

Title Improving the Performance of Six
Sigma; A case study of the Six Sigma
process at Ford Motor Company

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Improving the Performance of Six Sigma;
A case study of the Six Sigma process at
Ford Motor Company

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Abstract

This thesis concerns the question, "Why is the performance of Six Sigma within The Ford Motor Company below that experienced in other companies, and what can be done to improve it?" The aim of the thesis was to make recommendations that would improve the performance of Six Sigma within the Ford Motor Company.

Results from the literature were categorised according to headings found in the European Foundation for Quality Model (EFQM): strategy, people, process and leadership. The key factors identified from the literature review as being significant for a successful Six Sigma deployment were that projects were aligned to the strategy of the organisation, individuals were clear on their role and had appropriate skills, processes were well defined and understood and leadership team was committed to Six Sigma.

The research started with a review of the results from two employee surveys. The first was given to Black Belts and asked questions concerning Six Sigma. The second was given to all the employees in the organisation. The survey data failed to identify the cause of lower than expected results, and so the investigation followed with a series of twelve interviews. When these also failed to identify the factor or factors responsible for deployment performance, the project database was reviewed. The Define, Measure, Analyse, Improve and Control steps (DMAIC) were then analysed using Gardner's Model of Process Maturity.

The thesis concluded that the main influence driving Six Sigma performance was the low process maturity of the project selection and scoping processes and this gave rise to variable project performance. The thesis then presents material to improve project performance including a process map, a process Failure Mode and Effects Analysis (FMEA) of the project selection and scoping process, a control plan that ensures that the projects are on track and a macro using Excel and Minitab that works within the Ford Motor Company system to provide automatic evaluation of projects.

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Glossary of terms

BB – Black Belt

CBG – Consumer Business Group

CEO – Chief Executive Officer

COPQ – Cost Of Poor Quality

COQ – Cost Of Quality

CTS – Critical To Satisfaction

DBA – Doctorate of Business Administration

DFSS – Design For Six Sigma

DMAIC – The phases of a typical Six Sigma project, Define, Measure, Analyse, Improve and Control.

DMAICR - The phases of a typical Six Sigma project, Define, Measure, Analyse, Improve, Control and Replicate

DPMO – Defects Per Million Opportunities. This is a Six Sigma metric

EFQM – European Foundation for Quality Management

EI – Employee Involvement

EQA – European Quality Award

ESI – Employee Satisfaction Index

FCN – Ford Communications Network

FMEA – Failure Modes and Effects Analysis

FMC – Ford Motor Company

GB – Green Belt

GEC – Global Excellence Centre

GE – General Electric. An American company used as a comparator for Ford Motor Company

HRM – Human Resource Management

LLn – Leadership Level number. The number indicates the level of seniority within the company, 1 is the highest and 6 is the lowest leadership level.

MAIC – The original Six Sigma project phases, Measure, Analyse, Improve and Control

MBB – Master Black Belt

MBQA – Malcolm Baldrige Quality Award

MBTI – Myers-Briggs Type Indicator. This is the name given to a personality type questionnaire

P&L – Profit & Loss

PD – Product Development

PhD – Doctor of Philosophy

PTS – Project Tracking System. This is the Ford Motor Company database that stores information from all the Six Sigma projects

RDMAICR - The phases of a typical Six Sigma project, Recognize, Define, Measure, Analyse, Improve, Control and Replicate

SEI – Software Engineering Institute

Six Sigma – The name given to the quality initiative researched here

TGW – Things Gone Wrong

TQM – Total Quality Management

TVM – Team Value Management

$Y=f(x)$ – This is the Six Sigma notation to express an output in terms of the inputs

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1. Introduction

1.1 Introduction

The introduction describes what Six Sigma is and how it is related to Total Quality Management (TQM) and change management. Then follows a section to introduce the Ford Motor Company (FMC) and describe the research. The introduction ends with an explanation of how the thesis is structured.

1.2 Six Sigma

This section will describe Six Sigma, how it works and how it is linked to TQM and change management.

1.2.1 Introduction to Six Sigma

"Six Sigma is a long-term, forward-thinking initiative designed to fundamentally change the way corporations do business..." (Harry and Schroeder, 2000). Six Sigma is widely used and has gained acceptance as being a successful methodology for eliminating waste within companies (Harry and Schroeder, 2000 [9]) and can be defined as "a philosophy, a strategy, a goal, a benchmark and also a metric" (Dasgupta, 2003 [356]). It consists of a set of tools that aim to improve quality and reduce costs by targeting common cause or system variation, which Deming (1986) estimates to be responsible for 94% of the problems that exist within companies. It claims to work by providing problem solvers with the knowledge to guide teams through a process that identifies and quantifies problems before acting to control the main inputs that are causing the problems.

"The history of Six Sigma is a well-documented one and hence we note only briefly here that its origin as a quality improvement approach in the 1980s can be traced to the American electronics giant, Motorola where a goal of improving all products – goods as well as services – by an order of magnitude (e.g. a factor of ten) within five years was established" (Klefso et al., 2001). It is reported that Six Sigma focused efforts on all aspects of Motorola (Klefso et al., 2001). Harry and Schroeder report that Six Sigma saved Motorola \$2.2Bn over four years (Harry and Schroeder, 2000) and there are other claims that Six Sigma has brought about large-scale organisational change. General Electric (GE) for example claimed in their 2000 annual report that, "through the rigorous pursuit of four big Company-wide initiatives – Globalization, Services, Six Sigma Quality and Digitization – we've changed not only where we work and what we sell, but how we work, think and touch our customers", (GE, 2000). A further example of organisational enthusiasm for Six Sigma is, "Six Sigma has turned the Company's focus from inside to outside, changed the way we think and train our future leaders and moved us toward becoming a truly customer-focused organization." (GE, 2000). There is some evidence that these ambitions are being realised. It is

written that, “in business after business, process after process, Six Sigma reduces waste and rework” (Rath and Strong, 2003 [22]). Further work on its success is required and this dissertation will report on one such study.

1.2.2 How Six Sigma works

The procedure on which Six Sigma is based is that a number of change projects are run concurrently throughout the organisation. At a project level, the change occurs as a "state change" in Lewin's sense of unfreeze, move, refreeze (Lewin, 1947), taking the operating process from one performance level to another. Specific to Six Sigma programmes are the following features:

- They arrange senior management support for project teams' recommendations from the outset and are in this sense a top-down, rather than bottom-up approach.
- They are highly disciplined programmes using an approach that typically includes four stages: measure, analyse, improve and control.
- They use a data-oriented approach, making sound and heavy use of various statistical decision making tools.

(Klefso et al., 2001 [33])

However, Klefso et al. (2001) echo the view that Six Sigma is difficult to institutionalise, explaining that getting people involved in conquering mental barriers and using statistical methods in their everyday work is not easy. One of the assumptions of the Six Sigma technique is that people are rational-mechanistic and therefore can be influenced using data to produce improvements in organisational processes as is indicated by Harry and Schroeder (2000) who state, "Six Sigma's heavy reliance on performance metrics coupled with statistical analysis eliminates the fluff found in other quality programs". Six Sigma focuses on the "hard" aspects of TQM, and yet, being reliant on teams and dealing with organisational change, consideration should be given to the politics, culture and attitudes within the organisation. There are a number of ways that have been proposed. For example, GE and FMC have supplemented the Six Sigma training with leadership training that attempts to increase the awareness of change managers to the political, cultural and emotional aspects of change. FMC uses the LaMarsh model to describe the change process. The LaMarsh change model (LaMarsh, 2002) describes a process in which there are three main

components: the current state, the desired state and the "delta" representing the difference between the two. The leadership training assists the change agents in dealing with the 'softer' aspects of change that are not part considered to be part of the normal Six Sigma training syllabus. In determining how the performance of Six Sigma can be improved, this thesis will consider both the 'hard' and 'soft' aspects of the Six Sigma initiative.

1.2.3 Six Sigma within the context of change management

1.2.3.1 Change management

It has been asserted that the speed of significant change of the environment in which organisations operate has increased and during the last 20 years, the level of change has reached an unprecedented level (Burnes, 2000; Kotter, 1996; Paton and McCalman, 2000; Handy, 1992; French and Bell, 1999). It follows that surviving increased levels of change within the environment requires organisations to change to maintain alignment between what the company is seeking to achieve and how it conducts its business: the rate of change of the environment and the rate of change within the organisation should match (Ashby, 1964). This branch of management is called "Change Management".

Initial attempts at managing change fell under the titles of the "classical" and "contingency" approaches, as described by Burnes (2000), and involved telling employees what they should do. If the employees are rational and obedient, then they did as they were told (Burnes, 2000). The Human Relations movement then came to include the emotional consequences of change, through the use of leadership and persuasion (Burnes, 2000). The latest approach is known as the "Culture-excellence" model and its advocates rely on transformational change (relatively large scale systemic change) being achieved quickly though without prescriptive methods (Burnes, 2000). The concept of a learning organisation encourages learning as a motivation for change (Senge, 1990).

There have been a number of strategies for implementing change including: Total Quality Management (TQM), Business Process Re-engineering, Organisational Development, Learning Organisations, Emergent Change and the latest, the Six Sigma

technique. Marash (2002) believes that the number of quality-related programmes implemented since 1960 exceeds 70. The common theme that is central to each of these change management tools is that they all seek to take the current work process and move it to an improved level of quality.

Many modern change management techniques are founded in Action Research (French and Bell, 1999). "Action research is the process of systematically collecting research data about an ongoing system relative to some objective, goal, or need of that system; feeding these data back into the system; taking actions by altering selected variables within the system based both on the data and on hypotheses; and evaluating the results of actions by collecting more data" (French and Bell, 1999). Action research aims to encourage people to change and then demonstrates the improvements of the change to reassure people that things have improved (French and Bell, 1999).

Changes brought about by Six Sigma are carried out within the project itself and therefore the improvements can be described and measured. In this way Six Sigma is viewed as working on the basis of action research.

1.2.3.2 Total Quality Management and Six Sigma

Total Quality Management (TQM) is an integrative management concept through which the continuous improvement of products and services is achieved (Aldakhilallah and Parente, 2002). TQM aims to encourage the whole organisation to work towards a single goal (Aldakhilallah and Parente, 2002; Oakland, 2000) through a change in culture (Clinton et al., 1994; Caudron, 1993). As to the relationship between Six Sigma and TQM, it is written that one of the latest methods of achieving change is called "Six Sigma", born out of the Total Quality Management movement (Breyfogle, 1999; Henderson and Evans, 2000).

Throughout this thesis, the view held will be that Six Sigma is a development of TQM and therefore, TQM literature can be used to support the Six Sigma literature with regard to the deployment of a quality initiative.

1.3 Description of the research

1.3.1 Ford Motor Company

In 2003, Ford Motor Company was ranked number four in the Fortune 500 (Hoovers.com, 2003) and was acknowledged as being the world number two producer of cars (Hoovers.com, 2003). Hoovers.com (2003) reported that in 2002 Ford Motor Company employed some 350,321 people worldwide with an annual sales figure of \$163,420m.

When an organisation decides to change the way it operates, then a coordinated approach is required. Six Sigma is one means of producing such change and in 1999; Ford adopted Six Sigma as a means of bringing about large-scale organisational change with a view to improving organisational efficiency.

1.3.2 Problem description

This part of the report aims to explain the problem that exists. The problem description will form the starting point of the research question.

Part of the Six Sigma process is to understand the financial implications of any changes made to an operation. Six Sigma uses a value known as the "Cost Of Poor Quality" (COPQ) to drive improvements made to a process. The COPQ consists of all the costs over the life of a product or service that can be attributed to a defective part (Harry and Schroeder, 2000). This cost is the value used to record all Six Sigma savings. The fact that the Six Sigma technique insists on an accurate calculation of the money saved by each project allows the impact of Six Sigma on profitability to be known.

This research aims to understand why the performance of Six Sigma within Ford is below that of GE. While Ehrlich (2002) draws on the Ford's annual report (2000) and heralds Ford's Six Sigma initiative as an example of what can be achieved, the data portray a situation in which GE experiences a greater benefit from Six Sigma than Ford does. The gap in performance between the two companies needs to be investigated. The information presented in tables 1 and 2 is the situation in each

company two years after launch. Table 1 demonstrates that while the companies are similar and can be compared directly; there is a difference in the way in which Six Sigma has performed. To demonstrate that the companies are similar, the following metrics are considered, “Global revenues” which looks at company revenue, “Number of Black Belts” which considers the number of change managers within the company who are known as Black Belts within the Six Sigma quality initiative. To compare the performance, the following metrics are considered: “Average time to complete projects” which is a key metric since all process improvements within Six Sigma are carried out as projects, “Number of concurrent projects per year/ Black Belt”, a metric that would demonstrate if there were issues with the relative sizes of the projects, “Cumulative year 2 financial impact per Black Belt”, a key metric since this demonstrates the benefit seen by the company, “Number of completed projects” and “Cumulative Corporate financial impact”

Table 1. Comparison of performance of Six Sigma at Ford Motor Company and GE.

Six Sigma Metrics (At two year launch milestone)	Ford Motor Company (2000-2001)	GE (1996-1997)
Global revenues	\$162 billion (2001 CY)	\$91 billion (1997 CY)
Number of Black Belts	2,476	~2,600
Average time to implement projects	~240 days	120-180 days
Number of concurrent projects per year/Black Belt	1.3 per year	3 – 4 per year
Cumulative year 2 financial impact per Black Belt	~\$263,000	~ \$ 538,000
Number of completed projects	~2,500	~8,200
Cumulative Corporate financial impact	\$326 million	\$700 million
~\$370 M	Difference	

Adapted from A.T.Kearney analysis. Sources:

- (1) Ford Motor Company Six Sigma database
- (2) GE Annual reports
- (3) Public domain data

To understand the difference in the rate of deployment of the Six Sigma initiatives, it is necessary to investigate the progress of Six Sigma with regard to waste elimination on a year by year basis as has been done in table 2.

Table 2. Comparison of Six Sigma benefits at Ford Motor Company and GE by year of deployment

GE	\$M waste elimination	Ford	\$M waste elimination
1996	125	2000	52
1997	700	2001	326
1998	1275	2002	564

Adapted from A.T. Kearney analysis. Sources:

- (1) Ford Six Sigma benefits can not be directly tied to Profit & Loss (P&L) results for individual actions.
- (2) GE Annual Reports – Benefits impact bottom line directly and are documented in annual reports.

From the data measured in terms of Cumulative Corporate financial impact in table 1 and \$M waste elimination in table 2, it can be seen that Ford was achieving approximately half the performance level seen at GE. Critically, Ford and GE are companies of a similar size that have a similar number of Black Belts. The turnover at GE is lower and therefore the fact that Ford is seeing lower levels of financial savings suggests that there is huge potential to improve the performance of Six Sigma.

This thesis aims to answer the questions, “Why is Six Sigma performance at Ford below that achieved in other companies and how can it be improved?”

1.3.3 Problem scope

This part of the report sets out the scope of the project in terms of what will be investigated, what will not be investigated and why.

This thesis is concerned with understanding, “Why is Six Sigma performance at Ford Motor Company below that achieved in other companies and how can it be improved?” One potential risk of attempting to answer this question for the whole of Ford Motor Company is that it is a global organisation spanning a large number of functional areas and countries with different Human Resource (HR) policies. This

means that there are likely to be cultural differences and it may not be possible to apply a standard solution to all cases. To ensure that the scope is manageable, the size of the research scope has been reduced to that of the Product Development area of Powertrain Operations in the UK, which for this thesis forms the unit of analysis. The reasons for scoping the project in this way are:

- Access to informants. Working in this particular area means that it is possible to gain access to informants.
- There are people who believe that there are differences between PD and manufacturing issues and the way in which they are tackled.
- Between the US, UK and Germany, there are differences in the reward and recognition of employees as well as differences in working practices, and consequently it was believed that increasing the level of complexity of the project to include national differences would make the research unmanageable.
- It is possible that the reasons of varying performance are different across the organisation. Within the engineering area of the Powertrain organisation, the different departments will have similarities and therefore it will be possible to identify reasons for varying performance.

The scope of the research includes all potential factors that could impact the performance of Six Sigma, including technical, political and cultural. This thesis is concerned with examining the issue of Six Sigma project performance within the Product Development area of Powertrain Operations in the UK. If a problem is identified that is common to other areas of the organisation, then it is anticipated that the scope could be extended, but, initially a narrow scope will reduce the possibility of an over ambitious project denying any useful outcome.

1.3.4 The research question

The start point of this thesis was a comparison of Six Sigma performance at Ford Motor Company and General Electric that was conducted by A.T.Kearney (as shown in tables 1 and 2) to determine how the performance of Six Sigma at Ford Motor Company compared to General Electric (GE), a company that was deemed to have been successful in its implementation of Six Sigma. The data presented in section 1.3.2 demonstrates that Ford is not performing to the same level as Six Sigma in GE.

The aim of this research was to understand why a difference exists between the performance of Ford Motor Company and that of GE and having determined reasons for differences in performance, this thesis proposes solutions to enable the performance of Six Sigma at Ford Motor Company to be improved. The research question is, "Why is Six Sigma performance at Ford below that achieved in other companies and how can it be improved?"

1.3.5 Aims and objectives

This thesis aims to answer the following questions:

- What is achievable with Six Sigma?
- How can the reasons for poor performance be investigated?
- Why is Ford not achieving best in class performance with Six Sigma?
- How could the implementation of Six Sigma within Ford be improved?

1.4 *Structure of the thesis*

1.4.1 Introduction

Chapter 1, the introduction is set out in such a way as to explain what Six Sigma is, describe aspects that it has in common with TQM and change management, and then explain why it was the tool of choice for Ford Motor Company.

1.4.2 Literature review

Chapter 2 describes the literature review which in this case had two purposes: firstly, to review the literature and secondly, understand the decisions that had been taken in deploying Six Sigma and in particular critically evaluating these decisions against the literature to understand if there were any areas in which there had been decisions that deviated from the literature. This is not a standard approach, but one that will assist in communicating the context of Six Sigma within Ford Motor Company.

1.4.3 Research design and analytical approaches

Chapter 3 describes the way in which the research was conducted and how the data was analysed. As the research was conducted, the direction of the research changed and a brief summary of that change is provided here. The chapter ends with the way in which the different data collection methods will be used to derive a final conclusion.

1.4.4 Stage 1 data analysis: Survey data

Chapter 4 describes the survey data available within Ford Motor Company and the analysis of these data. There was a large amount of secondary data that had been collected before the start of this thesis and to understand the areas in which the deployment could be improved, the secondary data concerning Six Sigma was analysed. This chapter describes the analysis that was carried out to identify potential causes of poor performance. However, the survey data failed to identify aspects that would lead to improved performance and this led to the use of interviews.

1.4.5 Stage 2 data analysis: Interviews

Chapter 5 describes the analysis of the interview data, which revealed a number of possible causes that could be improved but did not identify causes that were believed to be responsible for the shift in performance.

1.4.6 Stage 3 data analysis: Project data review

Chapter 6 describes the analysis of the project data that was conducted after the analysis of the interview data. The interview data uncovered factors that were believed to influence the performance of Six Sigma but that were not believed to account for the differences observed between Ford Motor Company and General Electric. Here, the focus of the research shifted to analysing all the available project information to identify causes that would account for the difference observed in performance. Chapter 6 explains the nature of the analysis and highlights the conclusions that can be drawn from the analysis, namely that the differences in performance appear to occur at a project level.

1.4.7 Stage 4 data analysis: Training materials

Chapter 7 describes a review of the training material that contains the “how to” of Six Sigma within Ford Motor Company. Having identified that the performance of Six Sigma projects varied, it was believed that the project selection and scoping were potential causes of poor performance, it was necessary to understand the process that was described within the training material. It was found that there were gaps and contradictions within the material.

1.4.8 Data analysis summary, conclusions and recommendations

The conclusions section evaluates the outcome of the research using the objectives as presented at the start. The author will then comment on lessons that have been learned during the research and presents information that may help future researchers in the area of Six Sigma.

2. Literature review

2.1 *Introduction*

Chapter 2 is a review of the academic literature that is used to critically evaluate decisions taken within the Ford Motor Company concerning the deployment of Six Sigma. Each section is concluded with a statement evaluating the merits of the decisions taken by Ford Motor Company in their deployment of Six Sigma.

This chapter will also present information from literature to describe the development of Six Sigma. Since the history of Six Sigma is short in comparison to that of TQM, there is less literature available that is specific to Six Sigma than TQM. Further, much of the subject matter available concentrates on "how to" carry out Six Sigma and many papers attempt to draw upon the experiences of other companies listing factors deemed to be critical in implementing Six Sigma (see, for example, Antony and Banuelas, 2002). In this thesis the wider TQM literature is drawn upon to understand issues that have been encountered during TQM implementation, and this will provide further insight into factors that may be possible causes of variability in Six Sigma performance.

The Doctorate of Business Administration (DBA) is different to a Doctor of Philosophy (PhD) in that the DBA is concerned with the application of the methods and therefore requires a context within which to work. Here the literature review is undertaken against the context of the deployment of Six Sigma within Ford Motor Company. This allows the current deployment to be assessed against the theory contained in the literature and therefore permits a critical analysis of the deployment.

2.2 Introduction to Six Sigma

2.2.1 The development of Six Sigma

The development of Six Sigma and the mathematical concepts surrounding the sigma value are well documented and therefore, these topics are not covered. Instead, this section will explain what Six Sigma is, how the process has changed and how it works.

The Six Sigma breakthrough strategy is described as being a means of improving a process using a series of core process steps, namely Measure, Analyse, Improve and Control (MAIC) (Harry, 1998; Henderson and Evans, 2000). It would appear that different forms of the Six Sigma breakthrough strategy have materialised (Goh and Xie, 2004) and in 1999, Breyfogle (1999) wrote that Six Sigma consists of Deployment, Measurement, Analyse, Improvement and Control, of which the Measurement, Analyse, Improvement and Control phases are part of the project implementation phase.

