should be the system all the time. The perspective is very important. Always improvements should be taken from the point of this perspective of system improvement not aaaa.. blame, blaming people. The management needs to be mature and understand these issues before implementing six sigma. Because these projects will indicate deficiencies in some places. So at the management they need to take it from the perspective. Otherwise they will kill the initiative, they will discourage future six sigma projects, the management needs to be mature. Because that’s what I am saying visibility, but to have visibility you need to have maturity. Otherwise you.. it could be bad tool or pressing or etc. For I mean.. for… pinpointing people. No, it should not be used, six sigma should not be used as a political tool basically. How don’t use something as a political tool well it depends on the person ha ha ha ha ha has nothing to do with the tool yaaaaa

A:- something more you want to add?

H:- aannnn…. maybe it is going to be a lot some aspects of team work. There are many tools or what next? In my area because I am handling manufacturing engineering the.. my perspective has changed. There are lots of fire fighting. I am not saying they still not taken place but to a lesser much much and much lesser--. Aannnn it took of us sometimes but we feel now that we are starting to aaannnnn to understand the essence of six sigma. Now less fire fighting is taken place. Our efforts are concentrated in areas where it's really needed, meaning we're using eighty twenty group. But this is because of six sigma after four years of continuing these different twenty eight projects in the company. My engineers are now we are data oriented, we are following the data. And I am very glad to see that taking place. There is a shift in the culture before it was only experience but now it's shifting it's becoming data.. it's becoming validity of the data what data are you collecting is the data biased or not what data… again I am repeating myself.. what data to be collected? How do you collect the data? Where do you collect the data? Is the data are representative? And then what do you do with that data? And then can the data lead to, you need to which data can you take that would lead to a solution. I am seeing that and I'm very happy to see that. And I'm seeing that.. even my work load is.. is.. my stress level of stress is going down less and less. Aaannnnn I am glad to see that because the movement was that… well maybe you don't need to keep continuing projects all the time. There issues maybe you don't need to do but use the tools. Some issues, yes, because still we have some issues that are major issues we need to form a project of it. But I am glad to see that six sigma tools are being used in my department and it's leading to.. to interesting and… and.. effective results. I am very glad to see that. Even now I mean we are saying that aaam… we want to do more we are saying that.. remember when you start six sigma you will not use all the tools at the start you use 20% of them now I am starting to use 50 – 60%.

A:- aannnnn

H;- I forgot

A:- we talked about the data you know

H:- Yes.. the… many benefits of that things yaa… so I can see that.. that everything that is all the problems are occurring now people asking for the data. And what is the data saying so they want to hear the voice of data and it's becoming more apparent in many areas now. I'm giving the example of manufacturing but I can also see extending to other area people more about data and what the data is saying, so this is I am glad to see this aaannnn taking place.

Aannn as I've mentioned the operator I think already we are doing that. The other thing is the things the (nights) tools like we design experiments it's.. ok. Now, It has being about 4- 5 years since we first start the presentation but now.. aam.. after that time I am starting to see the results of experiments, because the tools that was not used earlier but now there is application for it, and we've seen the benefits of using this. It was aaam.. really beneficial in the sense that it has eliminated arguments. Because on this particular one that we have recently used we've used design of experiments a full facts ---- experiments meaning we have considered all the combined.. different combinations. So there was less argument on the methodology and more on the results, the actual results. But aaa.. this has helped us because earlier I mean facing many problems that.. that.. the other argument.. the other side.. the other argument with the other side was aannnnnn was.. well.. I think you should have done this and that, aaam.. have you considered all combinations aaa did you start this or the sequence aaannnn repeatability was the.. but now this tool that argument is over. The shift is more is not on the methodology which ----- it has reduced many stress because I am the manufacturing representative. I come up with the experiments and then people used to question the methodology itself, now it's less on methodology. Because this tool is helping me actually. One of my argument is now considered all the combinations. It has aaa.. really reduced my stress. And even now I am… we're taking this and we're trying to apply more into our daily routine work. Many of the trials are using now encouraging the use of design experiments aannnn I think this year the first one and now I am seeing an example of three others are following up from the engineers. So there are aannnn these tools are really important I see it. We have used the building… team building model aaaannnnnnnnnn that was in the.. I've seen also the results of that I mean people are different, people in team are different. When you.. the implementation of that.. I mean the idea behind that tool is that you need different roles in a team. And those roles are important, and the more roles you have different roles you have in a team the mo… the higher the probability of success of that team. What I found is that just by aaaannnnnn filling out or.. or filling out the questionnaires of that aaam.. survey or questioners by passing it around to the team, by administrating that test itself, I have seen the results. People started asking aann… so what am I? Am I implementer? Am I planed? Am I… aaa… I mean there are nine of them… or so the team.. Am I an investigator, am I a team worker, am I a specialist? What do I.. what character do I fit? What role do I have in a team? Also people was saying well so and so you know, he is… he is too shrew he is always.. heh.. detail oriented, he cuts of people he is always you know doesn't think like this but then that person now is… is.. Like oh no.. no it's ok …..