Some of the changes that have occurred include the addition of a Recognise (R) and Define (D) phase before the MAIC steps and Standardise (S) and Integrate (I) steps after the Control phase (Harry and Schroeder, 2000 [130]). Henderson and Evans (2000) observed that at GE, a Define phase had been added before the MAIC phases, and at Ford Motor Company, a Replicate phase has been added to create Define, Measure, Analyse, Improve, Control and Replicate (DMAICR). A further development of Six Sigma is proposed by Basu and Wright (2003 [82]) who describe a version of Six Sigma called Fit Sigma that incorporates lean methodology and tools to ensure sustainability of the initiative.

There are a number of different forms of the Six Sigma breakthrough strategy, but the most common form would appear to be Define, Measure, Analyse, Improve and Control (DMAIC) (Henderson and Evans, 2000; Eckes, 2001 [10]; Coronado and Anthony, 2002; Goh and Xie, 2004; Soderborg, 2005; Raisinghani, 2005). While DMAIC appears to be the standard process, the author will deem that the start of the Six Sigma problem solving process, at a project level, starts from the Recognise (R)

phase defined by Harry and Schroeder (2000) as the upfront phase – "Recognize functional problems that link to operational issues". The reason for starting from Recognize is that while projects typically start with Define, this project will tackle the issue of identifying projects for the DMAIC steps of the problem solving methodology and therefore it is concerned with the upfront work associated with identifying which project to work on.

2.2.2 Why deploy Six Sigma?

Within Ford Motor Company, the solving of special cause problems was well understood, but Deming (1986) wrote that the majority of quality problems can be tracked down to common cause or system issues, of which the organisation had relatively little experience. Gardner (2001) believes that there is a natural progression from special cause resolution to common cause resolution and that this equates to a process improvement from a repeatable process to a capable process. Ford Motor Company has used a number TQM techniques but many of the approaches used prior to Six Sigma concentrated on solving what Deming (1986) termed 'special cause problems' and not 'common cause problems'. Six Sigma is a tool that is developed specifically for the reduction of common cause issues and so is appropriate for the process maturity of Ford Motor Company. Many of the tools used within Ford Motor Company are common to Six Sigma and therefore, Six Sigma could build on existing knowledge within the organisation.

Six Sigma replaced a successful TQM programme in Motorola (Ingle and Roe, 2001) and therefore, it would appear to be a natural progression from TQM. Basu and Wright (2003 [33]) believe that Six Sigma is an improvement over TQM, because it employs advanced computer programs and performance benchmarking while, Klefso et al. (2001) believe that Six Sigma is in fact a methodology *within* TQM. Nevertheless, whether Six Sigma builds on TQM or is viewed as a part of TQM, it would appear to be a good match with the development of quality within Ford Motor Company. One area in which Six Sigma appears to be more focused than TQM is in assessing the impact on cost. Gabor (2001) writes that Ford has benefited from the disciplined cost-benefit analysis that is inherent within Six Sigma.

It would appear that Six Sigma was the right tool for Ford Motor Company to employ. As for the timing of the implementation, the two reasons for starting the Six Sigma initiative at the time that it happened were that Ford Motor Company was at a sufficient level of learning for Six Sigma to be relevant and that sufficient lessons had been learned with deploying Six Sigma as to make it a practical system.

2.2.3 The Six Sigma project

As experience is gained with the Six Sigma methodology, factors that are critical to the success of the initiative are becoming more widely understood. It is well documented that one of the aspects of Six Sigma that is critical to its success within an organisation is the selection and scoping of projects (Ingle and Roe, 2001; Henderson and Evans, 2000; Coronado and Anthony, 2002; Pyzdek, 2003 [188]).

This section details the literature surrounding project selection and scoping, critiques the current process and then details an improved process by which Six Sigma projects can be selected and scoped reliably. Where appropriate, experience is drawn from Ford Motor Company to illustrate one way of dealing with project selection and scoping.

In dealing with the project selection and scoping processes, the scope of this thesis requires clarification. There are two types of Six Sigma project, those known as DMAIC and those called Design for Six Sigma (DFSS). DMAIC projects are typically associated with quality problems that are already in existence, while DFSS projects are more often associated with upfront preventative work (Banuelas and Anthony, 2004; Hu et al., 2004; Khalaf et al., 2005; Soderborg, 2005). The process steps that give the project its name are Define, Measure, Analyse, Improve and Control (DMAIC). The DFSS technique is a relatively new technique with limited data describing its performance. The performance comparison regarding Ford Motor Company and General Electric concerns only the performance of DMAIC projects and therefore, the focus of this research is the DMAIC project and improving the performance of such projects. Design For Six Sigma (DFSS) projects will not be covered in this thesis.

2.3 Structure of the literature review

2.3.1 Organisation of the literature

The European Quality Award (EQA) and the Malcolm Baldrige Quality Award (MBQA) are the most widely used quality awards within Western Europe and the USA (Tan, 2002; Oakland, 2000). While the purpose of quality awards is to improve quality at a national level (Tan, 2002) and improve the ability of companies to meet the needs of their customers (Parker et al., 1999), they do provide a hierarchical framework within which the quality systems and processes can be analysed and can maintain a level of enthusiasm (Basu and Wright, 2003 [104]). Of these two awards, the European Quality Award places most emphasis on the people aspects of TQM (Tan, 2002; Oakland, 2000; Parker et al., 1999) and since this project is concerned with the softer aspects of TQM implementation, it is the relevant headings of the European Quality Award that have been used from the EFQM model (2003).

A wide range of frameworks could potentially have been used and one that initially looked attractive was developed by Sila and Ebrahimpour (2002 [906-910]) from an analysis of survey based research published between 1989 and 2000. The framework developed by Sila and Ebrahimpour (2002) consists of 25 different areas identified as having an influence on the deployment of quality initiatives. This framework was found to be unsuitable because there was no hierarchy for the potential causes. For example teamwork and culture were presented at the same level of analysis although, it could be argued that teamwork is a function of the values of an organisation and is therefore a potential factor within the culture of the organisation (Mullins, 1999). While the absence of a hierarchy itself could potentially be overcome, the overlap and duplication between categories could not.

The categories that are used from the EFQM framework are: Leadership, Policy and Strategy, People and Process. These categories cover all aspects of Six Sigma, but it would oversimplify the situation to describe process at one level. Eckes (2001 [9]) believes that there are two levels of process management involved: one at the business level and one at the process level, while Harry and Schroeder (2000 [136]) believe that there are three levels: the business level, the operations level and the process level.

2.3.2 Presentation of the literature review information

To present the information from the literature, a cause and effect diagram is used. The cause and effect diagram was developed by Ishikawa and for this reason, these diagrams are sometime known as Ishikawa or fish-bone diagrams since their appearance resembles that of a fish skeleton. The effect or defect is shown on the right hand side of the horizontal arrow and then each of the potential causes is shown as one of the bones (Dale, 1999 [297]). Within cause and effect diagrams, there is no indication of the direction or strength of the relationship between the cause and effect.

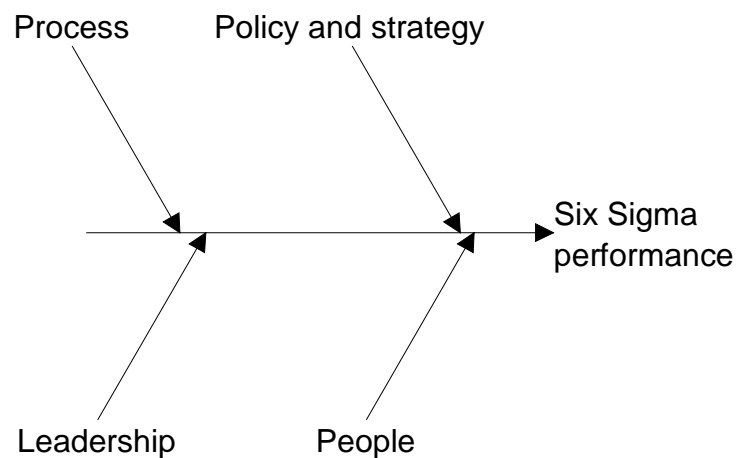


Figure 1. Cause and effect diagram showing EFQM framework headings

The headings on the cause and effect diagram shown in figure 1 are consistent with those identified from the EFQM framework. The headings will be tackled in the following order: leadership, policy and strategy, people and process.

2.4 Leadership

This section addresses issues including the development and implementation of the mission, vision and values via appropriate actions and behaviours. Additionally this section is concerned with the extent to which leaders are personally involved in ensuring that the organisation's management system is developed and implemented (EFQM, 2003).

The categories that will be considered here are the mission, vision and values and the leadership commitment as shown below in figure 2.

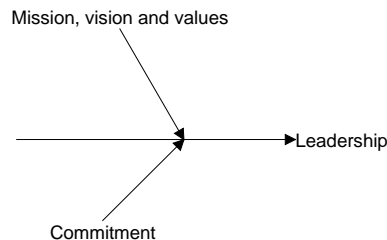


Figure 2. EFQM headings for leadership

2.4.1 Mission, Vision and Values

To communicate clearly the purpose of the organisation and the goals, it is necessary to develop a mission that sets out a picture of how things will be when it is achieved and translates a belief into targets (Oakland, 2000). The organisation also needs a vision that communicates its guiding principles, values, beliefs and purpose, which in turn communicates guidelines concerning conduct, responsibilities and responses to changes in the environment (Oakland, 2000). The core values act as a guide for all stakeholders and should be demonstrated through the behaviour of leaders within the organisation (Oakland, 2000), and therefore, it is necessary to gather data regarding leadership behaviour within the organisation.

2.4.2 Leadership Commitment

It is widely accepted that TQM can only be implemented successfully when top management are committed to it (Oakland, 2000; Clinton et al., 1994; Tan, 2002; Antony and Banuelas, 2002). One way of demonstrating commitment is to learn about TQM and the success of the initiative is dependent on commitment and support

from top management (Gatchalian, 1997), middle management (Capon et al., 1995; Basu and Wright, 2003 [81]), management in general (Eckes, 2001 [14]) and ultimately every member of the organisation (Clinton et al., 1994). The commitment of employees to TQM can be affected by the management style (Mathews and Shepherd, 2002) and to foster an environment in which TQM can prosper, it is necessary to change the leadership style to a more participative style (Clinton et al., 1994; Oakland, 2000).

Anthony and Banuelas (2002) maintain that the executive leadership should be involved in defining the strategy and goals of Six Sigma and that to develop a successful Six Sigma strategy a customer focused approach is required (Breyfogle and Meadows, 2001; Oakland, 2000).

2.5 Policy and strategy

This section is concerned with the way in which the organisation implements its mission and vision via a clear stakeholder focused strategy, supported by relevant policies, plans, objectives, targets and processes (EFQM, 2003).

The categories that will be considered are presented in figure 3, the cause and effect diagram shown below.

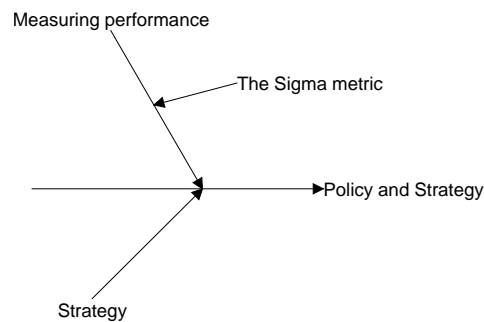


Figure 3. EFQM headings for policy and strategy

2.5.1 Strategy

To improve the chance of success, a TQM programme needs to result from an evaluation of the company's quality compared to both its own mission statement and its competitors' performance (Capon, et al., 1995) and for Six Sigma, the requirements of the programme should be established prior to deployment (Basu and Wright, 2003 [85]).

Prior to deployment, in 1999, the senior management at the Ford Motor Company conducted a thorough benchmarking exercise of operational performance against a number of other companies including some that had successfully implemented Six Sigma, notably including General Electric, (Henderson and Evans, 2000). The purpose of the exercise was to explore the potential benefits of Six Sigma to Ford Motor Company and determine whether it was likely to be a good fit with the further development of their quality strategy. The outcome of the exercise was a conviction by senior management at the Ford Motor Company that significant improvements could be made through improving *each and every* process throughout the company. To this end, Six Sigma was rolled out to all areas of the company including areas not normally associated with quality such as facilities management and corporate real

estate (Holtz and Campbell, 2003). Sanders and Hild (2000) describe this type of deployment strategy as "The Six Sigma Organization", which means that Six Sigma is implemented in all functions across the entire organisation.

Harry (1998) describes Six Sigma as a strategy for improving profitability, market share and customer satisfaction, while Sanders and Hild (2000) believe that the majority of Six Sigma initiatives tend to focus on cost with Basu and Wright (2003 [4]) reporting that in their experience, the majority of Six Sigma initiatives are driven by a desire to reduce cost. At the start of deployment, there was a conscious decision made within Ford Motor Company that Six Sigma should initially focus on customer satisfaction, (Ford Six Sigma office, 2001, Holtz and Campbell, 2003). To signal the change of emphasis, the Ford Six Sigma office (2001) stated that the strategy for deploying Consumer Driven 6-Sigma would be to, "Train Green Belts and Black Belts in the application of 6-Sigma tools and have them apply those skills to issues impacting customer satisfaction."

It seems that Ford Motor Company's decision to change the emphasis from cost reduction to quality improvement and create a customer-focused strategy for Six Sigma was the right decision according to the literature (Breyfogle and Meadows, 2001; Oakland, 2000). Having determined that the strategy was to improve customer satisfaction, it was necessary to ensure that the organisation was able to measure and assess the level of performance.

2.5.2 Measuring Performance

One reason why TQM programmes vary in their success is down to the way in which they have been implemented (Ghobadian et al., 1999), to the point where it is reported that incorrect implementation, including variable enthusiasm can result in the failure of TQM (Gatchalian, 1997). Ghobadian et al. (1999) write that there are two principal strategies that can be used to implement TQM: an "activity-driven" and "results-driven" approach. There is much support for the "results-driven approach (Ghobadian et al., 1999) and it is believed that Six Sigma is a way of achieving strategic goals and that those goals must be measurable if they are to be managed (Breyfogle and Meadows, 2001; Oakland, 2000, Basu and Wright, 2003 [2]). In addition to facilitating management of the initiative, Capon et al. (1995) found that displaying the

results of TQM performance improved the chance of success by between ten and fifteen percent.

While there appears to be agreement on the use of metrics, it is warned that misleading information can hinder performance (Oakland, 2000; McAdam and Bailie, 2002) as can inappropriate use of metrics (Capon et al., 1995) or use of inappropriate metrics (Eckes, 2001 [24]). To assist in the roll-out of Six Sigma, the performance measures should reflect the true performance of the process in customer-supplier terms, emphasising continuous improvement (Oakland, 2000; Eckes, 2001 [24]) and in the same way that they need to be appropriate at the start of a programme, they must be re-evaluated to maintain alignment with strategy (McAdam and Bailie, 2002). As a consequence, Oakland (2000) believes that financial measures should not be used for control instead preferring customer satisfaction as the main measure of system output while Clinton et al. (1994) suggest that it is important to measure employee attitudes towards quality.

The Six Sigma initiative within Ford Motor Company has been deployed in such a manner that the finance constraints for a project to be viable are assessed prior to starting, which ensures consistency with Six Sigma teaching that the inputs can be controlled. At the end of the project the final outputs for money saved and customer satisfaction improvement are produced and monitored, communicating the importance of the customer. The results of the projects are then audited to ensure that the results published for Six Sigma are accurate. In certain areas within the organisation an audit provision is added to ensure that result reported is not inflated.

Ford Motor Company has ensured that Six Sigma is aligned to the culture of Ford in as much as Ford Motor Company is based on the attainment of results. The Six Sigma office has developed a Project Tracking System which has been developed to monitor the performance of Six Sigma projects and display results. Breyfogle and Meadows (2001) believe that there is no metric that can be applied to every Six Sigma project, however, whichever metrics are used; the Sigma metric should be included. To move the Six Sigma initiative forward, it is recommended that process performance be expressed as a Sigma value.

2.5.3 The Sigma Metric

Six Sigma attempts to quantify performance using a standard metric. From the normal distribution, it is possible to quantify different levels of performance in terms of a sigma value, which in turn can be used to estimate the number of Defects Per Million Opportunities (DPMO). Harry and Schroeder (2000) report that the average company operates at between 3.5 and 4 sigma, which means that for every 1,000,000 processes, there are between 22750 and 6209 DPMO. Companies that have processes operating at 6-Sigma levels of quality experience only 3.4 DPMO. The corresponding Sigma value and DPMO are shown in the following table.

Table 3. Process performance shown as sigma, DPMO and percent accurate

Sigma level (short term)	Defects Per Million Opportunities	Percent accurate
1	697700	30.23
2	308700	69.13
3	66810	93.32
4	6210	99.379
5	233	99.9767
6	3.4	99.99966

Source: Breyfogle, 1999 [10]

It is asserted by Ghobadian et al. (1999) that for an action to add value to the organisation it must be aligned with the goals of that organisation and this can be achieved by reviewing performance levels (Caudron, 1993). Ford Motor Company used the Sigma value to assess the performance of the organisation and compare its performance with the industry average. Breyfogle and Meadows (2001) believe that the sigma metric should not be forced on an organisation, and instead, the correct metric for the situation should be used. As a means of measuring the performance of the deployment, specific metrics have been developed over and above those used by the Six Sigma office for measuring the project performance. The metrics developed include the number of Black Belts both active and integrated; Green Belts trained and verified, money saved, quality improvements made. To ensure that the metrics are linked with satisfying the organisation, the viewpoint of the Six Sigma organisation is investigated from the perspective of the customer.

Ehrlich (2002) writes that a distinguishing feature of service organisations is the high frequency of employee-customer encounters, also known as "moments of truth", which require a different perspective to quality from other types of organisation. Grieves and Mathews (1997) state that, in a service organisation, a large number of individuals come into contact with the customer. The Six Sigma organisation mirrors this structure with Black Belts forming the largest majority of full time personnel within the organisation and being the people who meet with the customers.

In providing a service, there are two opportunities for effective learning: that of the individual level during the service encounter and the organisational level characterised by market research (Grieves and Mathews, 1997). Additionally, Grieves and Mathews (1997) suggest that learning at both levels introduces greater reflection at the individual level and a wider awareness of the need to improve at the organisational level.

2.6 People

This section describes how the organisation manages, develops and releases the knowledge and potential of its people to support its policy and strategy and the effective operation of its processes (EFQM, 2003). This section will describe the informal and formal organisations and the following analysis of the formal organisation will be structured in the following way as shown in figure 5, the cause and effect diagram below.

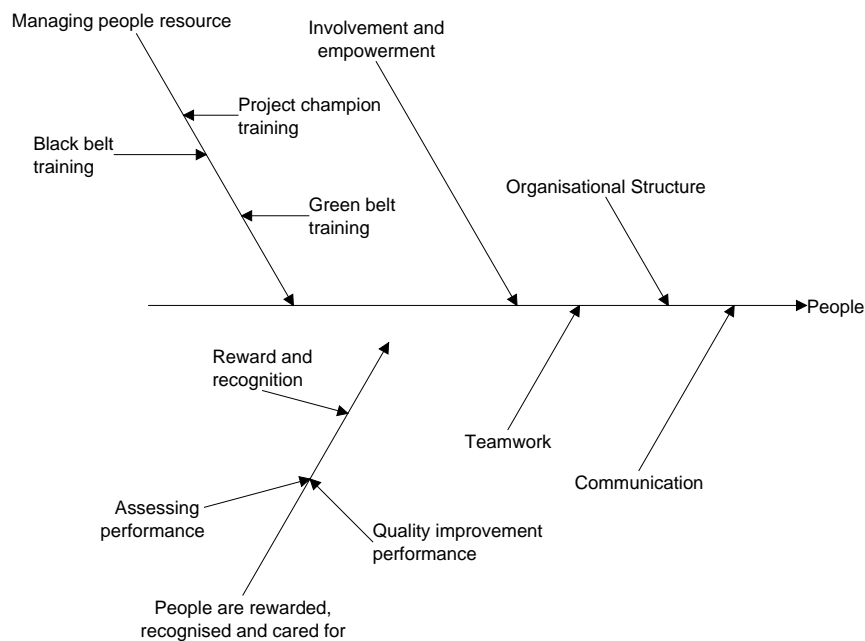


Figure 4. EFQM headings for people (supplemented from literature)

2.6.1 The Informal and Formal organisation

There are many definitions of what an organisation is. One of the less complex definitions is "a consciously coordinated social unit, composed of two or more people that functions on a relatively continuous basis to achieve a common goal or set of goals" (Robbins, 1998). Schein describes organisations in terms of the formal and informal organisation (Schein, 1988). The formal organisation consists of the goals, strategy, structure, systems and procedures, products and services, financial resources and management (Senior, 1996). The informal organisation comprises the values, attitudes and beliefs, the leadership style and behaviour, the organisational culture and norms of behaviour, the power, politics and conflicts and informal groupings (Senior, 1996). It is believed that the informal organisation has a significant effect on the way

in which work is done (Gray and Starke, 1988) and on the morale, motivation, job satisfaction and performance of staff (Egan, 1993; Mullins, 1999).

The concepts of culture, politics and power have come to embrace much of what is included in the hidden part of the organisation (Senior, 1996). Morgan (1989) states that "The culture and politics of many organisations constrain the degree of change and transformation in which they can successfully engage, even though the change may be highly desirable for meeting the challenges and demands of the environment". It has been suggested that changing the strategy and structure of an organisation (the formal organisation) does not bring about a change in an organisation (Johnson and Scholes, 1997). "Traditionally, this hidden domain either is not examined at all or is only partially examined" (French and Bell, 1999).

This project will tackle Six Sigma performance by considering both the informal and formal organisation.

2.6.2 The Informal Organisation

2.6.2.1 The cultural aspects of an organisation

Organisational culture has been defined informally as "how things are done around here" (Drennan, 1992; Mullins, 1999). According to the Burke-Litwin model of individual and organisational change, culture is defined as deep-seated assumptions, values, and beliefs that are enduring, often unconscious, and difficult to change (French and Bell, 1999). Johnson and Scholes believe that the culture of a company comprises the stories, symbols, rituals, paradigms, power, controls and structure of the organisation and use the cultural web to illustrate the culture of an organisation (Johnson and Scholes, 1997). There are people who do not believe that the culture of an organisation can be illustrated in this manner. Schein believes that organisational culture is, "the deeper level of basic assumptions and beliefs that are shaken by members of an organisation that operate unconsciously and define in a basic 'taken for granted' fashion an organisation's view of its self and its environment" (Schein, 1992).

If the statements about culture representing the values of the members of the organisation are to be believed, then it could be argued that changing the culture of an

organisation is a slow and difficult task. It is argued by some that the culture of an organisation can be changed. Kotter (1996), Johnson (1993) and Clark (1994) believe that culture is not a rational analytical phenomenon and that it is necessary to understand the culture that needs to be changed. The change must be reinforced by values within the organisation including those attitudes to risk and change (Burnes, 2000).

An example of a successful change in culture is given by French and Bell, and suggests some of the processes that need to be considered if we seek to supplement the Six Sigma technique. In the early 1980s Donald Peterson, then Chief Executive Officer (CEO) of Ford Motor Company "launched programs in Employee Involvement (EI), participative management training for supervisors, employee involvement teams and total quality management". These programmes changed the culture from being autocratic and functionally orientated to being a more successful company with empowered employees (French and Bell, 1999).

This example suggests that a change in culture resulted from changes to the formal organisation. In a similar way, to implement a TQM programme successfully, it is necessary to change attitudes (Ghobadian et al., 1999) and to instil a culture of quality within the organisation (Oakland, 2000; Clinton et al., 1994). To bring about a change in culture, it is necessary for the following to occur: Human Resource Management (HRM) should model the TQM values (Clinton et al., 1994); New organisational structures should be implemented (Ostroff and Smith, 1992); (Hammer and Champy, 1993); Employees spiritual needs should be taken into account (Chattell, 1995); Employee empowerment should be encouraged within cross-functional multidisciplinary teams (Peters, 1993). To understand the impact of culture, it is necessary to understand the different aspects of culture more fully.

2.6.2.2 The political aspects of an organisation

As stated previously, the informal organisation is influenced by political behaviour in addition to cultural behaviour. There are a number of definitions for organisational politics. Robbins (1998) writes, "For our purposes, we shall define political behaviour in organizations as those activities that are not required as part of one's formal role in

the organization, but that influence, or attempt to influence, the distribution of advantages and disadvantages within the organisation."

Robbins (1998) and Handy (1993) believe that politics is the result of competition between members of an organisation for a finite amount of resource, budget and power. Hardy (1994) defines politics as the use of power, and Senior suggests that power, politics and conflict are all parts of organisational life and that power and conflict should be considered as components of organisational politics (Senior, 1997). Senior (1997) writes that acting politically can be used to resolve conflict as part of negotiating, but that it can result in conflict if used to negatively affect a group or individual. In addition to classifying politics into positive and negative politics, Robbins has created another means of defining political behaviour by breaking politics down into legitimate and illegitimate politics and states that legitimate politics include such activities as complaining to one's supervisor, bypassing chains of command, forming coalitions and obstructing organisational policies. Legitimate politics can be beneficial to an organisation. Illegitimate political activities include activities such as whistle blowing and sabotage (Robbins, 1998).

Politics can therefore be seen as the relationship between power and conflict to influence or affect others, echoing the writings of Hardy (1994). Mullins states "Power can be interpreted in terms of control or influence over the behaviour of other people with or without their consent" (Mullins, 1999); this idea is reiterated by Handy (1993), Robbins (1998) and Senior (1997).

Senior (1997) agrees with McClelland (1970) and suggests that power can be used constructively or destructively, in that it can have positive and negative effects. Power when used positively can enhance the propensity to change, but when used negatively can be used to resist change. The use of power to resist change can be gauged by assessing the motivation to use power either for or against a change. The motivation to change can be assessed by considering whether the degree of power held will alter. Tichy and Sherman (1994) also believe that disruption to the power structure can lead to political resistance.

The use of power to resist change can result in conflict. Mullins defines conflict as "behaviour intended to obstruct the achievement of some other person's goals" (Mullins, 1999), which does not incorporate the beneficial aspects of conflict, while Gordon (1993) defines conflict as "the result of incongruent or incompatible potential influence relationship between and within individuals, groups or organisations." Robbins (1998) takes the interactionist view and asserts that conflict can be functional and have positive effects or be dysfunctional and have negative effects on organisational performance. If too little conflict exists, apathy can occur, while if too much conflict exists, then this is potentially disturbing for organisational members. Senior (1997) echoes the thoughts of Robbins asserting that power and conflict are required for good performance and need to be used in positive ways to reduce unnecessary resistance to organisational change.

Burnes (2000) writes that where a strong culture exists, it can help bind members together towards a common purpose and legitimate decision making. Without this, managers may find it difficult to agree amongst themselves or gain agreement from employees, which can lead to power struggles and conflict. With this in mind, it is necessary to plan carefully when considering changes to the informal organisation.

2.6.2.3 Cultural and political resistance to change

It is often said that change programmes experience resistance (Paton & McCalman, 2000; Burnes, 2000; French and Bell, 1999; Mullins, 1999). This is a broad statement that requires clarification; the subject of this project is concerned with managing the environment in which a change programme exists by understanding barriers to change including the political and cultural aspects of change, which can have an adverse effect on the change programme. For example, Chen et al. (1997) claim, "The organizational culture in many firms may still prevent the manufacturing people from having effective liaison with the quality manager."

The use of historical union-oriented systems may lead to a misalignment of personal and corporate objectives and values, in turn leading to sub-optimal performance in following the strategy of change. The notion that personal conflict can result in a difference in the values of the organisation and those of the individual is called "cognitive dissonance". Burnes and James (1995) describe the theory of cognitive

dissonance through asserting that people attempt to be consistent in both their behaviour and attitudes. When they sense an inconsistency either between two or more attitudes or between their attitudes and behaviour, people experience discomfort with the situation (Jones, 1990). Therefore, to implement TQM successfully, the cultural development programme must be designed to overcome the resistance to change and achieve more than just compliance to TQM (Clinton et al., 1994).

2.6.3 The Formal Organisation

The formal organisation is concerned with those aspects of the organisation that are explicit and tangible. The purpose of the following review is to present both the practice at Ford and literature concerning each of the critical factors concerning Six Sigma implementation. In constructing a logical argument, it is necessary to have a framework in which each of the categories concerning the performance of Six Sigma can be assessed.

2.6.3.1 Organisational Structure

While the aim of a TQM programme is to improve customer satisfaction, the initial phase of TQM implementation deals with improving the "internal competency" of the organisation, thereby making the organisation ready for a shift to increased customer focus (Ghobadian et al., 1999; Franklin, 1996). Oakland (2000) believes that, "A sound quality policy, together with the organization and facilities to put it into effect, is a fundamental requirement, if a company is to begin to implement TQM". To learn and improve, individuals need to have confidence and competence, encouragement and organizational openness and therefore, there is a comprehensive infrastructure (Shown in fig. 5).

To ensure that there is top level sponsorship of the initiative, it is important that the Executive Leadership are involved in setting the direction of Six Sigma (Breyfogle and Meadows, 2001) and take responsibility for its successful deployment. The Executive Leadership communicate the strategy by cascading targets to the Project Champions. The Project Champions are the senior leaders who are responsible for removing obstacles on each of the change projects that the Black Belts manage. The role of the Black Belt is pivotal within the Six Sigma initiative. The responsibilities of the Black Belt include leading the problem solving projects and managing the change

that occurs as a result of the project. Additionally, the Black Belts are expected to coach and mentor the Green Belts and the rest of the organisation. The Green Belts are intended to support the projects and form the team who are most likely to be impacted by the change. Master Black Belts provide the technical leadership to the programme, teaching the Black Belts in the tools and coaching them through the application of the tools to achieve the project goals. To ensure that the Six Sigma organisation operates in a coherent fashion, a Six Sigma office was set up within the Ford Motor Company. The Six Sigma office consists of a number of deployment directors who are responsible for setting the direction of Six Sigma with regard to training and deployment.

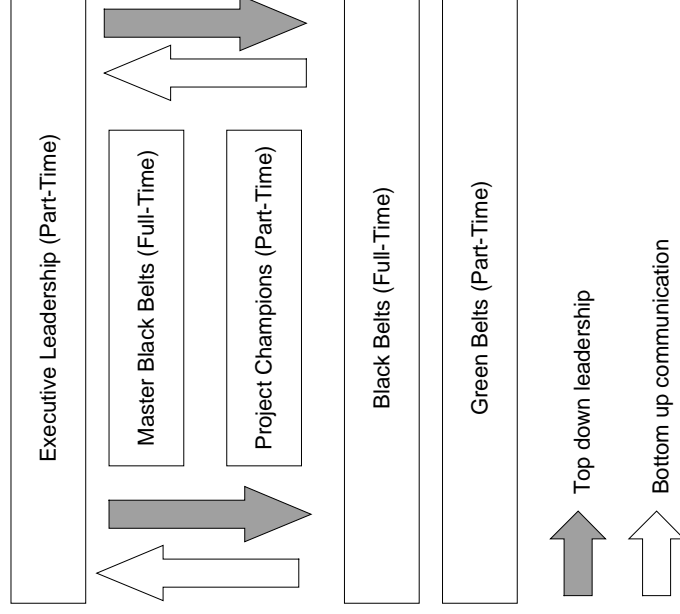


Figure 5. Structure of the Six Sigma organisation as defined on Six Sigma website

Source: Ford Six Sigma Office, 2001

The Six Sigma organisation within the Ford Motor Company is shown above in figure

5. The omission is that of how the Six Sigma office itself fits in to the organisation.

The Six Sigma office is answerable to the Executive Leadership and is responsible for the programme management of Six Sigma and is responsible for ensuring that there is sufficient resource to carry out the projects. Figure 7 shown below displays the Six Sigma organisation with the inclusion of the Six Sigma office.

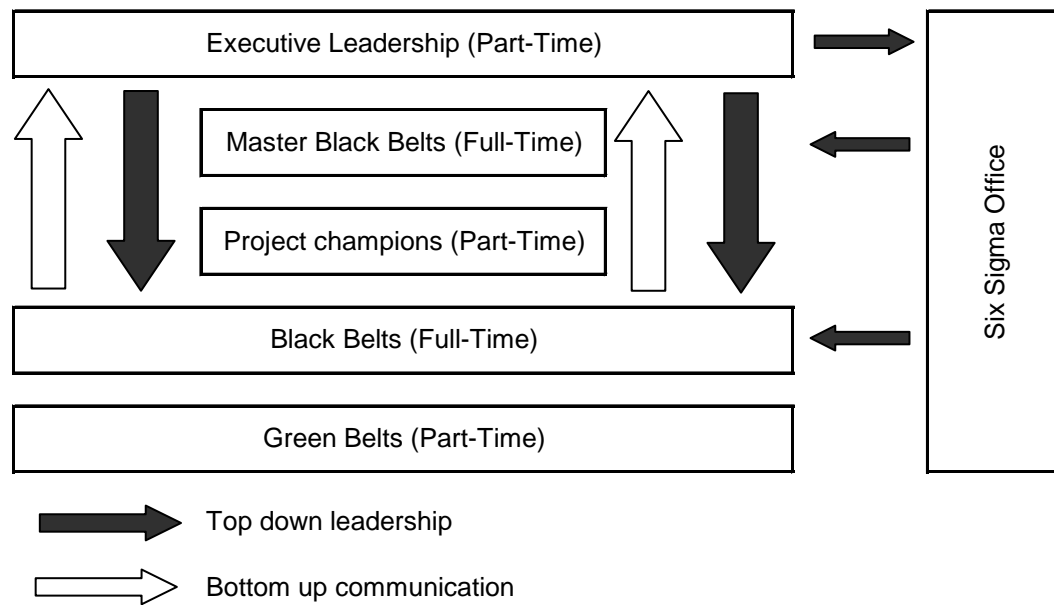


Figure 6. Graphical representation of the Six Sigma organisation including the Six Sigma office
 It can be seen from figure 6 that the Six Sigma office has direct communication links with a large number of the stakeholders and therefore, this affords the Six Sigma office good visibility of how the different stakeholder groups are performing and any requirements that would assist with improving the performance of the initiative.

2.6.3.2 Communication

Prior to implementation of Six Sigma, Ford benchmarked a number of other companies including General Electric, a company that had successfully implemented Six Sigma. Through conducting benchmarking studies, it was determined, that in addition to aligning Six Sigma to the needs of the customer and therefore the company, it was imperative that the way in which Six Sigma was integrated with other initiatives should be communicated via internal publications. The benchmark data was backed up by Caudron (1993) who wrote that communication recognising quality should be the first step in implementing TQM (Caudron, 1993) once a strategy exists (Gatchalian, 1997).

As to the means of communication, Caudron (1993) suggests that it is disastrous to accompany TQM implementation with banners, T-shirts, mugs and newsletter articles, while Walley and Kowalski (1992) report that they used quality days and newsletters successfully. To communicate the way in which Ford would be using Six Sigma, everyone involved in Six Sigma received a guidebook within which was written the

phrase, "Ford Motor Company is implementing Consumer Driven 6-Sigma to accelerate achievement of the corporate goal of becoming the World's Leading Consumer Company of Automotive Products and Services" (Ford Six Sigma Office, 2000).

To communicate the way in which the different initiatives would work together, internal communications including Communication days, Department meetings, Ford Communications Network (FCN), @Ford magazine and Product Development (PD) Europe Operating Report were used. Crucially, where there was conflict between initiatives, a directive was issued to resolve the conflict. Ford used a target cascade process to set targets for individual departments to ensure that the efforts of Six Sigma were aligned to company objectives and maintain a focus on the customer. The individual departments are then measured against the targets to identify potential issues.

Ford Motor Company developed a coherent strategy and then began communicating the strategy to the organisation through internal communication methods without using gimmicks to raise awareness. Ford Motor Company therefore demonstrated through actions that Six Sigma was important and yet avoided creating a belief that Six Sigma was another "flavour of the month."

2.6.4 Managing People Resource

2.6.4.1 Recruitment

It is desirable to have a high quality workforce (Ehrlich, 2002; Clinton et al., 1994; Evenson et al., 1999), and it is the role of Human Resources Management (HRM) to attract, retain and motivate this work force. Ehrlich (2002) writes that when recruiting for Six Sigma, selection criteria should be applied as rigorously as if recruiting for the organisation itself. It is recognised that the Black Belts are critical to the success of Six Sigma, and within Ford Motor Company the issue of selection has been dealt with through the use of strict guidelines and requirements laid down concerning the recruitment of different personnel for the role. Once the correct individuals have been selected, it is necessary to develop them into people who are successful at fulfilling their role.

2.6.4.2 Training

Training is one way of developing individuals and to be successful, TQM training should focus on issues concerning the employee's immediate job (Clinton et al., 1994). There is evidence to demonstrate that individuals continue to benefit after the initial training if they are supported (Wally and Kowalski, 1992). There are people who do not believe that training is beneficial (Mathews et al., 2001), and Caudron (1993) believe that many companies roll-out awareness sessions in place of focused training, which may in part explain the negative sentiment toward training.

Within the Six Sigma organisation, there are a number of different stakeholder groups and a key success factor that differentiates Six Sigma from TQM is the development of a structured training plan that ensures that the different needs of these groups are met (Basu and Wright (2003 [38])). At Ford Motor Company, the needs of each stakeholder group were identified and a range of courses were developed ensuring that everyone from middle management to the shop floor personnel were trained in the relevant tools. Each stakeholder group was covered separately. In determining how the training at Ford Motor Company should be conducted, it would appear that each course was developed to satisfy the needs of a particular stakeholder group.

There is much written about training Black Belts in Six Sigma literature; Ingle and Roe (2001) discuss Six Sigma implementation at GE and Motorola and their focus is almost exclusively on the training of the Six Sigma Black Belts.

The Six Sigma training courses within Ford Motor Company began in November 1999 with the start of the first wave of Black Belt training. Breyfogle (1999) states that as a rule of thumb, one percent of the workforce should be trained as Black Belts, however, Ford Motor Company wished to improve the deployment of Six Sigma with the aim of training a number that would ensure two and a half percent of the salaried workforce were active at any one time. Klefso et al. (2001) write that Six Sigma is difficult to institutionalise; within Ford Motor Company, the length of the Black Belt assignment was limited to two years in a bid to overcome difficulties with integrating the ideas.

With regard to the content of the Black Belt training, Ehrlich (2002) believes that the technical training should be accompanied by soft skills training while it is the opinion of Lynch (2005) that there are different requirements for transactional and manufacturing Black Belts and that project progress for the transactional Black Belts may be hampered by the lack of a curriculum for transactional Six Sigma.

One area in which Ford Motor Company has improved the deployment is in the development of a leadership training course, which provides additional skills to Black Belts to assist them in leading change projects. As opposed to one day awareness-training course, the courses are tailored to suit the level of knowledge required. Additionally, it can be seen that Ford Motor Company has attempted to overcome the issue of institutionalising Six Sigma through the development of a critical mass of Black Belts to ensure that people are trained faster than the skills can be lost.

It should be remembered that it is not only the employees who will require training, but also middle managers whose role will change from that of directing to that of coaching and supporting (Clinton et al., 1994).

In addition to training Black Belts, all the Project Champions have been trained in their responsibilities and tools to allow them to fulfil their role. The Project Champions are held accountable for the results achieved by the Black Belts in their area to ensure that the Six Sigma projects support the strategic objectives of the organisation. The situation in which the Six Sigma projects are not linked to the strategic objectives of the organisation is called a “cognitive disconnect” and is a problem that is often observed in Six Sigma initiatives (Pyzdek, 2003 [132]).

In 2001, the initiative was strengthened through the training of Green Belts. By the time the Green Belt training started, there were Black Belts who had sufficient experience to teach the Green Belts and ensure that practical examples could be provided. A target was set that by 2004, a number equal to that of almost all the salaried employees would be trained as Green Belts in addition to key hourly paid staff (Ford Six Sigma Office, 2004).

2.6.4.3 Involvement and empowerment

Within Ford Motor Company, the projects are controlled locally ensuring that employee empowerment is achieved. This ensures that the projects selected are the most applicable to the area and necessarily that a high level of support is maintained.

Committed employees wish to be part of an organisation and will exert more effort to assist the organisation in its goals (Mathews and Shepherd, 2002), however generating organisational commitment requires the creation of a high-trust organisational culture. Therefore, for a TQM programme to work, it is necessary to gain commitment from employees to obtain the maximum benefit (Clinton et al., 1994), and research has shown that where employee involvement techniques are used, the results from TQM are superior (Mohrman et al., 1996). To achieve improved quality levels, it is necessary that employees be empowered to make decisions concerning customer satisfaction (Clinton et al., 1994). Where there is inadequate empowerment, it is claimed that this can lead to the failure of a TQM programme (Gatchalian, 1997).

The deployment of Six Sigma within Ford Motor Company is clearly aimed at ensuring that decisions made regarding local use of the tools are made by the people closest to the issues. This ensures that employees are involved and feel empowered, which in turn will generate a greater level of organisational commitment.

2.6.4.3 Teamwork

It has already been stated that for TQM to prosper, it is necessary to develop a more participative leadership style (Clinton et al., 1994; Oakland, 2000). The reason for the participative style is to ensure that all stakeholders are represented. Stakeholders are the actors, agents, interested parties and interest groups (Cassell and Symon, 1994).

It is argued that if the different stakeholders hold attitudes that are in conflict with one another, then it will be difficult to achieve mutually agreeable solutions and in this situation performance can be improved by changing organisational processes to encourage alignment (Johnson and Scholes, 1997; Chen et al., 1997). To understand the perspectives of different stakeholders, it is necessary to ensure that information is gathered from all stakeholders. Within Six Sigma, this is achieved through the structure of projects and project teams, which where possible involve the different

stakeholder groups. The Black Belt is responsible for leading the project team and is able to do so because of the high level of skill in project management and problem solving tools. The team are then able to provide expert knowledge of the system under review and their involvement throughout the project necessarily means that the leadership style must be participative. This style of leadership is called functional leadership (Mullins, 1999).

Through the development of a powerful support network, the impact of cross-functional boundaries on team performance has been minimised and local support for the project is ensured. Ford has further reinforced the alignment of Six Sigma to business objectives through the deployment of the performance cell. A senior functional leader is responsible for the delivery of the Six Sigma projects and this ensures that departments work in a collaborative manner.

2.6.4.4 People are rewarded, recognised and cared for

One question that needs to be considered when developing a reward and recognition system is how performance will be measured.

There is much debate over the use of the annual appraisal with critics claiming that they can hinder the adoption of TQM by focusing employees' efforts on short-term objectives (Aldakhilallah & Parente, 2002). It is written that the success of a TQM programme is strongly linked to the performance of the quality improvement teams (Gatchalian, 1997) and therefore the appraisal system should focus on team performance (Clinton et al., 1994; Caudron, 1993; Aldakhilallah & Parente, 2002; Deming, 1986).

At Toyota, the number of completed projects per employee per year was used as a long-term trend of performance and is believed to motivate employees (Capon et al., 1995). The Six Sigma office measures projects completed per Black Belt per year. Additionally, the Six Sigma office operates a certification procedure whereby Black Belts achieve certification upon the successful completion of two projects and an exam. It is highly desirable to achieve certification early since clear distinctions are made between Black Belt Candidates and Certified Black Belts for the purpose of career progression. Stamatis and Munro (2002) believe that since there are a number

of different certification processes, each with differing requirements, that it is not appropriate to have a certification process: moreover, Stamatis and Munro (2002) believe that certification is an inspection technique and therefore deviates from the fundamental basis upon which Six Sigma is founded.