Actually he is an implementer, so it's ok. We need somebody like that he is important we understand he is different but now that difference is not.. not a negative aspect. It's actually positive aspect. We need a person like that actually. So I notice that… I notice that by administrating that test there was improvement and it is also too ---- available in six sigma team management. So… aannnn there are benefits you will not get it from one project but you need number of projects to reach that level. Aaa.. even yaaaaa. I think that's about six sigma.

A;- thank you very much I am glad to hear all these information, but also I have little bit questions about some you know what you've told me you know I'd like more explanation for some of you know themes, and some of what happen during your journey in six sigma. You've told me that the top management seeing the result that the six sigma scheme can you tell me more about how the top management see the result can you give me some examples?

H:- yes.. one of the projects aaannn this is part of.. this is one of the nice things of six sigma it has an objective and the objective is purely stated at the at the start of each project. Each project has a charter and it states the business things, and it states variable resources basically, and it states the opportunity it means where the area of the improvement lies in and it also states the goal in it. So the task was easy for the management actually. And then management.. and then there is time laying and then there is what is.. the in of scope of the project out of scope of the project. So the.. and the management accepted that or it forwards to the management they review it and accepted eventually, or argue some part and changes take place and then they accepted. So the management is given that and they aware about that. It's a contract basically and the goal states there. Basically on the project, One of the projects the target was 10% improvement in… in.. outcome.. in the production line or output.. total output in a given period of time, using one operational definition meaning specify measurement method. At the end of the project the same operational definition was applied and measurement was applied, and it was measured to be 30%. So based on that the management saw the results. It makes clear from the start. What the progress. And this is.. the.. I mean.. this is one of the advantage of Six Sigma makes clear from the beginning, this is the goal that what I have to achieve, have you done it or not. Have you sustained, is it sustained or not? So the chart was made afterwards shown that this level 20% the 30 % is maintained also, it showing and… and.. that metric was actually what company, was actually measuring from---- clearly also from those reviews everybody else was seeing the significant improvement

A: another…

H: and this also in each of the project it is coming from charter and global statement in the charter itself project charter.

A:- another question you have said there is different culture ---- you say about six sigma.

H:- yaaaa

A:- what do you mean exactly by different culture?

H:- Culture in terms of back… people background, demographics emmm.. education emmm… Here the structure in Dubai is.. that the lets take example of.. Dubai… Dubai Cable Company. And I think it's representative of whole of Dubai, or whole of industries in Dubai. You will find the same structure in many other manufacturing companies in Dubai. The word present the shop floor are mainly from sub continent the operating network are the operators in the shop floor. The top management is from Europe or UAE Nationals. The staff you find a mix and up to recently most of that technical aspects are covered by the sub continent mainly. It's changing now, because basically changing the country invest in a lot allegation to revelation etc. etc.