Ford Motor Company is consistent in its application of a result driven approach and therefore the annual review is ingrained within corporate policy. As well as measuring performance, it provides an opportunity for the employee to obtain feedback and therefore improve performance. A key feature of the Ford Motor Company appraisal system is the use of desirable leadership behaviours including "Develops employees and teams" and in this way the conflicting desires of the appraisal system are reconciled. Within Ford Motor Company, the purpose of having a certification process is to allow Black Belts to demonstrate that they have had sufficient experience and success to have an acknowledged level of proficiency in the tools. The difficulties described by Stamatis and Munro (2002) are overcome since the certification requirements within Ford Motor Company are consistent across the organisation. As regards the certification process, it is not used to inspect for individual quality, but instead is used as a measure of Black Belt maturity since the certification process is designed to be inclusive.

Having assessed the level of performance of a team or individual, it is then important to decide how people should be rewarded. Some believe that financial rewards generate greater enthusiasm for TQM than non-financial rewards (Capon et al., 1995), while others believe that non-financial perks such as visits to view TQM implementation at other sites act as motivators (Walley and Kowalski, 1992).

At Ford Motor Company, there are no specific rewards given to Six Sigma personnel, but it is believed that the Six Sigma skills and knowledge will assist in career development. To ensure that these skills are not overlooked, the internal Ford Motor Company employee profile paperwork has been modified to carry the employee's Six Sigma status. Additionally, one of the leadership behaviours required by the organisation, "Commitment to Quality" carries the description, "Applies a Six Sigma Mindset".

2.7 Process

This section is concerned with, "How the organisation designs, manages and improves its processes in order to support its strategy, fully satisfy, and generate increasing value for its customers and other stakeholders" (EFQM, 2003). Eckes (2001 [17]) writes that the most impact factors to improve productivity are the customer, processes and employees, as demonstrated by the way in which value is added for the customer by the employees. The project selection process feeds into the project definition phase and therefore, project selection is a potential cause of issues inherent in the scoping process.

2.7.1 Processes are systematically designed and managed;

Eckes (2001 [9]) describes two components of Six Sigma:

- 1 Business Process Management – getting management involved and
- 2 Process Improvement Methodology – Of which DMAIC is the methodology considered in this thesis.

Ehrlich (2002) however, believes that securing sufficient high-level support for the projects is an enabler to successful project activity. Ehrlich (2002) goes on to suggest that a process is developed to make decisions regarding the scope, selection, and success criteria of the project, while Eckes (2001 [9]) is more prescriptive and states that the key processes within Business Process Management are:

- 1 Creation and agreement of strategic business objectives.
- 2 Creation of core, key sub- and enabling processes.
- 3 Identification of process owners.
- 4 Creation and validation of the key measures of effectiveness and efficiency for each process (also known as measurement "dashboards").
- 5 Collection of data on agreed dashboards.
- 6 Creation of project selection criteria.
- 7 Using the project selection criteria for project selection.
- 8 Continual management of the processes to achieve strategic objectives of the organisation.

Source: Eckes, 2001 [9]

A critical point here is that the project activity actually occurs a long time after the start of the initiative. This would suggest that it is important to put in place a solid foundation prior to the start of project activity.

The process used to tackle projects has an impact on performance; Deming believed that 94% of an individual's performance was due to the system and 6% were due to the individual (Deming, 1986). In this way, Deming would attribute the majority of issues with Six Sigma to the systems used to drive the results rather than the individuals involved in the initiative.

2.7.2 Products and Services are designed and developed based on customer needs and expectations

Oakland (2000) states that, "A sound quality policy, together with the organization and facilities to put it into effect, is a fundamental requirement if a company is to begin to implement TQM. To learn and improve, individuals need to have confidence, competence, encouragement and organizational openness. Historically, many organizations, particularly in the manufacturing industries, have operated an inspection-oriented quality system for bought-in parts and materials. Such an approach has many disadvantages. It is expensive, imprecise and impossible to apply evenly across all material and parts, which all lead to variability in the degree of appraisal (Oakland, 2000). Many organizations, such as Ford, have found that survival and future growth in both volume and variety demand that changes are made to this approach. Errors upstream in a process will create errors further downstream in any given process and it is estimated that extra effort spent because of errors can be one-third of the organisation's efforts (Oakland, 2000). In adopting a preventative rather than corrective approach to problem solving, it is necessary to ensure that the processes are capable of meeting customer requirements and then, by monitoring the inputs to the process ensuring that the process continues to meet customer requirements (Oakland, 2000). The investigation of errors and defects can provide valuable error prevention information (Oakland, 2000).

This thesis aims to describe the extent to which the current Six Sigma process satisfies internal customer requirements and uses past experiences to drive improvements.

2.7.3 Six Sigma – Process performance

Here the problem is expressed in Six Sigma terms as a process metric.

2.7.3.1 Six Sigma Project Performance

Within Six Sigma, there is a desire to express issues mathematically as a transfer function and this generally takes the form, $Y=f(x)$, where Y is the dependent output of a process and is a function of a number of independent inputs, denoted as x. It is reasoned that in the case of Six Sigma, the Y, Six Sigma performance/year is dependent on the number of projects run, the benefit of each project and the likelihood of a project closing successfully.

Expressed as a transfer function the issue of Six Sigma project performance is shown in figure 7 as:

$$\left(\frac{\text{Six Sigma savings}}{\text{year}} \right) = f \left[\left(\frac{\text{No. of projects started}}{\text{Year}} \right) \cdot \left(\frac{\text{Benefit}}{\text{Projects closed}} \right) \cdot \left(\frac{\text{No. of projects closed}}{\text{No. of projects started}} \right) \right]$$

Figure 7. Transfer function describing Six Sigma savings performance

To assess the performance of Six Sigma further, each of the terms will be considered separately.

2.7.3.2 No. of projects started/year

The number of projects started per year is dependent upon the strategy used in deploying Six Sigma (Sanders and Hild, 2000) and the amount of resource dedicated to the initiative. Harry and Schroeder (2000) believe that Black Belts should represent one percent of the organisation. Within Ford Motor Company, two and a half percent of the workforce is actively engaged as Black Belts. While the amount of resource dedicated to Six Sigma can be increased, the issue lies not with the number of projects started, but with the yield performance of the Six Sigma project process. For this reason, the number of projects started per year is disregarded from the scope of the project.

2.7.3.3 Benefit/Project

Six Sigma is aimed at resolving issues that result from the variability that exists within every process, otherwise known as common cause problems (Deming, 1986) and each

project will typically yield a reduction in defects of approximately 70% (Six Sigma Academy, 2005). Six Sigma works by defining and measuring this variation, identifying the causes before controlling the inputs and reducing the variability (Sanders and Hild, 2000).

Juran (1964 [37]) writes of a breakthrough project that was reputed to have saved \$250,000. It is interesting that even after thirty five years, this value still appears to remain and today the estimated benefits of a Six Sigma project vary from US \$150,000 to US \$250,000 (Klefso et al., 2001; Harry and Schroeder, 2000 [204]; Scaff, 2002; Coronado and Antony, 2002).

2.7.3.4 Number of projects closed/ number of projects started

The number of projects closed/ number of projects started is known as the final yield and this was the metric that was used throughout the project is final yield. The definition of this is:

$$Final_Yield = \frac{Successful_projects}{All_projects}$$

Figure 8. Definition of Final Yield

Final Yield is also known as Traditional yield, which is "the number of units that pass a particular inspection, compared with the total number of units that pass through that point in the process" described by Harry and Schroeder (2000 [81]). The disadvantage with traditional yield is that it fails to recognise steps within the process that have been repeated, known as rework or the hidden factory (Breyfogle, 1999 [43]; Harry and Schroeder, 2000 [81]).

2.8 Conclusions

2.8.1 EFQM framework and analysis

The European Foundation for Quality Management (EFQM) framework and these categories will be used throughout this research to categorise the issues that were uncovered from the literature.

Table 4. Level 1 and level 2 headings from EFQM

Level 1	Level 2
Policy and Strategy	Strategy
	Performance measurement
Processes	Processes are systematically designed and managed
	Products and services are designed and developed based on customer needs and expectations
People	Managing people resource
	People's knowledge and competencies are identified, developed and sustained
	Teamwork
	Involvement and Empowerment
	People are rewarded, recognised and cared for
Leadership	Mission, Vision and values
	Commitment

The use of cause and effect diagrams shows the different categories in a way that assists with communication and understanding.

2.8.2 Leadership

Ford Motor Company has a strong corporate culture and if this is to be changed, then it will be a slow and difficult task. It is well known that senior leadership support is critical if lasting change is to be achieved. To create a formal link between the performance of Six Sigma and senior leadership, Ford Motor Company used the idea of a performance cell where each department had a Master Black Belt and a senior leader within the organisation that was responsible for the delivery of the projects.

2.8.3 Strategy

The initial benchmarking exercise carried out by Ford Motor Company ensured that there was conviction among senior managers at Ford Motor Company that each and

every process could be improved. Given the quality history of Ford Motor Company and the requirements of the initiative, Six Sigma is the right tool for Ford Motor Company to use to fix their quality issues. Since Ford has a culture that is strongly aligned to the use of metrics, it is necessary to maintain the metric culture to drive performance improvement and this has been achieved with the introduction of Six Sigma.

As to the focus of Six Sigma, Ford Motor Company changed the focus from reducing costs to increasing customer satisfaction. According to the literature, this is the correct decision to make. To ensure that conflict was minimised between Six Sigma and other initiatives, care was taken to weave the initiatives together and where there was an area in which potential issues could arise, a resolution was developed and this was communicated widely.

2.8.4 People

As far as training is concerned, each group of stakeholders in the Six Sigma initiative has a training course that is created in such a way as to train those people to do the job that they are required to do to assist with the initiative. Perhaps the most critical stakeholder group within a Six Sigma deployment is the group of Black Belts. Ford Motor Company has taken steps to reduce the difficulties in institutionalising Six Sigma through creating a critical mass of Black Belts, setting a nominal time that should be spent in the role and through creating training courses that differ according to needs. There is much debate over the use of a certification process to assess capability of a Black Belt. At Ford Motor Company, there is a certification process, which is standardised across the organisation and so issues with differences in standards are virtually eliminated. As a final improvement, Ford Motor Company has created a separate soft skills training programme that teaches people how to manage change within a project and team.

Issues surrounding the debate of whether individual performance reviews are a positive or negative thing are minimised through the use of individual performance reviews that measure ability to work as a team member.

2.8.5 Process

There is widespread agreement that the steps in a Six Sigma project are Define, Measure, Analyse, Improve and Control (DMAIC). It is also recognised that defining a good project with the appropriate scope is one of the most critical aspects of deploying Six Sigma.

It is interesting that literature suggests that project selection criteria are created, but there is not literature to explain how this should be done. An additional issue is that the selection and scope of a project could be incorrectly developed if an organisation is structured hierarchically rather than in a process led manner, since a hierarchical structure will mask the true way in which work is carried out.

2.7.6 Literature

There is a sufficient body of literature covering most aspects of Six Sigma. What is apparent is that there is a scarcity of literature covering the project selection and project scoping aspects of Six Sigma. The literature review did show some inconsistency concerning fire-fighting in that the training material suggests that this is not a source of good projects. Curiously, Six Sigma is about fixing processes and fire-fighting is a symptom of inadequate processes. This could represent a serious omission in the philosophy behind Six Sigma.

2.8.7 Summary

In summary, it would appear that Ford Motor Company has deployed Six Sigma in a way which is in agreement with the majority of the literature and where there is a great deal of debate, the effect of the decision has been mitigated to ensure that the initiative has the greatest chance of success.

To move the investigation forward, the data available from employee surveys will be used to identify the largest cause of the issue. The greatest issue or issues can then be tackled to ensure that the performance of Six Sigma is improved to the level of those companies that are best in class.

3. Research Methodology

3.1 *Introduction*

This chapter will present the ontology and epistemology of the researcher and describe the intended research strategy relating the design back to the paradigm in use and the tools used during the research. Denzin and Lincoln (2000 [368]) believe that there are five basic questions surrounding design:

- a) How is the design connected to the paradigm in use in such a way as to acquire information
- b) How will the empirical tools enable the researcher to speak to the problem of praxis and change
- c) What is the focus of the research
- d) What methods of inquiry will be used
- e) What research methods will be used to gather and analyse data

In addition there will follow a chronology of the research undertaken and a description of how each of the parts of the research was analysed. This chapter will answer each of the above questions so as to enable the reader to understand how the test methodology will answer the research question.

3.2 Research question

During the course of the research, the research question was refined as a result of initial findings during the research and this is summarized here.

3.2.1 Development of research question

At the start of the project, the researcher believed that the issues with Six Sigma performance were due to the political and cultural aspects of the organisation. Although, it is not widely used in management research, the researcher decided to use repertory grids to determine the attitudinal aspects of the deployment related to politics and culture that had impacted on the deployment in a negative way.

An investigation of the secondary data was undertaken to get an initial understanding of the issues. The outcome of the initial investigation was the identification of possible issues and critical areas in which it was necessary to gain a greater depth of knowledge regarding potential causes of the issues. In the case of this project, the researcher became aware that the use of the repertory grid would not allow the research question to be adequately answered and gain further information into the causal factors of the poor performance of Six Sigma. Once this was known, it was decided that interviews should be used as the research tool.

3.2.2 Final research question

As stated in chapter 1, the aim of this research is to understand why a difference exists between the performance of Ford Motor Company and that of the best companies. Once reasons have been established for the differences in performance, this thesis will propose solutions that will improve the performance of Six Sigma at Ford Motor Company. The research question is, "Why is Six Sigma performance at Ford below that achieved in other companies and how can it be improved?"

3.3 *Philosophy and background of the researcher*

3.3.1 Ontology

The ontology of the researcher is the philosophical stand point from which the world is viewed. This section will explore the ontology held; explain the reasons behind the ontology and changes that occurred during the research.

During the research, the focus of the research shifted from “managing the cultural and political aspects of change” to understanding and improving the performance of Six Sigma within Ford Motor Company. Strauss and Corbin (1998 [32]) write that there are dangers associated with only being concerned about beliefs without concentrating on action and when the limitations of an attitudinal study were unearthed, it was decided that action should be included as a part of the research. This change in focus meant that the subject of the research changed from an attitudinal investigation to a study into the performance of a change management tool and with this the ontology of the author had to change to accommodate the different characteristics of the subject under investigation.

For the research study into the performance of Six Sigma in Ford Motor Company, the ontology of the author is that of a critical realist, and therefore part of the post-positivist movement. The premise of this ontology is that there is a real world, which can only be approximately viewed (Guba, 1990; Lincoln and Guba, 2000; Healy and Perry, 2000). There is however a truth that exists and which can be discovered, although it will not be known whether this has been found or not (Guba, 1990). Up until recently, criteria to evaluate the quality of research were not available (Healy and Perry, 2000). It is noted that Healy and Perry (2000) state "social phenomena are fragile, so that causal impacts are not fixed but are contingent upon their environment. For this reason, it is recognised that while the findings of this research can be applied to other situations, the specific causes are limited to the application of Six Sigma within Ford Motor Company within the UK.

Having determined that the ontology of the researcher is critical-realism, it is necessary to determine the way in which the data is gathered and to ensure that it will assist the researcher in understanding the issue.

3.3.2 Epistemology

The most important question here is “how will the data gathered allow the researcher to understand the problem?”

Post-positivism accepts that knowledge cannot be gained objectively without influence from the inquirer, however the inquirer attempts to minimise the effect of their influence, and describes their own predispositions (Guba, 1990). Therefore the epistemology falls into the category of modified objectivist; the belief is that there is real world, but it is only possible to get an approximate view of that world (Guba, 1990; Lincoln and Guba, 2000; Healy and Perry, 2000). It is suggested that post-positivists rely on multiple methods to obtain as big an insight into reality as is possible (Denzin and Lincoln, 2000; Healy and Perry, 2000). Post-positivism conforms to critical realism and modified subjectivity and therefore uses triangulation to reduce the distortion that occurs, because observations cannot be objective (Guba, 1990 [20]).

Throughout this project, the intention is that the interviews are triangulated with the results from the surveys and project performance data to reduce the risk of adopting a skewed viewpoint based on the data gathering tools and their limitations which could lead to them providing only a limited insight into the issues at large.

3.3.3 The Researcher

Denzin and Lincoln (2000) believe that the class, race, gender, and ethnicity of the researcher influence the outcome of qualitative research and here the author will describe these and expand upon his experience with Six Sigma and Ford Motor Company, both of which could skew his attitude toward the issues that are dealt with.

The author is a White male born in the UK who has worked at Ford Motor Company in range of engineering departments for fourteen years. In 1999, the author started his two-year secondment as a Six Sigma Black Belt. As part of the first wave of

European Black Belts, there were many problems encountered first hand. A number of these early deployment problems were dealt with to the satisfaction of the European first wave Black Belts. Taken together, this means that the researcher is an internal change agent, and therefore able to use and understand that technical terms that are used within Six Sigma and engineering within Ford Motor Company. This also means that he has a similar experience to those people that will be interviewed in the research. The risk is that the author will not be able to view the situation as objectively as an outsider could.

After attending a series of management modules as part of a Master's degree, the author decided to embark upon the Doctorate of Business Administration (DBA) to understand the reasons why Six Sigma is not producing the results it should and if possible to understand the issues and resolve them to improve the performance of Six Sigma at Ford Motor Company.

3.3.4 Ethics

Stake (2000) writes that the issue of ethics needs to be considered and suggests that the people who are studied should not be embarrassed or negatively affected by the research, and that those studied receive drafts showing how the answers are to be presented. Stake (2000) therefore believes that the subjects should be protected.

Throughout this research, the identity of respondents has not been divulged and their responses treated in such a way as to ensure that their identity cannot be determined from their answers.

3.4 Research design

Having set out the philosophical standpoint of the researcher, this section will explain the research strategy and describe the link between the philosophy of the research, the strategy and the methodology.

3.4.1 Research strategy

The approach being taken is that of a case study. Stake (2000) writes that case study is not a methodology, but instead the scope of the research determining what is to be studied and it is therefore necessary to identify the case being studied, and define an integrated system (Stake, 2000). Comparative data from the Ford Motor Company and GE has been used to verify that the research question is valid and that there are significant opportunities for Ford to improve Six Sigma performance. Having established that there is a large performance gap between Ford and GE, the investigation will take the form of a single case study. Yin (1994) defines a case study as having more variables than data points and therefore a case will rely on multiple sources of converging data to prove or disprove a priori propositions. This is in line with the teachings of Eisenhardt (1989) who espouses the benefits of multiple sources of data rather than large sample sizes.

It is generally accepted that multiple case studies are more rigorous; however, part of the assumption of using a case study is that the environment is a significant part of the case (Yin, 1994). This research project focuses on the Six Sigma projects that are undertaken within engineering departments within Ford Motor Company in the UK. The purpose of researching the case is to understand how to improve the performance of Six Sigma projects within the area of study and consequently, this project is an intrinsic case study; that is to say that the case itself is of interest (Stake, 2000). The findings of this body of research apply directly to Six Sigma within the engineering area of Ford Motor Company, but the approach used should be applicable generally for Six Sigma. Further, it is expected that many of the findings will be applicable to other Six Sigma deployments.

To ensure that there is sufficient data to act upon; the case will explore the opinions of the different stakeholders and as such fulfil the requirement to demonstrate

redundancy within the research. With Six Sigma performance, it is believed that there are many ways of achieving good performance and it is not possible to compare each variable directly. Consequently, a comparative case study would not improve the rigour of this case study.

3.4.2 Methodology

As a methodology, it is suggested that postpositivists use critical multiplism, attempt to inquire within more natural settings to improve external validity, using more qualitative methods (Guba, 1990; Lincoln and Guba, 2000). Initially, the research was to use quantitative data to scope the project, and then use a qualitative research technique to gain a greater insight into the causes of the difference between the actual level of performance and the expected level of performance.

Strauss and Corbin (1998 [11]) describe qualitative analysis, as being a "nonmathematical process of interpretation" rather than the "quantifying of qualitative data". To assist with understanding, the data is often ordered according to a classificatory scheme (Strauss and Corbin, 1998 [19]). It is acknowledged that some are critical of the seemingly unscientific approach of qualitative research (Denzin and Lincoln, 2000). Researchers will have different ways of construing accuracy, and however this is done, no willing researcher wishes to be inaccurate. In a bid to reduce misinterpretation, different procedures are used including redundancy of data gathering and procedural challenges to explanations (Denzin, 1989, Goetz and LeCompte, 1984; Fontana and Frey, 2000. Denzin and Lincoln (2000) draw on the work of Flick (1998) who, as an interpretivist believes that qualitative research necessarily uses multiple methods, since an objective reality can never be captured. The methodology of using multiple methods does have a wider application and it is suggested that post-positivists also use critical multiplism in an attempt to inquire within more natural settings to improve external validity, using more qualitative methods (Guba, 1990; Lincoln and Guba, 2000). Within the post-positivist paradigm, a great deal of value is placed on the internal and external validity of the research and there is emphasis placed on qualitative research methods that produce structured results.

While the paradigm employed during this investigation changed, the quality of the research is of the paramount importance and throughout this research; it is the intention of the author that multiple data sources will be used to ensure a high level of internal and external validity.

3.4.3 Methods of inquiry

The aim of the research is to ascertain why Six Sigma performance at Ford is below that achieved in other companies and understand how it can be improved within Ford is not providing the same benefits that other organizations claim to have achieved. To date there have been a number of surveys issued by Ford Motor Company and the Six Sigma Office used to understand these reasons. It would appear that the questions asked are aimed at testing hypotheses and do not represent a methodical approach to determining the causes of the issues. This research used existing data where possible to complement research data and to search for reasons why Six Sigma is under performing.

Having analysed the existing data, it was decided that further information should be gathered using a series of interviews. Section 3.6 explains the reason for selecting interviews as a research methodology and details the preparation for the interviews, specifically describing the development of the procedure, questions and identification of interviewees. Crucially, this section explains the way in which the results are processed and analysed and describes the method used to develop conclusions.

3.5 Survey data

In this section, the different sources of secondary data are described along with the way in which the analysis was conducted.

3.5.1 Global Black Belt and Master Black Belt survey

A web based survey was issued by the Six Sigma Corporate Office to all Ford Motor Company Black Belts on 9th April 2001. In 2001, there were approximately 2000 Black world wide and 1424 respondents returned the survey creating a response rate of 70%. It was stated that the purpose of the survey was to, "determine, at a macro level, the support the Black Belts are receiving in implementing their projects" to allow senior management to formulate corrective actions. For the 2001 survey, 811 respondents were from Ford Motor Company North America and 482 were from Europe (1293 from Ford Motor Company). It should be noted here that while the majority of the respondents were from Ford Motor Company America and Ford Motor Company Europe, there are other countries that appear in the results but who have not been considered here. The 2002 survey had 738 respondents from Ford North America and 615 from Ford of Europe (1398 from Ford Motor Company). The questions are presented as statements and the respondent is asked to which of the following five statements best represents their views:

1. Strongly agree with the statement
2. Agree with the statement
3. Neutral
4. Disagree with the statement
5. Strongly disagree with the statement

The results were published as an internal document on 18th June 2002 as per Appendix I, showing the number of respondents who answered and a summary of the results. Where the response was a 1 or a 2, this was interpreted as signifying that the respondent agreed with the statement. The data for 2001 and 2002 were compiled and published as the percentage of respondents in agreement with each statement presented. This type of analysis has the effect of simplifying the data, but filtering out some of the information that was provided by the survey. When data is summarised in

this way, the strength of the response is not known and so it is not possible to evaluate whether the respondent strongly agreed or simply agreed.

3.5.2 Employee satisfaction survey

Every year, Ford Motor Company gives each and every employee the opportunity to reply confidentially to an employee satisfaction survey, which is known as “The Pulse Survey”. Some of the questions are also asked to other companies to create an industry benchmark, allowing comparison between organisations. The results are presented as the percentage of responses unfavourable, percentage of responses neutral and percentage of responses favourable. The pulse survey is taken every September and the results published on the Ford Intranet. The overall response rate is shown in table5 shown below.

Table 5. No. of responses to employee satisfaction survey by year

Year	No. of responses
2002	70,148
2001	70,010
2000	61,313

Source: <https://www.pulse.ford.com/oss/> : accessed on 10/01/2003. [It should be noted that this web address can not be accessed from outside the Ford Intranet]

The questions for the Pulse survey are presented as statements using the same method as for the Black Belt survey. The responses are collated and analysed by an independent external company to ensure that confidentiality is maintained. Then the results are presented in a format that indicates percentage of favourable responses, percentage of neutral responses and percentage of unfavourable responses.

3.5.3 Survey to assess perception of impact on career

An MBB suspected that one of the issues with the deployment of Six Sigma concerned the Black Belts and their perception of the impact of the Six Sigma assignment on their career. To understand how the Black Belts felt about this, a survey was developed. The survey was distributed on 12th July 2002 to 231 Black Belts who had finished their assignment and asked the Black Belts (BB) to provide their opinion on the following statement, "I believe that being a BB would positively enhance my career potential at FMC" as per question 6783 of the Global Black Belt and Master

Black Belt survey. The results are presented as the number of responses in each category and were made available by email from the Master Black Belt, though the data was never officially published.

The possible responses to the question included:

- Promoted
- Positive
- Not positive
- Other

The survey administrator also decomposed non-responses to one of three reasons:

- Out of office
- No reply
- No longer at company

After the analysis, the results were published in figure 14, section 4.4.4.

3.5.4 Employee psychological test to assess personality type

Type theory analysis is the name given to the analysis of personality type. Testing for type theory is often done through a psychological questionnaire from which the personality type can be assessed. It is reported that type theory can assist with assessing an organisation or team (Jessup, 2002; Oakland, 2000) since there is considerable evidence that personality correlates with occupation and management style (Mullins, 1999; Jessup, 2000). Moreover, personality type can reveal preferences concerning the communication of change initiatives and improved team composition (Jessup, 2002). The type theory personality questionnaire administered by an external consultant hired by Ford Motor Company was given to 60 engineers and managers from the Diesel Engine Engineering Department. Critically, the Diesel Engine Engineering Department is based in product development and as well as including teams from which people were interviewed, it comprises engineers from a product development area in the UK and this profile matches those of the interviewees.

The results of Type Theory Analysis is presented in the form of four scales which can be Extrovert (E) or Introvert (I), Sensing (S) or iNtuitive (N), Thinking (T) or Feeling

(F) and Perceptive (P) or Judgemental (J). The combination of these four alternatives produces sixteen possible personality types that define the personality. Where the respondent is classed as borderline on one aspect or more aspects of the personality, then the mark will be split between the categories.

3.5.5 Analysis

As noted previously in section 3.3.1, this research project considers Six Sigma within the product development area of the UK. One difficulty is that the survey data is only available at a Global level and at a European level.

This analysis is a statistical study that is conducted to identify whether a statistically significant difference exists between Ford of Europe and Ford Global. This may identify possible differences in performance between Ford of Europe and the rest of Ford, which would give an indication of the homogeneity of the issues and therefore assist in ascertaining the range of applicability of the solutions. Additionally, where data are available that describes a performance change over time; this may help to identify how changes in the deployment have affected the perception of Six Sigma. The final reason for analysing the available data is to make a comparison of the responses and understand why there is a difference in the way in which different questions are answered. In particular, it is envisaged that a poor response to a question may highlight a weakness in that particular category. A poor response is defined here as being a response in which fewer than 50% of the respondents agreed with the statement.

3.5.6 Analysis Method

In this situation, the aim of the analysis is to take proportion data and compare the results to understand whether a statistically significant difference exists. When establishing statistical significance it is conventional to use a 95% confidence level, although it is possible to use any value chosen, (Morris, 1989 [193]; Dubois, 1964). Oppenheim (1992) writes that the significance level is dependent on the sample sizes available and throughout this project, the sample sizes permit analysis at the 90% confidence level, and therefore since the analysis is retrospective, this is the confidence level at which the significance level is reported.

Table 6. Example analysis of survey results

Question no.	2001	2002	P-value
Ford Global	A%	B%	1
Ford of Europe	C%	D%	2
P-value	3	4	

In the majority of cases, there were proportion data from 2001 and 2002. In this case Minitab test for 2 proportions was used to compare the results statistically. In this way, if A% and B% are compared, then the result is 1 expressed as a p-value. The p-value provides the probability of that results occurring due to random chance. Therefore values lower than 0.1 would indicate that there is a difference when analysed at a 90% confidence limit.

Additionally, a test was conducted to determine whether Ford Global and Ford Europe were different. In this case A% and C% were analysed using Minitab and the test for 2 proportions to give a result, 3 again expressed as a p-value. Here again, a value lower than 0.1 indicates that there is a difference when analysed to a 90% confidence limit.

3.6 Interviews

The purpose of the interviews was to gain a greater understanding of the information used in other parts of the research. Interviews are an extremely popular means of conducting research; Silverman (2000) writes about "the interview society" and Mishler (1986 [23]) opines that "interviewing has become a routine technical practice and a pervasive, taken-for-granted activity in our culture".

To understand the results of the surveys conducted on the Black Belts, it was decided that similar information should be gathered from other groups within the organisation through the use of interviews. The purpose of these interviews was to understand the influence of the other groups on Six Sigma performance and so, the interviews are best described as exploratory in nature. The interviewer intended to obtain the experiences of the subject and therefore access the everyday lived world (Kvale, 1996) and therefore the interviews carried out here constitute phenomenological interviews. The context of the interview is that of an auxiliary method as described by (Kvale, 1996) and is therefore used in conjunction with other data within the case study.

3.6.1 Interview Design stage

French and Bell (1999) write that internal change agents are particularly susceptible to being absorbed by the prevailing culture within an organisation. In researching the performance of Six Sigma, it was intended that the interviewer build up a picture of the world as seen through the eyes of the interviewee without bias from the observer. Holstein and Gubrium (1995) believe that the interview participants are "actively" constructing knowledge which makes it difficult to avoid observer bias during the interview, which is described by Fontana and Frey (2000) as an interactional encounter and is therefore influenced by social dynamics, since they view the interview as a negotiated discourse. Since the researcher is an internal change agent, this is a real risk. To minimise this risk as far as possible, other people were asked to choose interview participants on a number of different criteria. This meant that the impact of the researcher choosing interviewees who possessed a certain bias was minimised. The author believed that by structuring the interviews in such a way as to get a balanced viewpoint and the use of another person to choose the interview

participants, the risk of observer bias would be reduced to a minimal and acceptable level

3.6.1.1 Sampling

Kvale (1996) writes that the answer to "How many interview subjects do I need?" is, "Interview as many subjects as necessary to find out what you need to know." Kvale (1996) continues by saying that for exploratory studies the point of saturation may be a good point at which to stop interviewing; that is when new interviews add little new knowledge. Miles and Huberman (1994 [27]) believe that qualitative researchers use small samples of people and therefore the samples tend to be selected for a reason rather than chosen randomly. Therefore, it is necessary to make extensive use of theory, both at the start and as the research progresses (Miles and Huberman, 1994 [27]). Holliday believes that when sampling, there are certain factors that need to be considered. These include the choice of social setting, the choice of research activities and the choice of themes and focus, suggesting that it is important to ensure that opportunity is used, but not at the expense of research rigor (Holliday, 2002 [8]). Regarding the social setting, each interview was conducted in a room on a one to one basis which ensured that confidentiality was maintained. Additionally, other factors that were considered included: functional area, accessibility, experience, highest Six Sigma belt awarded and perceived experience. Throughout this project, particular attention has been paid to the stakeholders in Six Sigma. These have included Master Black Belts who are responsible for coordinating the projects, Black Belts who are responsible for leading the projects, Green Belts who form the project teams and people who are not Six Sigma trained that make up the majority of the organisation. It is believed that by seeking opinion from different stakeholder groups, the number of perspectives will be increased and this too will improve the quality of the research.

One consideration of the interview is that regarding the preparation of the interview questions in that the different stakeholders have received different levels of training and consequently the interview questions need to be asked in a way that will lead to the question being understood. There is a potential weakness here in the design of the interview, since the interpretation of the questions could vary between individuals as well as the interpretation of the researcher in determining the best way of asking the question.

One potential problem is non-response bias, since those people wishing to participate may hold very different views from those who do not wish to participate (Bryman, 1989). Bryman suggests checking whether there are different levels of participation from different groups within the organisation (Bryman, 1989).

3.6.1.2 Interviewee selection

Ford Motor Company is an engineering company and therefore, the majority of the workforce comprises engineers. For this reason the project focuses on engineering. Additionally, for accessibility reasons, the majority of the subjects were based in the UK. The different categories of Six Sigma personnel included Integrated Master Black Belt, Master Black Belt, Black Belt, Green Belt and Not Trained.

For the purpose of the first round of interviews, the subjects identified resulted from people who were known to the author, fitted the desired profile and who were willing to be interviewed or who fitted the desired profile and happened to ask questions about Six Sigma at the time of considering who should be interviewed. There were five first round interviews. Details of why the participants were selected are contained below in table 7.

Table 7. People interviewed during 1st wave of interviews

Role	Reason for selection
Master Black Belt	Relatively new to MBB. Known to author.
Integrated Black Belt	Continuing in Six Sigma area. Certified. Known to author.
Black Belt	Uncertified. Known to author
Green Belt	Never involved in a BB project. GB raised question about status within Six Sigma prompting interview.
Non- Green belt	Not involved in a Six Sigma project. Asked author about GB training prompting interview.

Round 2 interviews

To select the interviewees for the second and subsequent rounds, it was decided that different criteria should be applied to each of the stakeholder groups to ensure that

different experiences are covered within the interviewing process. Strauss and Corbin (1998 [44]) advocate obtaining a wide variety of perspectives to maintain distance from the problem. The approach of developing the sampling as the research process evolves is known as theoretical sampling (Strauss and Corbin, 1998 [202]). Strauss and Corbin (1998 [203]) do however warn that it is important to plan the theoretical sampling and balance rigid procedure with making use of opportunities that occur. To ensure that the researcher obtained information on the different aspects desired to satisfy the research, a plan of desirable attributes was developed. Additionally, to minimise interviewer bias from the selection process, the way in which the interviewees are selected is as follows:

A Master Black Belt who works in an engineering area in the UK in a PD environment was asked to supply names for one set of interviews. For the subsequent rounds of interviewees, the following criteria were presented to the MBB. The following criteria would provide a wide range of viewpoints for each of the different stakeholder groups. E.g. having interviewed a relatively new Master Black Belt during round one, rounds two and three should contain a Master Black Belt who was experienced and a Master Black Belt that had been integrated.

Table 8. Desired interviewee characteristics

	Interview round		
Role	Round 1 (Already interviewed)	Round 2	Round 3
Master Black Belt	Relatively new	Experienced	Integrated
Integrated Black Belt	Continuing in area	Promoted	Moved but not promoted
Black Belt	Uncertified	Certified	LL6 before becoming a BB
Green Belt	Never involved in a BB project	Involved in a BB project	Led a GB project
Non-Green belt	Not involved in a Six Sigma project	Involved in a team	Someone new to the company

An MBB was then asked to provide names of people who fitted the agreed criteria. In addition to meeting the criteria, the MBB was then asked to provide a reason for each interviewee where there was a choice. There were six second round interviews. Table

9 describes the perceived attributes of each of the candidates. The candidates were chosen on the basis of fitting the test plan as closely as possible. This approach does carry the risk of introducing research bias, however, by using another Master Black Belt to carry out the selection, it distanced the researcher and so minimised the impact of any preconceptions held by the author.

Table 9. Described characteristics of possible interview candidates

Participant	Role	Background	Attributes
1	Integrated Master Black Belt	Background in quality	
2	Master Black Belt	Most proactive in Europe	Forthright views
3	Integrated Black Belt	Constructive in spite of the way in which treated	Awful lot of time and effort into Six Sigma. Promoted as a result
4	Black Belt	Successful application of Six Sigma in Team Value Management (TVM)	Not certified, not active. Interesting situation
5	Green Belt	GB involved in BB projects	Clear views. TQM background. Seen initiatives, and not 100% impressed.
6	Non- Green belt	Involved with projects. Positive and has very clear views on its use as a problem solving technique.	Has seen a number of initiatives and is still positive

The MBB supplied a list of six names of people who were perceived to fit each of the above categories. These people were all invited to be interviewed and the first people to accept were those that formed the second interview stage. All six agreed to be interviewed and this formed round two. Table 10 describes the attributes of the participants.

Table 10. Negotiated characteristics of interviewees

Participant	Role	Background	Attributes
1	Integrated Master Black Belt	Background in quality	
2	Master Black Belt	Most proactive in Europe	
3	Integrated Black Belt	Constructive in spite of the way in which treated	Substantial time and effort into Six Sigma. Promoted as a result
4	Black Belt	Successful application of Six Sigma in TVM	
5	Green Belt	GB involved in BB projects	
6	Non- Green belt	Involved with projects. Positive and has very clear views on its use as a problem solving technique.	

The round two interviewing took an unplanned turn, since one of the Integrated Black Belts indicated that they would soon be unable to take part in an interview and therefore, it was necessary to carry out the interview sooner than intended. During the interviews, one the Master Black Belts indicated that they too would be leaving the company. Although unplanned, this turn of events meant that there was representation from the people involved in Six Sigma who were leaving the company and reduced the effect of research bias that would otherwise have prevented any access to those people. Of the six people interviewed, two went on to leave the company within a few weeks of giving the interview.

3.6.2 The Interview Stage

Kvale (1996) writes that as an investigation progresses, the interviewer may go through a process of 'getting wiser'. In the case of interviewing to understand how best to improve the performance of Six Sigma, it was decided that the transcription of the interviews should take place as the interviews are conducted, rather than conduct the complete series of interviews without a period of reflection. With this in mind, and the fact that the interviews were exploratory in nature, it was decided that any lessons should be incorporated as the interviews progressed. Kvale (1996) believes that, there is no easy solution to the problem of whether to improve the interview

guide to incorporate new discoveries; among the disadvantages are that this approach will not allow comparison between similar groups, while the advantages are that the opportunities to learn from the interview are maximised. Miles and Huberman (1994 [38]) also believe that instrumentation should be revised as learning takes place.

The start point from which the questions were developed was the survey questions that had been given to the Six Sigma employees within the company. Analysis of the survey data revealed little and the interviews were intended to draw out more detail to understand the reasons for lower than expected performance. The EFQM model had been adopted as a framework that could be used to structure the information into categories that would ensure that the data could be stored in a rigorous format. The researcher then used the literature review to supplement the survey questions where it was believed that the survey questions on their own would not provide sufficient information. The survey questions were then structured according to the EFQM model and this formed the prompt for the first interview. The first interview was carried out using the list of prompts (as per Appendix IV) in a semi-structured manner to ensure adequate coverage of the topics. For the first interview, the questions were designed to allow the interview to roam and be guided loosely by the structure of the EFQM model and notes made during the interview. The goal of the interview was to understand why Six Sigma was performing at a lower level than expected. The interviewer although a novice made a conscious effort to follow leads to understand the critical aspects of Six Sigma. The first interview provided a great deal of information and certainly worked as a guide for questioning, in as far as the questions were sufficiently open to prompt full responses and the way in which the questions had been categorised meant that the interview flowed through the different subjects. For this reason, the questions were kept for the first round of interviews.

For round 2, the questions were updated in line with Kvale's idea of getting wiser (1996) which is consistent with the opportunist ideas of Strauss and Corbin (1998 [205]). The process used to improve the questions was to include lessons learned during the interview including areas where the question needed clarifying and where extra questions were used to understand a particular issue. This was repeated at each stage to ensure that the greatest opportunity for learning was taken. Additionally, a

context statement was added to ensure that the reason for the research was understood. The updated questions are shown in Appendix V.

One aspect of the interview that is critical is the quality of the information. It is not possible to assess the quality of the answers, however, it is possible to assess the quality of the interview and (Kvale, 1996 [144]) writes that the criteria to measure the quality of an interview are:

1. "The extent of spontaneous, rich, specific, and relevant answers from the interviewee.
2. The shorter the interviewer's questions and the longer the subjects' answers, the better.
3. The degree to which the interviewer follows up and clarifies the meanings of the relevant aspects of the answers.
4. The ideal interview is to a large extent interpreted throughout the interview.
5. The interviewer attempts to verify his or her interpretations of the subject's answers in the course of the interview.
6. The interview is "self-communicating" – it is a story contained in itself that hardly requires much extra descriptions and explanations."

It is recognised that the assessment of quality of the interviews is subjective; however, every effort was made to achieve high quality interviews.

3.6.2.1 Recording the interview

When conducting any type of research, the question concerning the way in which data is stored arises. While the aim of the research is to unearth “external” realities, the foundation of the analysis is the words spoken by the interviewee (Silverman, 2000). Prior to starting the interviews, it is necessary to determine a means of recording the interviews. For the purpose of this research, it was decided that a tape recorder should be used for each interview with the interviewees consent. The purpose of using a tape recorder was to ensure that a record of the words was maintained with the appropriate level of accuracy and detail (Silverman, 2000). Once recorded, all of the interviews were transcribed.

Once the interview was transcribed, all interviewees were offered the opportunity to review their transcript. Only the GB and the member of the organisation without Six Sigma training wished to review the transcript. The GB expressed concerns that information within the transcript could identify him/her. The author stressed that the information would be presented in such a way as to ensure that this would not be the case and would allow them to read the finished version. They agreed to this.

3.6.3 Analysing the interview data

This section is concerned with describing the way in which the interview data would be assessed and analysed.

3.6.3.1 Transcription

Initially, the tapes used during the interview were transcribed verbatim to ensure that a written record was available of the interviews. Kvale (1996 [168]) discusses some of the issues that are involved with transcribing interviews. It appears that many of the difficulties associated with transcription involve differences in interpretation between transcribers. Throughout this project, the issue of consistency was kept to minimum, because all the transcription was conducted by the author. The first round of interviews were transcribed verbatim, however, further learning resulted in the following set of guidelines being drawn up and following this, the tapes were transcribed according to these guidelines. To ensure that the process was applied consistently across different rounds of interviews, the first round interviews were reviewed and where necessary, modified in line with the guidelines.

The author also uses the following guidelines:

- The interviews are transcribed verbatim – as heard on the tape.
- Pauses are marked by dots in the form "...". A large number of dots indicate that the pause was considered to be long.
- Where it is felt that a guess can be made about an unclear word from the context, this is done.
- Where the word is critical to understanding and it is unclear, then this is marked.
- False starts of words and repeated words are not to be transcribed.
- Sentences that are started and unfinished digressions are transcribed.

- Tones and body language are not remarked upon.
- Where names are used by the interviewer or interviewee, these are removed and replaced with a description of that person's position within the Six Sigma organisation. This removes the issue of identification of the interviewee and issues with reporting stories about other members of staff.

The reason for the above guidelines is that the purpose of conducting the interviews is to allow analysis of possible reasons why Six Sigma performance is not as desired. The analysis will be in the form of coding and not a linguistic analysis. Therefore, the stutters and repeated words will not be transcribed, since this may affect the analysis in terms of the number of times a word is used (Kvale, 1996 [171]). Kvale (1996 [171]) expands to suggest that interviewees will be shocked when given transcripts to read through. During the first round of interviews, the interviewees were given the transcriptions to read. As stated above, the first round interviews were transcribed verbatim. This did lead to some shocked interviewees, since they were surprised at the result. This reaction and further learning led to the changes made in the level of editing conducted.

Kvale (1996 [163]) asserts that the transcribed text becomes the rock-bottom data. The author kept all transcripts to ensure that throughout the analysis, unexpected results and contradictory data could be reviewed to ensure that mistakes had not been made that would lead to errors in drawing conclusions.

3.6.3.2 Classification

Kvale (1996 [179]) believes that the ideal interview is one that has already been analysed before it has ended, and suggests that as much analysis is moved into the interview situation as is possible. The realist approach to interview data is that the interview responses index some external reality and that it is possible to build in devices to improve the accuracy of the results. Checking the results against other observations makes it possible to check the accuracy of the findings (Silverman, 2000).