The engineers are mix. So you have this aspect from.. aam.. and.. mainly the people from the sub continent or were coming from the sub continent working in shop, they mainly here for… to make the money and then send it back all off their home. Basically in case is. So... in many other industries could be the case… it is the case that... aa... the attitude in the shop floor is just I'm doing my---and that's it. I am doing what I am requested to do and that's it. So in many cases I mean.. it is nature.. it is.. you know.. if I know something better I keep it for myself to insure a longer stay to insure that I'm still a key in that process. And you can take this simple idea across the different levels. Even from the top management up to… it is sure process across the industry. Ok some companies are different because the work culture is different, their attitude is different from the beginning. The management insures that there is visibility, insures that stress is getting the job out and insures that no internal politics, insures that it.. it… attacks the system, it corrects the system not.. it doesn't blame the people no blame... blame free culture etc. etc.. There are… And here in Ducab have this no blame free

culture, we haven't perfected it but it is one of the management thinking, we have that. But it can be a factor, it can be a negative factor. If it is there… if you have this mentality and you gone make everything visible and clear and in Japan I think they call it 'poki yoki' mean so simple that anybody can do it. Because the result of six sigma give visibility and so you will have a problem there. --- Some of these forces may counter maybe counter product and it will not be… they not... they will be not fully aligns towards achieving the visibility and continuous improvement you will have this difficulty. So... and then because the majority of the work forces they are coming from the sub continent, I mean... it is the culture I mean the people of shop floor is that.. if you look at it.. they are inward thinking they are not outward thinking, And… I think this is for operators all over the world, engineers are different, management I think.. different, operators are inward thinking. Meaning even if you discuss.. if the supervisors approach them they always…. The nature of the operators regardless the nationality always they feel that they know better than their management and then the management is not practical and any improvement that takes place. It is taken place to cut down cost not to ignore human side things. So this is in general, this can be a block specially in manufacturing company any improvement is looked at they are trying to take my job or to make me redundant.
Also the culture I mean because of the sub continent culture generally is that they don't take emmm.. blame result. They..emmm it's mainly from my experience is that if you find a fault in one area is not a fault, difficult to accept that aaaaaaaaaaa for an often --------he said fault is very different to do that. So if you trying to improve something it is also no this is right, it can't be even is the best way this is best way to do it you can't change it no you can't change. So this is a problem but here we did not face, it wasn't editorial factor because already the company has a blame free culture style of thinking as I said it is not perfected but it is already there, so it wasn't that much of problem.

A: Ok, again you've said that success training based on projects when you talked about how six sigma can you know be chosen, can you give me an example or examples for these training projects you have any?

H : yaaaaaaaa

You want examples of projects that we have that, well the project… that we have… We have projects in the bottle neck identification and it to be increment by 10% we had another project in reducing rework and scrap we had another project to increase the conversion of inquiries into the sale orders we had another project in reducing raw material consumption and given product to minimum and still passing we had project.. six sigma project on manufacturing certain type of product right first time increasing the yield we had another project in improving the reliability and cost defectiveness of purchasing of sundry raw material which are materials are not common. We had also the project to incre… to reduce over usage of another I mention one material but this is I think to reduce the usage of high voltage material, we had a project to increase aaannnnn an output for certain no… this is repeating team but it's another line also another product plant because it's a functional demand increasing output of building wire we have a project on delivery performance improvement we had project on increasing the factory scheduling appearance or factory schedule appearance we had a project that this material saving project another one on another material it's a repetitive team we have scrap monitoring system project we had a cost comparison project we had the project on over time.

Ha hahahaha

So these are the… and we had a design project even to… you could do it as design for six sigma we had a project for that also.

A:- And.. how do you describe the result of all these projects ?

H:- ok, I think in total number is 28 projects. The.. from the financial point of view I think the success ------- project I think about 70 to 60 % of successful. Successful in the sense that they have shown tangible results. The other projects aaam.. about the ok.. 40% of them are specially in areas such as aannnn sales and marketing they have identify reasons because the project started and finally they realise well they can't achieve that the problem actually is not that. The problem is lying somewhere else. I mean, one of the project was to increase the enquiries but then they realise that well.. even if we do the problem is that we not able to meet them so the learning was that well we need to enhance the capacity. So the project started from one angle and then it shifted to.. it..it another it.. I mean, because of the define, definition and analysis it was found that well, the problem is not there, the problem was somewhere else and you need to attack, so there is no financial gain maybe there but there are other.. other intangible gains in that, and that is the nature of project. So what I say 60% what I meant is that financial gains well I mean 60% of them showed direct but the others I can't justify it. Some of them ok. They drifted and… and were not successful in the sense that the project was abounded. But nevertheless, they have identified areas that we need to improve it. So 60% is I would take it but maybe 60 – 70% I would say that was success. Here the thing is some project the problem is that they take long time, they go out of the time scale original time scale. This is the problem, but it is the patience of the management and because as I've said they have long term view, they have a vision that's why the patient is important.