When classifying the interview data, Strauss and Corbin (1998 [115]) describe a process of open coding to develop concepts, recognising that the literature is a good

source of concepts, allowing the development of established ideas. Strauss and Corbin (1998 [115]) further explain that care should be taken to ensure that the researcher is clear on their meaning and definition and that they exist within the data. Miles and Huberman (1994 [18]) write that researchers should have an understanding of the various categories that are going to feature within a research project, which can be derived from theory or experience. The issues were classified in the framework that has been used throughout the project, namely that derived from the European Foundation for Quality Management literature. Miles and Huberman (1994 [22]) advise new researchers of the following:

1. Use graphics when assembling conceptual frameworks
2. The process should be iterative
3. Ensure that researchers compare results
4. Don't avoid making decisions
5. Lay out your own prior orientations

Having determined data that are relevant to particular categories as determined from the literature, it is necessary to carry out axial coding in which subcategories are related to categories (Strauss and Corbin, 1998 [127]). Miles and Huberman (1994 [23]) write that research is improved when research decisions and assumptions are explained rather than portraying research as being inductively pure.

Strauss and Corbin (1998 [136]) believe "a category is considered saturated when no new information seems to emerge during coding, that is when no new properties, dimensions, conditions, actions/interactions, or consequences are seen in the data."

3.6.3.3 Coding

Silverman (2000) writes that the realist approach to data is to code the results into Ethnograph or NUD.IST allowing factors to be established for the research question. Miles and Huberman (1994 [58-61]) write that their preferred method of creating codes is to use a "start list", which is created prior to conducting the fieldwork, however, it is recognised that the codes will change. During the literature review, a framework was developed based on the subject areas that were reported as being significant for Six Sigma performance. A convenient way of laying out the categories

was that used in the EFQM quality model as shown in table 11. This formed the start list for categorising the data. The framework is as follows:

Table 11. Use of EFQM framework to assist with interview coding

Level 1	Level 2
Policy and Strategy	Strategy
	Performance measurement
Processes	Processes are systematically designed and managed
	Products and services are designed and developed based on customer needs and expectations
People	Managing people resource
	People's knowledge and competencies are identified, developed and sustained
	Teamwork
	Involvement and Empowerment
	People are rewarded, recognised and cared for
Leadership	Mission, Vision and values
	Commitment

These categories were developed further through the analysis of the survey data and were then improved further through the coding of the interview data. The interview data provided the highest resolution information and so, it was possible for the first time to link the data from the responses rather than from the questions. This gave rise to the following set of tables with level 1, 2, and 3 categories.

Table 12. Coding for Policy and Strategy

Level 1	Level 2	Level 3	Operational definition
Policy and strategy	Strategy	Clear strategy exists	Deals with the existence of a strategy, but not the communication of it. This probably means that only BBs and MBBs can talk about it.
		Six Sigma aligned with organisation	How well Six Sigma fits with the needs of the organisation
		Implementation of strategy	How the strategy has been implemented
	Performance measurement	Appropriate metrics	Are the metrics appropriate

Table 13. Coding for Process

Level 1	Level 2	Level 3	Operational definition
Processes	Processes are systematically designed and managed	Process management	How is the process updated
	Products and services are designed and developed based on customer needs and expectations	Customer involvement in targets	Use of internal customers in refining process

Table 14. Coding for People

Level 1	Level 2	Level 3	Operational definition
People	Managing people resource	Training quality	Comments on training
	People's knowledge and competencies are identified, developed and sustained	MBTI category	Using surrogate data to backup theory on personality type and shortfalls
	Teamwork	Extent used	Any comments regarding teams used in Six Sigma
		Perceived benefit	Comments regarding the perceived benefit of using a team
	Involvement and empowerment	Resource available	This is used to describe whether team members are available
		Target setting	Were the team involved in target setting
	People are rewarded, recognised and cared for	Impact on career	How is the Six Sigma assignment viewed with regard to career progression
		Recommendation	Would the stakeholder recommend Six Sigma involvement to someone else
		Reward vs. performance	Covers any thoughts regarding whether the reward is commensurate with performance
		Recognition	Has the subject been recognised for their effort

Table 15. Coding for Leadership

Level 1	Level 2	Level 3	Operational definition
Leadership	Mission, Vision and Values	Communication of expectations	Is the subject aware of exactly what is expected from them
		Communication of progress	Is the subject aware of how Six Sigma is performing within Ford Motor Company
		Communication of strategy	Is the subject aware of how Ford Motor Company is intending to use Six Sigma
		Company quality values	Is the subject aware of the company's values regarding quality
	Commitment	CBG commitment to Six Sigma	Is the CBG/GEC leader a strong visible supporter of Six Sigma
		Manager support	Does the subject feel that they have sufficient support from their manager
		PC support	Does the subject feel that they have sufficient support from their Project Champion
		Mid-level support	Does the subject feel that they have sufficient support from their Middle management
		Exec level support	Does the subject feel that they have sufficient support from their Executive leaders
		Commitment to quality	Does the subject feel that the leadership is committed to quality

Miles and Huberman (1994 [63]) maintain that however codes are developed, it is essential that clear operational definitions are developed so that the codes can be applied consistently. For each level 3 category, a separate operational definition was created to ensure that the coding would remain consistent throughout the analysis. This was helpful where the responses for a question could contain information for a number of different categories. The level 3 categories and operational definitions were refined through the process of coding the interview data. This was an iterative process and as information was collected, it was categorised according to the operational definitions. If there was sufficient information that challenged the operational definition, then this was modified to accommodate the new information. If the information did not fit the categories or definitions, then a separate category was created to reflect the information and an operational definition created.

Miles and Huberman (1994 [64]) write that coding should be checked to ensure that they have been applied in a reliable manner. As an extra check, it is recommended that researchers check their early work against their later work (Miles and Huberman, 1994 [64]). The use of operational definitions throughout the analysis meant that the coding of later work could be checked with the results of earlier analysis in an attempt to achieve the highest level of quality in the analysis.

3.7 Analysis of project data

Initially, the interviews were coded by the nodes determined from the literature and secondary data. Initially, comparing the interview responses against the literature and nodes, it appeared that there were a large number of aspects of Six Sigma that could be improved. What also emerged is that no single node appeared to stand out as being the root cause, which if tackled would deliver the greatest benefit.

To understand what could be creating a difference in the performance of Six Sigma, the author attempted to analyse Six Sigma, but from a perspective in which the completion of projects is viewed as a process, rather than a series of individual achievements. This analysis revealed that project selection and scoping appeared to be the greatest factors in determining the performance of the deployment. The next step was to determine whether in fact these process steps could be responsible for this difference.

Here, the anatomy of a process is reviewed and a framework developed to ensure that the information can be correctly analysed to identify a potential reason or reasons as to why Six Sigma at Ford Motor Company is not performing at the intended level. First, it is necessary to define what is meant here by the term 'process'.

3.7.1 Description of a process

This section will describe what a process is and explain how processes are managed. Breyfogle (2003 [1114]) describes a process as “a method to make or do something that involves a number of steps, while Harry and Schroeder (2000 [12]) write that a process is “any activity or group of activities that takes an input, adds value to it, and provides an output to an internal or external customer.” Pyzdek (2003 [125]) writes that a process is, “any activity or set of activities that transform inputs to create values for stakeholders.” The Software Engineering Institute describe a process as “a sequence of steps performed for a given purpose” (Carnegie Mellon University, 1995 [8]). In this research, a process will be taken to mean a sequence of activities carried out to deliver an output to the organisation. In this thesis the Six Sigma problem solving methodology is usually described in the form, DMAIC and since the intention

is that each Six Sigma project adds value to the customer and organisation, it can be viewed as a process.

In section 2.7.2, the importance of the customer and need to add value according to a strategy was discussed and further, it is written that the improvement of business processes is critical, (EFQM, 2003; Gardner, 2001). The question remains and so it is important to explain what is meant by the improvement of a business process.

3.7.2 Improving business processes

Improving a business process has two parts to it, identifying the appropriate process and determining a way of measuring the improvement. These areas will be tackled separately.

3.7.2.1 Identification of the appropriate process

Gardner (2001) writes that improving unimportant processes will yield little benefit, which means then that if effort is to be expended, then it should be done so by focusing on the areas that add the maximum benefit to the customer. Since the scope of this research is limited to the completion of the Six Sigma problem solving process, this will be the focus of the process improvement.

3.7.2.2 Measuring process improvement

As previously discussed, for the purpose of this research, a process will be taken to mean a sequence of activities carried out to deliver an output to the organisation. It would seem reasonable then that this output can be measured and this will give an indication of the performance level of a process and therefore, if an improvement is made, the start and end values can be used to understand the improvement that has been made. As described in section 2.5.2, the use of quantitative metrics ensures that the measurement is accurate. The question that remains is whether the measurement of the output is sufficient and provides sufficient information about the performance of a process.

There are authors who believe that the metrics of process capability can be applied to all processes including business processes (Pyzdek, 2003 [58]; Harry, 1998). There is however some debate with other authors suggesting that process capability is not the

only metric that can be used (Breyfogle and Meadows, 2001; Gardner, 2001) who believes that to assess a process, it is necessary to assess process performance on the basis of effectiveness, efficiency and adaptability (Gardner, 2001). In addition to this conflict, there is in fact a further debate as to whether one metric is appropriate for the life of a process. Crosby (1996 [31]) believes that an improvement in quality can be assessed by the level of quality maturity of an organisation and that the measure of process performance will vary as processes are improved. He further states that the journey of quality improvement can be expressed with the Quality Management Process Maturity Grid, which uses the idea of process maturity to communicate process performance levels.

3.7.3 Process maturity

Process maturity is the name given the level of competency that an organisation has reached in running a particular process. The Software Engineering Institute (SEI) believes that there is a link between the ability of an organisation to produce high quality products consistently and what it calls the maturity of an organisation (Carnegie Mellon University, 1995 [8]).

The idea of process maturity is that it is possible to express the maturity of an organisation in terms of the maturity of its processes. Crosby has developed the Quality Management Maturity Grid and subsequently the Quality Management Process Maturity Grid (Crosby, 1996 [34]). These both have five phases: Stage I: Uncertainty; Stage II: Regression; Stage III: Awakening; Stage IV: Enlightenment; Stage V: Certainty (Crosby, 1996 [32]). The SEI process maturity framework also has five levels: 1. Initial; 2. Repeatable; 3. Defined; 4. Managed; 5. Optimizing (Carnegie Mellon University, 1995 [15]). The Process Improvement Reference Guide developed by Gardner has six steps: Level 1: Unknown; Level 2: Defined; Level 3: Repeatable; Level 4: Capable; Level 5: Efficient; Level 6: Adaptive (Gardner, 2001). It can be seen that the idea of process maturity has created a suite of reference tools, each of which is slightly different. Of the four frameworks, only one can be used throughout the rest of this thesis.

Crosby's Quality Management Maturity Grid was superseded by the Crosby's Quality Management Process Maturity Grid to improve the success rate of organisations

attempting to grow their process maturity (Crosby, 1996 [34]). The SEI framework is aimed at the software industry while Gardner presents likely tools that can be used to move from one level to the next. For this reason, the Gardner model of process maturity is used.

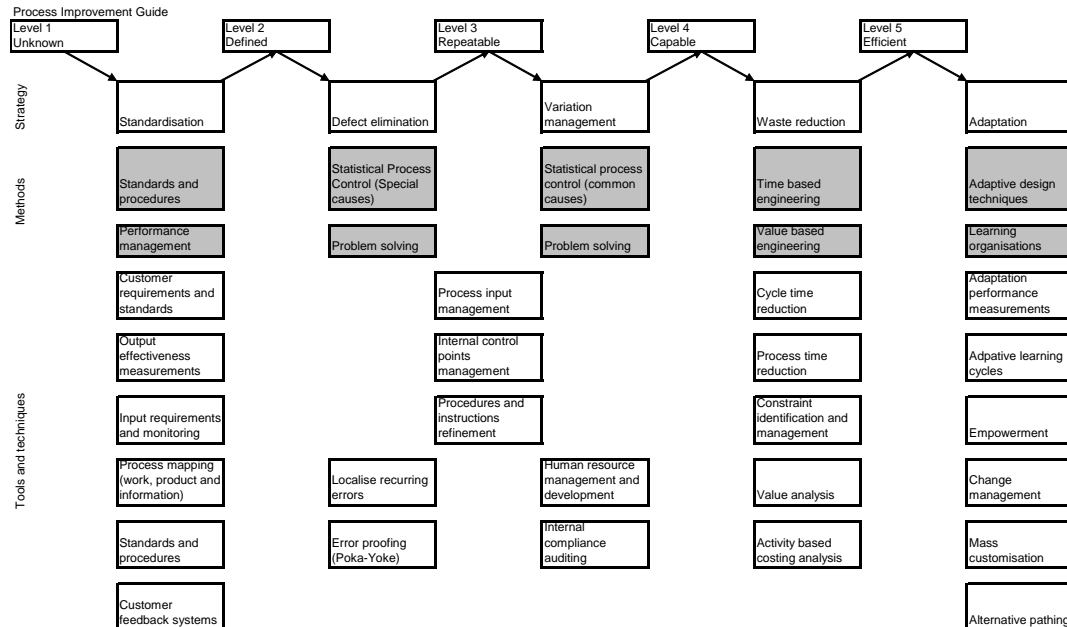


Figure 9. Process improvement guide showing levels of process maturity

Source: Gardner, 2001 [58]

Unless the Six Sigma organisation can demonstrate the benefit of a mature process, with the understanding of how processes can provide benefits to the organisation, then it will be difficult for the Black Belts to develop the process maturity of the organisation. The role of this stage of the research then is to assess the process maturity of the organisation and, if necessary, provide the means to improve the processes involved to assist the performance of Six Sigma in line with the Gardner process maturity continuum (Gardner, 2001). The process maturity continuum provides an explanation as to the different process maturity levels, but it is possible to encounter difficulties when some aspects of a process satisfy a high level, and others do not. To avoid confusion, the author has added a further clarification that a process will be considered at the lowest process maturity level unless all the requirements of a higher level can be satisfied. Having defined the framework within which process maturity will be assessed, it is necessary to define the framework within which processes throughout the organisation will be assessed.

3.7.4 Process levels within the organisation

In addition to being able to describe processes by maturity, it is possible to describe processes in terms of their level within the organisation. There is basic agreement that there are three levels of process within the realm of project and process management (Turner, 1999 [16]; Eckes, 2001 [17]), Rath and Strong, 2003 [250] and Basu and Wright, 2003 [92]). The names used are different, for example, Eckes (2001 [17]) calls these levels, core, key sub and enabling process, while Rath and Strong (2003 [250]) call these level 1, 2 and 3., but these levels will be called strategic, high level and working level after Turner (1999 [16]) follows:

3.7.4.1 Strategic level

This process level, which for Six Sigma is also called the deployment level, is concerned with how the organisation determines the strategy for how it operates. The deployment level is the process by which Six Sigma is actually implemented within the organisation. Basu and Wright (2003 [92]) describe a process for deploying Fit Sigma.

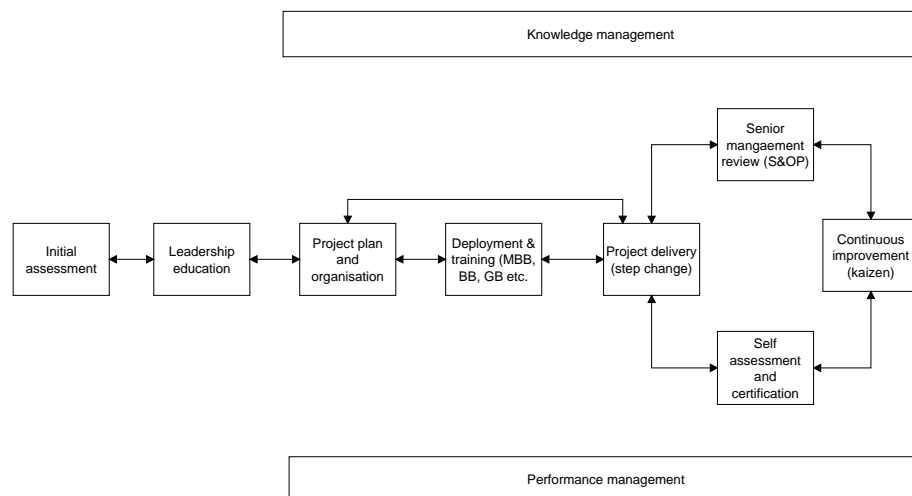


Figure 10. Process for deploying Fit Sigma

Source: Basu and Wright, 2003 [92]

The deployment level process is concerned with rolling out the initiative across the organisation. The scope here has been narrowed down to include only Europe. The key function of this process is to deliver an operational initiative throughout the organisation in line with the needs of the business. From the interview data, it was determined that the key issue within Ford Motor Company surrounds that of project

selection and scoping, however, the data here will be analysed to assess the performance of the deployment process.

Key indicators of the deployment process performance will include the variability of the project yield by Business unit, Country, Deployment Director, and function. Where there is sensitivity to deployment process level noise, this will be discussed along with potential solutions. At the next level of detail are the high-level processes, which are in place to deliver the strategic goals of the organisation.

3.7.4.2 High-level organisation processes

This level of the organisation is concerned with processes such as the Ford Production System, Ford Product Development System, Global Product Development System, Six Sigma process improvement process and these are the processes that form part of the strategic level processes. If the projects at this level are coordinated and managed correctly, then it is down to the working level processes to ensure that these processes are performed capably. This is the process level at which the projects are managed and is concerned with process steps within the project including the selection and scoping of projects. Prior to commencing the analysis of the project data, it is necessary to describe the existing literature for this level of process.

3.7.4.3 Working-level organisation processes

This is how the work is actually achieved and is sometimes called the project execution level. The majority of projects focus at this level of the organisation and this is where many of the issues manifest themselves. This is the level at which the work within the project is done.

The execution of the project is dependent on the incoming selection and scope, however the naming of the project type by the phases (as is the case with DMAIC) ensures that the high level process is understood and adhered to. Prior to assessing the project data to assess whether the key issues are located at this process level, it is necessary to describe what happens at this level.

Six Sigma is described as a means of reducing variability (Harry, 1998) and so it is necessary to consider how this is actually done. Ingle and Roe (2001) believe that

reducing variation is a 2 step process: step 1 is to reduce variation and sensitivity to variation in design; step 2 is to eliminate sources of variation in manufacturing. Gardner (2001) believes that often process improvements fail to deliver the expected results, because they are poorly focused, because organisations are not aware of which processes are important or their performance level. Ford believes that it is operating at a level of between 3 and 4 Sigma. To understand the performance level of Six Sigma project closure, a review was conducted. Firstly, it was necessary to define the Measures of success. To satisfy the internal customers, a project should finish successfully and should close within the 128 day target, and failure to achieve either of these goals warranted a project defective. The projects contained on the database were then assessed against these two requirements. It emerged that the performance of Six Sigma projects was lower than the overall performance level of the organisation with respect to projects being successfully finished.

The current method of running a project and auditing the result appears to be in keeping with the historical inspection method. It seems from the literature that at a high level, the process is described and the measures of success are expressed in post-inspection terms. The author proposes that to improve the performance of Six Sigma, it is necessary to describe the inputs that are required to adequately define a project. What is required is a process to ensure that good quality projects are selected from the start. Basu and Wright (2003 [143]) believe that it is so basic that the terms of reference, also known as the project charter within Six Sigma projects is signed up to by the client prior to starting work, they apologise for writing it down!

In the training material, the example used to illustrate the process by which a project should be selected is based on a vehicle attribute rather than process performance. As to the identification of a project selection and scoping process, this is omitted from the training material. It is expected that in the case of an organisation in which the process maturity level is high, then there will be sufficient process metrics available to drive the selection of suitable projects. The issue of selecting a process performance based project is made more difficult still, because Harry and Schroeder (2000 [130]) define the upfront phase as Recognise (R) – "Recognize functional problems that link to operational issues". While this statement details the required action, it is open to misinterpretation, since it does not explicitly state what form the functional problem

may take and could lead projects being selected based on attributes rather than process performance.

According to Gardner's (2001) description, the Six Sigma process within Ford Motor Company is at level 2, that is to say that customer requirements are defined and there are feedback systems in place, there are course-grained procedures in place, customer requirements have been translated into measures and results are managed by post-process inspection. Gardner (2001) believes that transition to a level 3 process is characterised by a correction action system, fine grained procedures, output measures focusing on repeatability with internal measures defined and repeatable, and defects must have been eliminated from within the system. This section is concerned with the analysis of project data that has been recorded on the corporate project repository known as the Project Tracking System. Prior to any analysis, it is important to understand the way in which the Project Tracking System (PTS) works and define the process steps that will be used throughout the analysis. Having defined the issue in top level terms, the project will be decomposed into its constituent parts and the largest of these considered. The aim of this section is to determine what problems exist with project performance and where possible, diagnose causes of such issues. This will be done by analysing each stage of the DMAIC process in terms of Gardner's Model of Process Maturity.

Before conducting the analysis, the training material will be reviewed to understand the Six Sigma process in detail.

3.7.5 The problem

Within Six Sigma, there is a great focus on accurately describing the problem that is to be solved, and it is advocated that a problem statement is formed. The aim is to do this in such a way as to eliminate as far as possible any possible misinterpretation (Basu and Wright, 2003 [139]). For the purpose of this research project, a problem statement has been created.

3.7.5.1 Problem Statement

The scope of this project has been narrowed to Ford of Europe and is concerned primarily with projects that end without any benefit to Ford Motor Company.

Specifically then, this project aims to reduce the number of projects that end up as Cancelled or End-Unsustained. To assess any improvement, it is necessary to declare the initial capability of the process under consideration, here the Six Sigma DMAIC process.

3.7.5.2 Initial Process capability

The performance of Six Sigma comprises three key inputs: No. of projects started/ year, benefit/project and final yield. Each of these three inputs will be considered in turn to validate the decision to work with the issue of cancelled projects in Ford of Europe.

3.7.5.3 No. of projects started/ year

The number of project started/ year is a function of the time taken to complete a project. The target for the length of time that a project should take is 128 days.

3.7.5.4 Benefit/ Project

For a given method of selecting a project, the benefit per project is determined by the size of the issue to be fixed. Much is written about the benefit of a typical Six Sigma project (Antony and Banuelas, 2002). If all projects are chosen in the same way, then the benefit is dependent on the issues and therefore, this aspect will not be included within the scope of this research.

3.7.5.5 Final yield

To understand the initial process capability, it was necessary to interrogate the Project Tracking System (PTS) to understand the final yield for all Ford of Europe projects ever conducted. From the data, it is possible to determine the Defects Per Million Opportunities (DPMO) for the final yield. The target yield is ninety percent which is equivalent to a DPMO of less than one hundred thousand parts per million.

3.7.5.6 Cost of Poor Quality – Cancelled Projects

Based on BB costs alone

Cost of cancelled projects = proportion of cancelled projects * BB no. * annual cost of a BB to the company

3.7.5.7 Cost of poor quality – Failing to meet time requirements

This is calculated as being the amount of time spent on successful projects that run over 128 days.

3.7.5.8 Cost of poor quality – Benefit per project

While it would be possible to get information detailing the benefit of each individual project, this has not been done, because the benefit per project is an outcome and therefore can not be managed.

3.7.6 Root cause analysis

According to Bhote and Bhote (2000 [111]), the variability can occur at 3 levels, between families, between parts and within part. Between families refers to variability that is accounted for by batch, or by type or some other discreet identifier that will group a number of projects together. Between parts, refers to issues that occur on an individual basis. Here there is no grouping, and the variability occurs as a result of uncontrolled noise within the process. A within part failure means that an individual part may fail under certain conditions or at a certain point during operation.

3.7.6.1 Project definition and measurement

Juran (1964 [17]) writes, "all human progress has been a series of breakthroughs". Six Sigma is dependent on the successful completion of a number of projects to deliver a breakthrough improvement that is associated with the quality initiative. Ford Motor Company has approximately two thousand active Black Belts at any time and with each Black Belt expected to deliver between three and four projects per year, the number of projects carried out is likely to be enormous. To ensure that the projects and their outputs are adequately managed and documented, the Project Tracking System (PTS) has been set up within Ford Motor Company. The PTS offers additional functionality over and above that as a project repository and can be used to record, share and track the performance of the Six Sigma initiative. Each project is aligned to a performance cell and this allows the performance cells to be compared. The PTS also drives discipline through the process by ensuring that projects can only progress if the registered stakeholders formally register their agreement to proceed on the system. The process flow and signatures required to proceed at each step are documented below in figure 12.

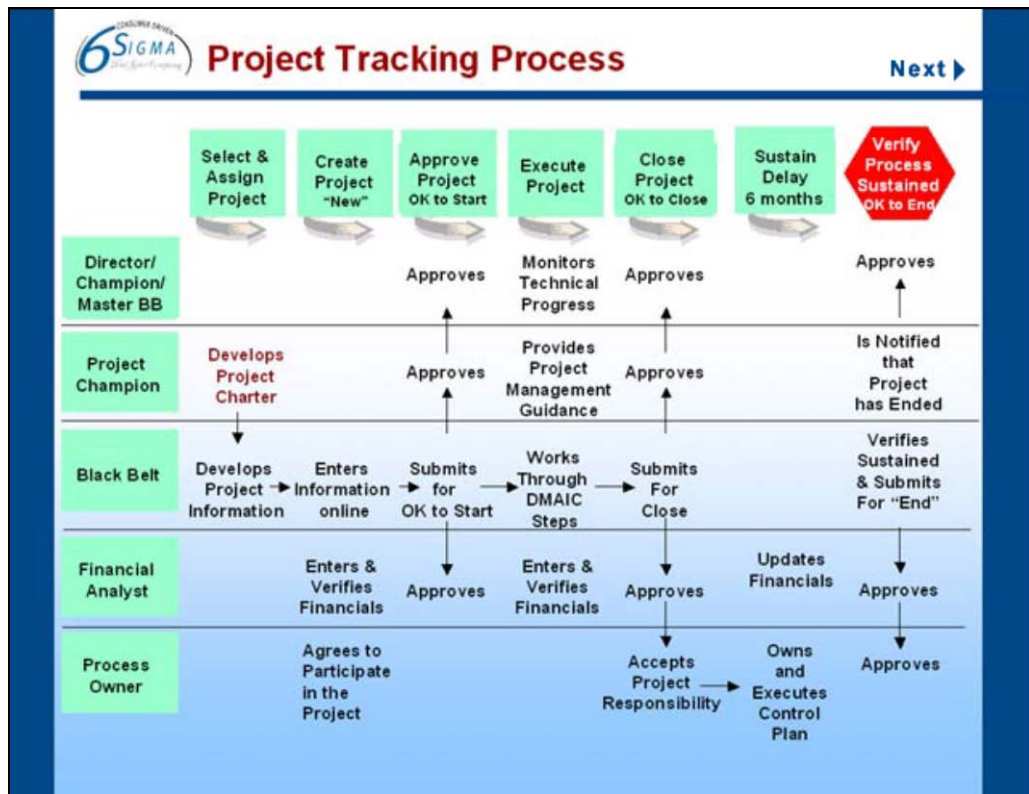


Figure 11. Project tracking process

Source: PTS Project tracking process accessed 18/09/2006 from www.6-sigma.ford.com

What is critical here is that the Project Tracking System (PTS) is in place and is used as a means of recording projects, but also is a store of information concerning every project ever started for Six Sigma within Ford Motor Company. The next critical step is to understand what information exists on the PTS and what data are required for the analysis.

3.7.6.2 Data collection plan

To understand where it is necessary to gather data, a high level process map has been developed by the author.

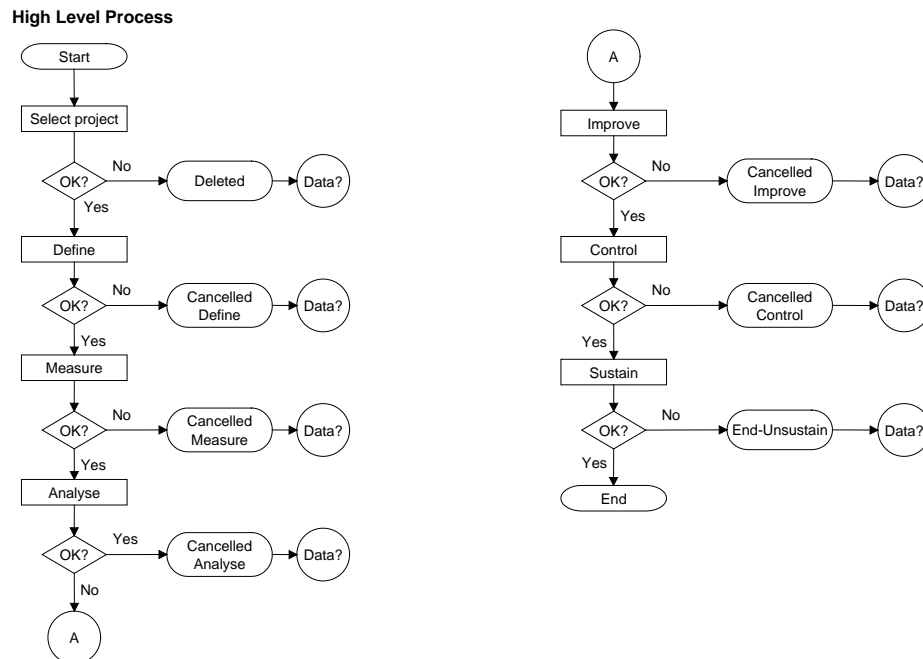


Figure 12. High level process map of the Six Sigma process

This process map shown in figure 13 reveals that to understand cancelled projects, it is necessary to understand the age of a project at the point of cancellation. Before the information could be used to identify the problem or problems, it is necessary to describe what the problem is in explicit terms.

3.7.6.3 Conducting the analysis

The analysis will be done in such a way as to locate a source of variability. Bhote and Bhote (2000 [111]) identify three sources of variability, positional, cyclical and temporal. These three sources of variability give rise to family to family variability, part to part variability and within part variability. To understand the sources of variability in Six Sigma performance, the analysis will be conducted on family to family, project to project and within project variability. Here, a family is taken to be a group within which projects are run such as a country, business unit or organisational function. Project to project variability is that variability that occurs within a family and within project variability would indicate a propensity for projects to encounter problems at a particular stage within a project.

In each case, the analysis will be summarised to indicate whether the result was that there was a significant difference which could indicate that there is an issue or whether there is no difference and the factor under consideration can be eliminated from the research. In addition to the summary, there will be a table of data in the appendices.

3.7.6 Family to family variability

This section is concerned with identifying whether a change in yield performance can be attributed to a particular factor or number of factors. The way in which this is tested is via a chi-square test for association Morris (1989 [222]) warns that the number of each expected value should exceed 5 before chi-squared can be used safely. In the analysis, categories in which there are insufficient samples to meet this criteria have been removed to ensure that the results are not unduly influenced by small sample sizes.

3.7.7 Within project variability

One example of a cause of within project variability for project cancellation would be a part of the project process that had a particularly high failure rate. For example, if an audit occurred at a particular part of the project that was extremely difficult to pass, then this could lead to a higher occurrence of project failure and could therefore account for a higher cancellation in certain projects.

To test for within project failure, a test will be conducted to understand whether projects get cancelled at a particular point. The data at this level of detail is extremely sparse, so it is only possible to understand how the length of time open varies with status.

3.7.8 Project to project variability

The third type of variability after family to family and within project variability is that of project to project variability. As previously stated, the way in which Six Sigma works is to eliminate potential causes until only a few potential causes remain that could be responsible for the variability.

The interview data suggested that it was the project selection and scoping process which was reported as having the biggest effect on the performance of Six Sigma.

The project data when analysed suggested that the following factors are significant: year of project start, project alignment, business unit, deployment director, country, Green Belt projects and replicated projects. It is clear that while there are differences, it is not possible to isolate one or two key factors that explain the majority of the difference in performance between good and bad projects.

Investigating the potential causes further, it can be seen that the Green Belt projects and replication projects affect only the way in which the projects are chosen as is the case with project alignment. The year of project start could also be accounted for in the fact that as time passes and more projects are completed, it is more difficult to find the so called, “low hanging fruit.” As for business unit, deployment director and country, these differences too could be accounted for by variation in the project selection and scoping process. The fact that no single factor accounts for the majority of variation means that evidence from the interview data and process data is not refuted. When considering the process itself for selecting and scoping projects, it is identified that there is not a defined process. Using the Gardner classification of process maturity, the project selection and scoping process is at level 1: unknown (Gardner, 2001). Barney and McCarty (2003 [76]) believe that project selection and scoping will be one of the key areas for future innovation indicating that this is an area in which improvement is desperately needed. From a critical realist perspective, the evidence taken together proves that the project selection and scoping process is likely to be the root cause for varying project performance within Ford Motor Company.

3.8 Review of training material

Having focused the research onto the process used within the Six Sigma approach, then it is necessary to investigate how the process is related to the training material, since this is the most detailed reference source for the DMAIC process.

Currently, there are a significant number of projects that fail to conclude satisfactorily and where this occurs, the amount of effort spent on such projects is wasted. To measure the performance of the project closure process, the metric of traditional yield has been employed. Traditional yield is "the number of units that pass a particular inspection, compared with the total number of units that pass through that point in the process" described by Harry and Schroeder (2000 [81]). The disadvantage with traditional yield is that it fails to recognise steps within the process that have been repeated, known as rework or the hidden factory (Breyfogle, 1999 [43]; Harry and Schroeder, 2000 [81]). Juran (1964 [40]) recognised that breakthrough change programmes are difficult and suggests that a success rate of seventy five percent would be "very good indeed". The name of the programme suggests that the final goal should leave only 3.4 projects out of a million that do not conclude successfully. For these reasons, the initial improvement step focuses on improving the traditional yield for successful project closure.

The analysis of the training material will comprise a review of the available training material within Ford Motor Company and within the literature. The purpose of this review is to understand where there are contradictions or gaps in the training.

3.8.1 Review of the training material

In this section the training material was review to understand how the material related to sections that had been identified as critical. The purpose of this section is to provide information to confirm or refute conclusions from the other pieces of the research through comparing what has been said with what exists within the training literature.

In this section, the Ford Motor Company was supplemented with other available literature to provide the best possible information with which to work.

3.9 Conclusions

3.9.1 Connection between design in use and paradigm

Here the research philosophy is that of a critical realist and therefore, it is believed that there is a truth that can approximately be identified through the use of multiple methods of research. Here, the use of interviews to understand the perspective of the different stakeholder groups will give some insight into the factors that affect Six Sigma performance. When triangulated with the use of secondary data in the form of survey data and project performance information, this ensures that the approximate truths discovered can be compared to check for internal validity.

3.9.2 How does the research deal with changes to the research process?

As stated in chapter 1, the original focus was on the attitudes surrounding the political and cultural aspects of change, starting with the poor performance of Six Sigma within Ford Motor Company. The end point of the research tackles the same original issue: the level of performance of Six Sigma within Ford Motor Company, but the research design, tools and data used have developed throughout the research. Denzin and Lincoln (2000 [369]) write that the research design can vary. Here as a critical realist, the research was carried out in such a way as to use the best tool for the issue in question, which did change as a result of the change in focus of the research.

Having determined the problem with the implementation of the Six Sigma change programme, it will be possible to propose a range of tools and uses that will correct flaws within Six Sigma at Ford Motor Company. Unfortunately, due to the constraints of time and resource, it will not be possible to develop, institutionalise and measure the benefits of these changes and therefore, it will not be possible to validate the improvements.

After the changes to the scope of the project, it became necessary to reduce the scope of the project to that of identifying the need for a tool or process change and then developing such a tool or application.

3.9.3 Focus of the research

The focus of the research was always the performance of Six Sigma within Ford Motor Company. Initially, the research focused on attitudes concerning Six Sigma and specifically those attitudes concerning the political and cultural aspects of Six Sigma. As the research progressed and preconceptions were challenged and dispelled, the focus of the research moved to allow the research to identify the source of the issue and then propose a solution. The final research used interviews to gather the data from the different stakeholders as well as a technical analysis of the processes involved within Six Sigma to understand the link between the reported issues and those that were uncovered through analysis. The impact of this changed the methods of inquiry.

3.9.4 Methods of Inquiry

The plan was always to use Ford Motor Company as a single case study. As a post-positivist, the researcher collected data from different sources to allow the technique of triangulation to be used and so discovered a truth that is as close to the real truth as is possible. To ensure that there was sufficient data available to support the triangulation, the data was collected using a number of different methods.

3.9.5 Research methods used to gather and analyse data

The interview data was analysed in two ways. The first way was the conventional means of coding according to nodes as per Strauss and Corbin (1998 [56]) which gave rise to an expanded set of nodes based on the EFQM model described in section 2.8.1. This analysis provided little help with identifying the root cause and so the data was re-coded according to the process steps for operating Six Sigma. This provided a set of further questions that could then be tested on existing project data from Ford Motor Company.

4. Review of Secondary Data

4.1 *Introduction*

This chapter is concerned with the review of the secondary data analysis that was undertaken with a view to gaining information regarding the possible causes of variation in performance. Each of these data sources would provide information on different aspects of the Six Sigma performance and was analysed in line with the procedure described in chapter 3. As discussed in chapter 2, the EFQM categories have been used to structure the subjects researched throughout this chapter. The categories defined within the EFQM are policy and strategy, process, leadership and people.

4.2. Policy and strategy

This section is concerned with the way in which the organisation implements its mission and vision via a clear stakeholder focused strategy, supported by relevant policies, plans, objectives, targets and processes (EFQM, 2003).

4.2.1 Strategy

This part of the project deals with the effectiveness of the strategy in place for implementing Six Sigma.

4.2.1.1 Is there a clear strategy for implementing Six Sigma?

To date, the only questions regarding strategy involve the strategy for using Green Belts who represent the majority of the organisation. Understanding how the perception of the strategy regarding Green Belts is important, because at the beginning of 2002, the decision was taken to train 70,000 Green Belts across Ford Motor Company by the end of 2004. Prior to starting a training exercise of this size, it is important to have a clear idea of how these people would be used within the Six Sigma deployment and how the training will support the strategy.

Question 6776 – My CBG/GEC has a clear strategy for utilizing Green Belts to significantly improve customer satisfaction

Table 16. Responses to question linking GB strategy to customer satisfaction

Question 6776	2001	2002	P-value
Ford Global	25	39	0.000
Ford of Europe	19	27	0.002
P-value	0.002	0.000	

In 2001, the comparison of Ford Global (25%) and Ford of Europe (19%) provides a p-value of 0.002 which, being less than 0.1 would indicate that there is a significant difference. Similarly, in 2002, the comparison of Ford Global (39%) and Ford of Europe (27%) provides a p-value of 0, which indicates a significant difference.

The table also allows comparison over time and therefore considering Ford Global in 2001 (25%) and 2002 (39%), the p-value is 0. This is lower than 0.1 and therefore indicates that there is a significant difference. If the same question is asked

concerning Ford of Europe, and the difference between 2001 (19%) and 2002 (27%), then the p-value is 0.002, which again would indicate a significant difference.

Question 6782 – My CBG/GEC has a clear strategy for utilizing Green Belts to significantly improve quality

Table 17. Response to question linking GB strategy to quality

Question 6782	2001	2002	P-value
Ford Global	26	41	0.000
Ford of Europe	18	33	0.000
P-value	0.000	0.000	

The percentage of respondents that agree with the statements is low over both years and across Ford Motor Company. It is possible then that the results point to a situation where the Black Belts and Master Black Belts are not aware of the strategy for using Green Belts. As stated above, in 2002, Ford Motor Company started to train 70,000 Green Belts and therefore having a low result here indicates that something is potentially missing, whether it is the strategy, the communication of the strategy or the understanding of how the strategy will affect the Black Belts. If the strategy is such that the Green Belts will assist the Black Belts, then it is important that the Black Belts are made aware of how they should use the Green Belts. It is interesting that there is a difference between Ford Global and Ford of Europe and would suggest that the strategy regarding Green Belts is not covered at a corporate level, but instead is tackled at a local level. The results also show that the situation is improving in both Europe and Ford worldwide and that Europe is below the level of Ford worldwide.

The Green Belt training material describes the strategy regarding the Six Sigma rollout strategy in the following statement (Green Belt facilitator guide, V3.0 – Business [Ford Context, p. 13] Feb. 2001) as shown in Appendix II, "Rollout Strategy: The strategy for rolling out Consumer Driven 6-Sigma is straightforward: Train Green Belts and Black Belts in application of 6-Sigma tools and have them apply those skills to issues impacting customer satisfaction." The role that Green Belts are to play within the Six Sigma strategy is then described as being as per Appendix III:

"Role of Green Belts: Participate in larger Black Belt DMAIC or DFSS projects; Lead Green Belt level 6-Sigma Projects; Apply 6-sigma problem-solving tools and principles to daily work; Specific details regarding the deployment and role of Green Belts are determined by each organization."

(Green Belt facilitator guide, V3.0 – Business [Ford Context, p. 29] Feb. 2001)

One possible reason why the percentages of positive responses are low is that the Green Belts are not at a level of sufficient understanding to comprehend how the Green Belt role fits within the context of Six Sigma, while the Master Black Belts and Deployment Directors who are responsible for writing the material see the role of Green Belts as obvious and therefore requiring no further explanation than is given in the material. It is also noteworthy that the Green Belts are not trained in how to select projects and this could reduce the effectiveness of the Green Belts in fulfilling the intended strategy.

4.2.1.2 Is Six Sigma aligned with the objectives of the organisation?

At the highest level, Six Sigma aims to improve customer satisfaction and reduce cost, which will assist Ford Motor Company in its corporate objectives. When cascaded to a working level, this question manifests itself as the following:

Question 8498 – Six Sigma is integrated into my department's business objectives

Table 18. Responses to question regarding integration of Six Sigma to business objectives

Question 8498	2002
Ford Global	65
Ford of Europe	52
P-value	0.759

Question 8499 – Six Sigma projects in my organisation are properly aligned to key business issues (i.e. Top 25, Balanced Scorecard, etc.)

Table 19. Responses to question regarding alignment of Six Sigma to business issues

Question 8499	2002
Ford Global	66
Ford of Europe	48
P-value	0.409

Both questions relate to the alignment of Six Sigma with business objectives. The data suggests that Ford Global Six Sigma is more closely aligned to objectives than Ford of Europe is. The results are low and one possible explanation could be that there is conflict between Six Sigma objectives and business objectives. This in turn could impact project performance and resource allocation, and so this would be an interesting area to explore further. It is noteworthy that the European alignment score is lower than that of Ford Motor Company global, which is consistent with the responses concerning the strategy for using Green Belts which identified that where developed locally, European strategies were not as well received as those developed by Ford Motor Company global.

4.2.1.3 How effectively has the organisation implemented their strategy?

There is one question that asks about the extent to which Six Sigma has impacted quality.

Question 6785 – To what extent has Six Sigma fulfilled its potential to positively impact quality?

Table 20. Responses to question regarding impact of Six Sigma versus potential

Question 6785	2001	2002	P-value
Ford Global	66	70	0.086
Ford of Europe	63	73	0.000
P-value	0.177	0.104	

This shows that people believe Six Sigma has fulfilled its potential to improve quality and that the extent to which Six Sigma is fulfilling its potential to impact quality has improved significantly. This would indicate that the deployment of Six Sigma is successful with regard to quality. It is of interest that the perception concerning the extent to which Six Sigma has impacted quality is not significantly different between Ford Motor Company global and Ford Motor Company in Europe. What is clear is that the perception of Six Sigma has improved across the organisation. It may be then that the strategies are being developed and that this may be driving the improvement in this response. It is interesting that the responses are the same between Ford of Europe and Ford Global and that the rate of improvement is the same. One possibility is that, this is because the question is asked in relative terms against the respondent's perception of the capability of Six Sigma to positively impact quality.

4.2.2 Performance Measurement

The literature review suggested that the metrics used to drive TQM improvements had a significant impact on performance.

4.2.2.1 How appropriate are the metrics being used?

At an organisational level, it is possible to measure Six Sigma results and compare with organisational results. Of concern is how appropriate are the metrics at a project level.