A: Ok, again you've told me that it needs a lot of patience and is not easy.. six sigma. What do you mean exactly by not easy?

H: Meaning that it's not well.. when I first started implementing the six sigma project.. when first started the training program I thought it's a magic box honestly. Ha hahaha

I thought it's aaaaa.. it's something that in… in… you can within a very short period of time you could solve everything. Of course that was because of my ignorance in six sigma methodology aaannnn then I realise that the… it is not magical tool.. it's not a magical box. But it's a magical tool. It has effective tools that if you use properly would you and… would that.. would lead you to gain the results. But it takes a lots of time and you don't expect that you would achieve this is over night it takes you time. It.. it you will need the support of everybody specially from the top ----- to achieve result at the same time, you need a support of your… immediate managers also, and supervisors to achieve that result. Aannnn.. and it takes a lot of time. It's hard work it's don't expect that you would aannnn.. I mean, sometimes you need to collect data, that is not available. It's difficult chapter. Sometimes you collect data and you find out that well.. it's not the data that I want, so you have to restart the process again. It takes time. You need patience that's why it's not easy. But the thing is after implement so many of them then it becomes second nature you start understanding what it is what all about. Some projects are straight forward. I mean you would start with some projects straight forward you would get the gain quickly, but some projects are not. But on the longer run you find that number of project in different areas you find the results start appearing everywhere different areas, but it is not easy it takes lot of everybody from the management to yourself from everybody.

A: again…

H: even sometimes from home because you intend to stay sometimes additional time in.. to make it work enthusiasm to keep enthusiasm to keep the momentum you will have pits you will go through pits that you will be at red button and.. and you are looking for life and then persistence and by support from the management and the trainer will come to see the -------

that's why it's important to have a good trainers and experienced why trainer the prove hehhehheh

A:- ok, again another question you know.. you've talked about change managing, or…?

H:- Yes, change management, yes

A:- Could you please tell me about change management in your company how they you remember particular example in change management ?

H:- Yes, aannnn.. in top management realise that the implementation when to.. to have --- of success the middle management needs to be on board. So what they've done they have involved them from the beginning with the aaa… projects selection. For work six sigma they invite them to the training. so they would on board, so this is a way of managing this, that was one. The second thing is that aaam.. the management lifted six sigma to special forum at the top, that was another way to manage this aa.. change, that takes place. The third is the incentive for black belts another is the it actually insure that they would they allow to spend more than 70% of their time or sometime full time doing the six sigma that was part of the… aaannnn the training itself was one that the management put in there and ensure that first there is.. it's phases, first it's.. it's the training itself would be on live project that was one way management insure that managing six sigma. Aaannnn the quarter review meeting it had… the coordinator was briefing all the other management about six sigma, aaannnn it was put as quality initiative for the company, so now when we get audited we also the six sigma projects they.. are part of audit when it takes place.

This is.. so the management I mean.. first because invest by top management the it was made part of the system, so that it does not become aligned ann.. ann. it does not.. it doesn't become eliminated from the current system try to make it as part of the current system. So now I get.. so that at many points of time it's difficult they would say to start six sigma project initiative project by the chapter so they need a part of the way to do the business actually. So that is I think what the management did to manage this shift.

A; Can you please tell me more about the commitment of the top management and could you please give example.

H: aaannnn I give some examples of aannn... the top management... I… I… about the managing director himself getting involve with the project coming and visiting. First we made special room call six sigma room for all the black belts were sitting in there it was like a lab. They were given special lab tops with the software in it, statistical software. So it was look that something different and the managing director from time to time would come and visit the black belts at work, and review the flow charts on the wall and just take convinced visibility. That was, that was encouraging and even on the pilot projects he would come himself and watch the improvement on the ----- aannnn in many occasion he would different speeches he would discuss six sigma. In many of the successes of the company… he would relate.. he would relate many of the successes in the company to six sigma. In many of news bulletin he would mention six sigma aaannnnn and also they encourage some of the black belts to give presentations to other companies of the ----- aannn promotion.

A: Money wise

H: Money wise the.. no it was in term of promotion aannn… going up the leader in the origination. As I've mentioned two black belts became move in management… three black belts moved to management they were staff level they were moved to management one lift to Canada and another one is… ok.

A: I mean fund of the programs and training and all these..

H: of course yes, I mean all the programs are funded there is special budget excuse me… there is a special budget that was made for six sigma. that there is in my budget now there is a budget for six sigma that is made -------as aannn ------ and one second yaa haaa there are budgets there is the budget that is made only for six sigma expense

A: ehm... which is enough

H: It is enough for the projects. This covers the training, the yearly training the green belt training that takes place. Well, the projects also are supposed to be… their projects that they supposed to be paying for themselves. If you start the project there is.. there is aaa.. financial measurement, you allow to spend this and this not more than that, that's for you.. the.. you select important projects in the project the gains of projects… they.. they pay for projects, or some improvements. And that's… and that's what we trying to do on these management meetings, we are trying to identify the gains of the projects to see the projects are paying for themselves there is an accountant who sets at -------- value of that project

A: Last question is, I'd like to know you've said that is sort of math and statistics would you give me example of about sort of math and statistics which you use or you need in six sigma?

H:- Math's and statics

A: Math…

H: yes, amm.. we use I mean a central.. I mean ok. Math… we use probability we use capability studies and in capability studies aaa.. you need to understand the different definitions of Cpk and top and aaannnn… ok... not so much with the equations because the software they do a lot of work. But sometimes after doing so many works you need to understand the back ground of these statistics. So physic themselves are equations that you need to understand, the concept of probability itself you would be to understand it, the distributions and the validity and the differences between different distributions, which distribution is an equitation you need to understand them. -----the normal distribution the way you turns a distribution these all involve equation and math. The statistical software made it simpler but nevertheless it is... when you calculate even on measuring the central tendencies or the variability you need to understand the differences between them, so you need to know how to calculate the ranges the variance, the standard deviation, this all about math. On the central tendency and calculating the mean the mud the mediate, you need to understand how to dissolve or calculation it might be simple calculation here, because it could be on Algebra or straight forward Math. But the problem is when you come to aaa.. the.. when you come to distribution could involve.. maybe higher level of math in it, may be integration. Ok, it is simpler Math because you use many cabery you use the tables and it will tell you, but nevertheless it is there. When you use we use we use the control… the control limits.. when you are doing the controls you need to understand the differences between them. Aaaa.. the math may be not that high you could get confused when you start to differentiate between too many things which one to use etc. etc. but it is the concept itself.. it is the concept… the concept can be… the concept is the most important thing. I think I've mentioned in my interview that.. the stress should be on understanding statistics not understanding the equations or dwelling on… on the equations themselves. It should be understanding the meaning of what are you doing the end results of what are you doing. And the validity of what are you doing that is. Not to do too much on the equations the equations are covered by the

A: the program

H: by the program itself. But you need to understand which tool to use and what is the difference between this one and this one, but eventually you need to take that separately as you go long otherwise you will stop. You need to continue your education on Math and that ----- black belt. Although I've took it, but I have also other resources that I keep study from time to time using example and this how I build myself .

A:- What kind of qualifications you need to do this math and statistics ?

H:- I think BS Degree is very.. is good enough.

A: what about labours?

H: Labours when you come from green belts the math is... is simple there, because it only about even adding and multiplying and subtracting that is. But the reason I see for I mean black belt needs to be at least BS holder because he is going to formulate system for that you need a level of understanding and that's my opinion because it's more than that because it's about knowledge of the business itself. Because if you are in a plant that is manufacturing… manufacture plant you need to have knowledge about the electrical system otherwise by itself statistics can't solve it. So you need we need business knowledge is important, that's why I say BS level.

A:- Ok in the end do you think there is a question that I have to ask you and I didn't ask you ?

H: Aaannnn…. Yes, I think I would aaa... I think you would have to ask me what next what is the future. I think that is a question. And the reason is that in five, six years, seven years ten years how do we see the results of six sigma. We had a review recently by the trainer who comes here and reviews the progress from time to time and one of the question is I surprised you still continue six sigma may companies that start six sigma and two years time they stop, or three years they stop. Something make you continue. So if you had ask this year ago, two years ago the ------- maybe three years ------ in the first year I made sceptic, but now I think I'm confident that this will be the way of the company. This will be the way of the engineers will be coming to the company, it's a manufacturing company mainly, so it expected that 98 % of the project or 90 and above of the project will be in the manufacturing centre. This is excepted this is a… this is manufacturing company so.. but how do I see the future as I said everybody have to have training in six sigma the methodology… the work system will be… will be aaa… based on six sigma methodology. Now everything is in project but in the future maybe it will not be a project. It will be expected that you will do these thing naturally. Aannnn the future I think now more and more realising the link between the different departments that what one department does affect the other. So, I think now we are thinking in terms of system thinking not every.. not department in isolation but it's going to be action isolation It will be every action that somebody is taking will be linked to the bottom line of the organisation or it will affect the organisation somehow no matter where you are in the organisation. I think the future will be like this, so to this it will may be the aaannn it will be expected that people will do these things without even --- projects so it will be way of life I think. If I see it 10 years down the line… 10 or 15 years down the line. I expect to ask me how long it will take you to become a full six sigma company? That's the question I would expect you to ask, I would say it will be 15 years down the line

A: To reach Six Sigma?

H: To reach.. to reach six sigma.. no, you say for the whole fact for.. the whole… I mean.. Ok.. it depends how you look at… I am not.. I am not worry about reaching six sigma we are in a growing… we are in growing industry.. we are in growing.. no, sorry, we are in growing economy. I am not worry that much now for reaching six sigma. I'm not that worry it's a growing economy. So it aannnn also future generate a lot ----- . Demand is always more than what can we produce you are good. But the reason I'm saying that, in the future may be it will shift so then, all of these tools become very important, if you geared to them from now it will be very good, so you are investing for the future. I think maybe… I am already seeing the results but to have everybody follow it. I mean, now the change that is happening I am starting to recruit people who are.. who I see can fit to become black belts. So my recruitment now I don't only look for very good engineers, I look for engineers who I see can have the.. can fit as black belts. Even the questions now I'm asking that are about problem solving methodologies I chick for that. So, I do that, but in the future I expect the company I mean.. that I see it is ok, because many people… I mean even I see it in other example I've given internally for… I see six sigma question some… so it is push that even without us realising that, it is already becoming us. But I think 15 years, 10 years I think, 10 to 15 years we will become six sigma 100%, 10 to 15years we should, the drives now still there, after four years still there is enthusiasm and still it's.. it's alive. So that's what I'm saying. I can see but you know. Now we attacking the big ones, the big projects or we are shuffling the business and seeing the area the major area of improving we are… we are restructuring in this time maybe not physically but even in our thinking. And indirectly in the way we are doing work or indirectly in our recruitment so we are going in that direction. But15 years I think we will be… I see it to keep up with this level of enthusiasm and in 15 years we will become six sigma in many areas, in many areas.. more than one area we are not only conforming to standards but in many other areas are coming in six sigma. I see the drive… I see the drive from the top, I see the drive… I see the commitment even recently I would surprise few days ago people want another project even from middle level I can see that. It will be the way this company is doing the business I can tell you that from now, we've seen the benefits we've seen the results we've.. we are developing more than one factory one in Abu Dhabi and one in here we want to have the same system we want.. we should be thinking alike. This the way to do it six sigma is the way to do that.

A: Thank you very much Mr. Hassan

H: No problem

A: for your time for your host… host…

H: Hospitality, no problem, heh hee

H: hospitality, and I'm glad to hear these things from you and if I need another session I'll call.

H: there are no issue no problem, you most welcome any time