Question 8496 – My project results can be measured against my department's objectives

Table 21. Responses to question concerning measurement of Six Sigma performance against department objectives

Question 8496	2002
Ford Global	61
Ford of Europe	56
P-value	0.638

The results from this question are positive and it would appear that there is not a significant difference between Ford of Europe and Ford Global. However, 40% do not agree with this statement and this response could demonstrate that there have been issues with aligning the metrics in the Six Sigma projects to those of the department, which can either mean that the department objectives are not aligned to organisational objectives or that the metrics from Six Sigma projects are not aligned to the organisation.

4.3 Processes

This section is concerned with understanding how processes are developed and maintained.

4.3.1 To what extent are internal customers involved in determining strategy?

There are no data concerning the use of internal customers specifically in Six Sigma, and therefore Pulse survey data are used to assess how well this is done within Ford.

Question 11. My work group uses feedback from our internal customers (people inside the Company who use our work) to improve the quality of our work.

Table 22. Response to satisfaction survey regarding use of feedback from internal customers

Year	2000	2001	2002	2002 Global Ext
Sample size	(60,051)	(68,772)	(69,078)	B/mark (72,702)
% Favourable	72	73	79	56
	2000 vs. 2002	2001 vs. 2002		
P-Value	0.000	0.000		

This information shows that in the area of using feedback from internal customers, Ford is better than the industry benchmark of 56%. Between 2000 and 2001, while the difference is statistically significant, it is in fact a 1% difference, but is deemed statistically significant because of the very large sample sizes. The question here then becomes whether the difference is significant at a practical level. This difference is unlikely to represent a real change in attitudes. However, there does appear to be a real difference between 2001 and 2002.

One issue with this question is that it does rely on people within the organisation having a clear understanding of what an internal customer is. It is not possible to determine from the response whether this is known or not. Neither is it possible to glean how well this is achieved within Six Sigma, but if it is believed that people do understand the concept of the internal customer, then this is an encouraging result and could be a result of the long history Ford has had with TQM.

4.4 People

4.4.1 Managing People Resource

There are currently no data on the satisfaction of the training received for Six Sigma. These data are necessary for each of the training courses for each of the different stakeholder groups involved in Six Sigma. There are however data available for Ford in general from the Pulse survey:

Question 19. I have received the training I need to do a quality job

Table 23. Responses to satisfaction survey question regarding training for job

Year	2000	2001	2002	2002 Global ext
Sample size	(60,842)	(69,616)	(69,437)	B/mark (405,060)
% Favourable	72	72	72	64
	2000 vs. 2002	2001 vs. 2002		
P-Value	0.997	0.999		

From these data, it would appear that training is regarded highly and that training at Ford is of a consistently high standard and in fact better than the industry benchmark (64%). It would be interesting to understand how the attitudes concerning training vary between organisations and how Six Sigma training is received.

4.4.2 People's knowledge and competencies are identified, developed and sustained

The results from the type theory test are given in the form of four characters. Each character represents a particular scale defining personality type. The scales are defined as being Extrovert (E) or Introvert (I), Sensing (S) or iNtuitive (N), Thinking (T) or Feeling (F) and Perceptive (P) or Judgemental (J).

The type theory results have been analysed to understand the last two scales, the F/T scale and J/P scale. It is believed that for reasons as described by Kolb (1984), that the distribution of personality types within an engineering area will be similar. According to Kolb (1984), people with a TJ personality types will adopt a convergent learning style, which is often seen in engineering. TJ personality types tend to perform best when there is one right answer. This can however, have an impact on understanding change, since TJ personality types tend to focus on the task and therefore, it is expected that these people would not focus on the cultural and political

aspects of the organisation, instead preferring to get involved in the technical detail of a project.

60 engineers within diesel engineering were invited to take the Myers Briggs Type Indicator (MBTI) test by an external consultancy working within the diesel engineering area. The results are presented as the number of people who fall into different categories. The data was taken from an internal Ford working paper that showed the type indicators of the 60 different people.

A sample of 60 engineers within diesel engineering produced the following results:

Table 24. Results from personality type questionnaire

No. TJ	No. TP	No. FJ	No. FP
37.25	15.25	4.25	3.25

The results sum to 60, but it is noticeable that there are fractions. As previously noted in 3.2.4, this is caused by situations in which a respondent could be interpreted as being either personality types. It can be seen that TJ dominates the results by quite a margin backing up Kolb's theory; TJ types are more task focused than people focused and it could be that the lack of people focus influences the lack of focus on the "soft" aspects of TQM, which in turn could influence the performance of Six Sigma. In particular, this result could be an indication of the management style surrounding Six Sigma and it would be beneficial to understand how the management style is perceived within the Six Sigma organisation.

4.4.3 Involvement and Empowerment

These data concern the level of involvement and empowerment within Six Sigma. Where data are not available, Pulse survey information has been used.

Question 8494 – I have the authority to work full time on Six Sigma

Table 25. Responses to question regarding time spent on Six Sigma

Question 8494	2001	2002	P-value
Ford Global	75	71	0.081
Ford of Europe	65	71	0.031
P-value	0.000	1.000	

The results here show that in 2001, there was a significant difference between Ford Global and Ford of Europe. Ford of Europe has made significant improvements in this area and in 2002; there was not a significant difference between Ford Global and Ford of Europe.

From the start of Six Sigma, it has been communicated that Black Belts need to be able to work full time on Six Sigma. It is interesting that the number of Black Belts responding positively to this question is less than 100%. This could indicate a difference in understanding of what is meant by full time by different stakeholders and this is worthy of following up to gain further knowledge surrounding this issue.

Question 31. I participate in setting work-related objectives.

Table 26. Responses to satisfaction survey question regarding involvement in objective setting

Year	2000	2001	2002
Sample size	(60,512)	(69,206)	(69,385)
% Favourable	74	75	69
	2000 vs. 2002	2001 vs. 2002	
P-Value	0.000	0.000	

From 2000 to 2001, there was an increase in the number of positive responses, but in 2002, there has been a significant decrease in the percentage of favourable responses and this is concerning. Data are not available for involvement in setting Six Sigma targets, but as an organisation, Ford appears to use a participative style of management. More data are required to understand how work-related objectives are set within the Six Sigma organisation.

4.4.4 People are rewarded, recognised and cared for

This section is concerned with the HRM aspects of Six Sigma.

Question 6783 – I believe being a BB will positively enhance my career potential at Ford Motor Company

Table 27. Responses to question regarding benefits of Six Sigma for career potential

Question 6783	2001	2002	P-value
Ford Global	57	50	0.006
Ford of Europe	45	41	0.172
P-value	0.000	0.000	

This result is very low. Significantly, the result is lower in Europe than Ford Global. Perhaps more concerning is that the results are worse in 2002 than in 2001.

When analysed statistically, it is apparent that there are differences between the perception of Six Sigma on career in Ford Global and Ford of Europe. In Europe, this perception remains constant, while overall in Ford Global, this perception has deteriorated. Six Sigma at Ford started at the end of 1999 and so the end of the assignment for the first BBs would be at the end of 2001. It is possible that the deterioration in the response from 2001 to 2002 is that the BBs had high expectations of the impact of Six Sigma on their career and then when these were not realised, the BBs became more negative about their future.

To understand this question more fully, a Master Black Belt put the Question 6783 – “I believe being a BB will positively enhance my career potential at Ford Motor Company” to 231 people on 12th July 2002 who had finished their Black Belt assignment.

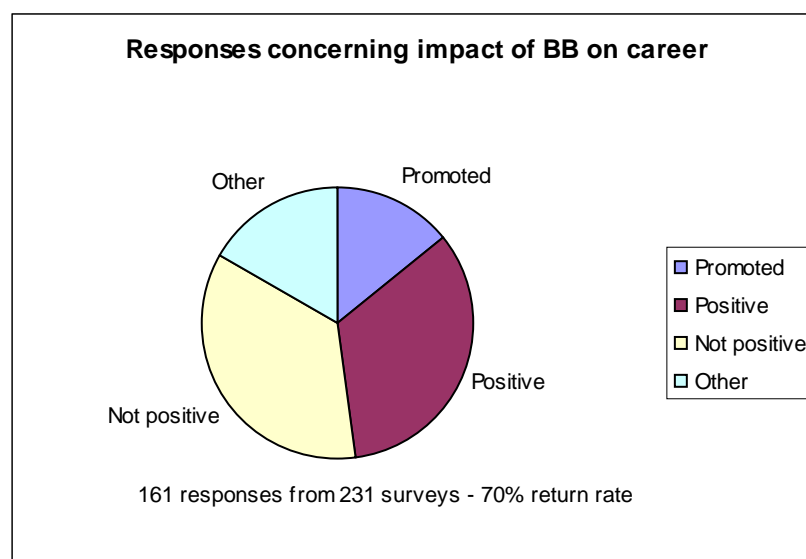


Figure 13. Responses to survey on perception of benefits of Six Sigma on career potential

The survey concerning the perceived effect of the Six Sigma assignment on their career indicates that opinions are mixed. Significantly, out of the 161 responses, only 77 were positive or had been promoted. From the responses to the survey, 23 BBs had been promoted, which is 14.3% of the respondents, which is a low percentage given that these people were recruited into Six Sigma on the basis of being high potential candidates. At that time, the automotive industry was suffering from over capacity and so, promotions did decrease. Perhaps the greatest cause is that the expectations of how the role would benefit the BBs were not met and this led to a negative view of Six Sigma. Interestingly, of the 12 people interviewed, 2 people left within a few weeks of being interviewed. This is an indication that people are dissatisfied with the treatment they receive within Six Sigma.

Two possible reasons for this are that there is a lack of involvement in the initiative or that people have not formed a definite opinion on this, and if this is to be understood, then some form of follow up will be required.

Question 6784 – I would recommend becoming a BB to my colleagues at Ford

Table 28. Responses to question regarding recommendations of BB role to colleagues

Question 6784	2001	2002	P-value
Ford Global	60	60	0.993
Ford of Europe	59	53	0.045
P-value	0.709	0.000	

The response to this question is significantly lower in Europe than Ford global and it has decreased by a significant amount in Europe. What is interesting is that the programme started at the end of 1999 and therefore, the first Black Belt waves would be finishing their assignments at the end of 2001. One possible explanation of the decrease of the perception regarding the choice of Black Belt assignment is that the re-integration of Black Belts may not have been dealt with well in Europe. The subject of how Black Belts view the role and would recommend it to colleagues is believed to be worthy of further investigation.

The Pulse Survey measures employee satisfaction. The employee satisfaction index (ESI) is calculated using 8 of the 55 questions asked in the survey. The ESI gives a single number that summarizes the Pulse scores. It is calculated from the following:

3 items from Reward and Recognition

2 items from Job & Company

1 item from Training and Development

1 item from Empowerment

1 item from Diversity

Table 29. Employee satisfaction by year

Year	2000	2001	2002
Employee Satisfaction Index/ %	64	64	61

It is noteworthy that employee satisfaction has dropped, although the fact that employee satisfaction comprises a number of different measures means that it is not possible to identify whether Six Sigma has had an influence on this. While it would be invaluable to establish a link between the introduction of Six Sigma and employee satisfaction, the best that can be achieved within this project is to understand whether the stakeholders view the assignment as a positive experience.

Question 23. In this organisation, people are rewarded according to their job performance.

Table 30. Responses to question regarding reward versus job performance

Year	2000	2001	2002	2002 Global Ext
Sample size	(60,183)	(68,911)	(69,212)	B/mark (335,664)
% Favourable	43	46	44	39
	2000 vs. 2002	2001 vs. 2002		
P-Value	0.000	0.000		

Question 37. How satisfied are you with the recognition you receive for doing a good job?

Table 31. Responses to question regarding recognition for doing a good job

Year	2000	2001	2002	2002 Global Ext
Sample size	(60,656)	(69,463)	(69,626)	B/mark (90,895)
% Favourable	51	53	51	47
	2000 vs. 2002	2001 vs. 2002		
P-Value	0.997	0.000		

It is of concern that the response concerning how people feel about being rewarded according to job performance is as low as it is and does not appear to be improving. The satisfaction regarding recognition for doing a good job is higher, but there is still room for improvement. Since these questions relate to encouraging the right behaviour within the organisation, it is necessary to determine how these questions would be answered by Six Sigma stakeholders, since people may be unwilling to volunteer for extra-curricular tasks if there is a perception that it is unlikely to be recognised.

4.5 Leadership

This section addresses issues including the development and implementation of the mission, vision and values via appropriate actions and behaviours. Additionally this section is concerned with the extent to which leaders are personally involved in ensuring that the organisation's management system is developed and implemented (EFQM, 2003)

4.5.1 Mission, Vision and Values

This section will ascertain the perception of people within the Six Sigma organisation regarding the leadership involvement in terms of setting out the mission, vision and values. The main question that needs to be answered is whether the performance of Six Sigma is suffering from a lack of mission, vision and values as set out and communicated by the leaders of the organisation. In the surveys, there are in fact four questions that relate to this subject. To ensure that a balanced analysis is conducted, all four of the responses will be presented together and the answers evaluated collectively after the tables.

Question 6781 – I am aware of my CBG/GEC leader's specific expectations regarding Six Sigma

Table 32. Responses to question regarding expectations of Six Sigma

Question 6781	2001	2002	P-value
Ford Global	63	68	0.04
Ford of Europe	57	63	0.047
P-value	0.008	0.008	

Question 8500 – I am kept well-informed about Six Sigma by internal communications (i.e., FCN, True Blue News, etc.)

Table 33. Responses to questions regarding level of internal communication

Question 8500	2002
Ford Global	73
Ford of Europe	84
P-value	0.039

Question 8501 – The role that Six Sigma plays in the company's revitalisation/transformation effort is being communicated effectively throughout the company.

Table 34. Responses to question regarding role of Six Sigma in company transformation effort

Question 8501	2002
Ford Global	56
Ford of Europe	61
P-value	0.149

Pulse Question 12. The Company's values concerning quality have been communicated clearly to me.

Table 35. Response to satisfaction survey regarding communication of values concerning quality

Year	2000	2001	2002
Sample size	(60,819)	(69,560)	(69,789)
% Favourable	84	85	86
	2000 vs. 2002	2001 vs. 2002	
P-Value	0.000	0.000	

It would appear from the data shown above, that the corporate message concerning quality is very strong, as is the corporate communication concerning Six Sigma. The data suggest that the local leadership communicate the expectations regarding Six Sigma less clearly and people are unclear as to exactly how Six Sigma fits into the revitalising the company. One aspect that requires testing is whether the understanding of how Six Sigma will transform the company is linked with the way in which the expectations of Six Sigma are communicated.

4.5.2 Leadership Commitment

The results presented below concern the levels of commitment demonstrated by leaders within the organisation.

Question 6780 –My CBG/GEC leader is a strong visible supporter of Six Sigma

Table 36. Responses to question regarding support of senior management for Six Sigma

Question 6780	2001	2002	
Ford Global	71	71	0.998
Ford of Europe	65	61	0.18
P-value	0.004	0	

It is interesting that the response to this question is high when the response to the question regarding the CBG/GEC leaders' expectations concerning Six Sigma was lower and it may seem that while the exact expectations are not known, it is clear that CBG/GEC leaders are strong visible supporters of Six Sigma. Something that can not be explained is the difference between Ford Global and Ford of Europe and therefore clarification should be sought through an interview question.

The following tables relate to support for Six Sigma within the organisation. Here, each level of the organisation is asked as a different question and therefore there are a large number of responses. Here it is useful to take the results together to get a balanced analysis and therefore, there will follow four tables and then the analysis.

Question 6787 – Overall, my direct manager/supervisor supports me in my role as BB/MBB

Table 37. Support of Six Sigma by direct supervision

Question 6787	2001	2002	P-value
Ford Global	77	76	0.651
Ford of Europe	73	73	0.982
P-value	0.051	0.086	

Question 6788 – Overall, my Project Champion supports me in my role as a BB/MBB

Table 38. Support of Six Sigma by Project Champion

Question 6788	2001	2002	P-value
Ford Global	79	75	0.06
Ford of Europe	77	74	0.245
P-value	0.313	0.576	

Question 6789 – Overall, the mid-level management (LL3 to LL5 management) supports me in my role as a BB/MBB

Table 39. Support of Six Sigma by mid-level management

Question 6789	2001	2002	P-value
Ford Global	54	58	0.118
Ford of Europe	53	59	0.047
P-value	0.68	0.624	

Question 6790 – Overall, the executives (LL2 management) support me in my role as a BB/MBB

Table 40. Support of Six Sigma by executives

Question 6790	2001	2002	P-value
Ford Global	66	62	0.101
Ford of Europe	59	53	0.045
P-value	0.002	0	

The data above portray a situation in which local management support the Six Sigma effort as do senior management, and it is the middle management who appear to be the least supportive.

When analysed for significance, it would appear that with exception of LL2 management, there has been no change in the perceived level of support for Six Sigma. As far as support from the LL2, direct manager and CBG/GEC leader is concerned; the perception within Europe concerning the level of support is lower than that observed in the rest of Ford Motor Company.

Question 84. My supervisor demonstrates that quality is a top priority.

Table 41. Responses to question about supervisors demonstrating priority of quality

Year	2000	2001	2002
Sample size	(60,226)	(69,007)	(69,373)
% Favourable	81	82	79
	2000 vs. 2002	2001 vs. 2002	
P-Value	0.000	0.000	

The data again show that local leaders are committed to quality. The other results concerning the communication of Six Sigma and its role within the transformation of the organisation may point to a situation in which the general population are unclear as to the link between quality and Six Sigma.

4.6 Conclusion

In this section the framework from the EFQM was used to separate the different categories of the deployment. The analysis was further developed by using the EFQM model framework to align the questions into the different areas that were covered

shown below in tables 42, 43, 44 and 45, which ensured that the data analysis was conducted in a consistent manner.

Table 42. Categories for analysing survey questions for Policy and Strategy

Level 1	Level 2	Level 3
Policy and Strategy	Strategy	Is there a clear strategy for implementing Six Sigma?
		Is Six Sigma aligned with the objectives of the organisation?
		How effectively has the organisation implemented their strategy?
	Performance measurement	How appropriate are the metrics being used?

Table 43. Categories for analysing survey questions for Process

Level 1	Level 2	Level 3
Processes	Processes are systematically designed and managed	
	Products and services are designed and developed based on customer needs and expectations	To what extent are internal customers involved in determining strategy?

Table 44. Categories for analysing survey questions for People

Level 1	Level 2	Level 3
People	Managing people resource	I have received the training I need to do a quality job
	People's knowledge and competencies are identified, developed and sustained	MBTI category
	Teamwork	
	Involvement and empowerment	Authority to work full time on Six Sigma
		Participation in setting work-related objectives
	People are rewarded, recognised and cared for	Do you believe that being involved in Six Sigma will have a positive impact on your career?
		Would you recommend being a Black Belt/Green Belt to a colleague?
		In this organisation, people are rewarded according to their job performance
		How satisfied are you with the recognition you receive for doing a good job

Table 45. Categories for analysing survey questions for Leadership

Level 1	Level 2	Level 3
Leadership	Mission, Vision and Values	I am aware of my CBG/GEC leader's specific expectations regarding Six Sigma
		I am kept well informed about Six Sigma by internal communications
		The role that Six Sigma plays in the company's revitalisation/transformation is being communicated effectively throughout the company
		The company's values concerning quality have been communicated clearly to me
	Commitment	My CBG/GEC leader is a strong visible supporter of Six Sigma
		Overall, my direct manager/supervisor supports me in my role as a BB/MBB
		Overall, my Project Champion supports me in my role as a BB/MBB
		Overall, the mid-level management (LL3 to LL5 management) supports me in my role as a BB/MBB
		Overall, the executives (LL2 management) supports me in my role as a BB/MBB
		My supervisor demonstrates that quality is a top priority

Having mapped the survey data questions against the EFQM headings, gaps in the information available were identified. For this reason, it was necessary to develop a set of interview questions that probed deeper to understand the reasons as to why respondents answered the survey in the way in which they did and how this related to the Six Sigma deployment process itself. What is clear is that for this type of exploratory research in which the purpose is to identify factors that are responsible for different levels of performance, this survey on its own is unable to identify issues with deployment. As a start point, it would be beneficial to use the questions in the survey as the basis for the interview questions.

One possible explanation of why this particular survey has not identified factors related to the performance of Six Sigma is that the questions may have been developed as a series of hypotheses rather than as part of a systematic approach to determining possible causes of varying performance in the Six Sigma deployment.

5. Interview Data Analysis

5.1 Introduction

This chapter presents the results using the framework derived from the EFQM model. During the research, twelve interviews were conducted, analysed and coded into nodes as detailed in chapter 3. Each node will be treated separately and discussed where appropriate to arrive at a conclusion regarding the validity of that node being linked to a potential cause. It is hoped that through elimination, it is possible to identify those potential issues that may enable the performance of Six Sigma within Ford Motor Company to be improved. To facilitate this discussion, the cause and effect diagram will be used as in previous chapters. Where gaps are identified, the diagram will be augmented to demonstrate the increase in knowledge.

Each heading will be taken in turn and discussed in line with the headings identified from the EFQM as shown below, so as to generate a conclusion.

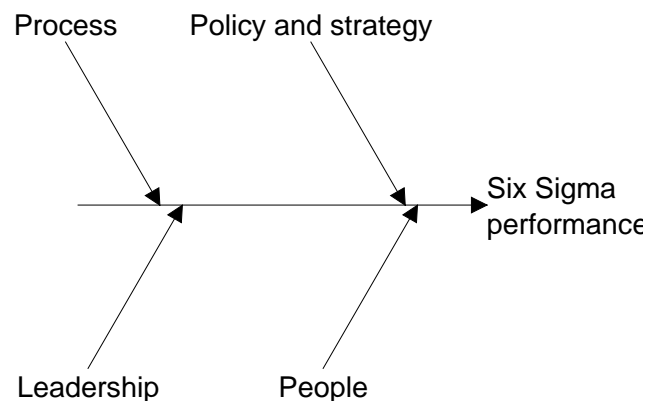


Figure 14. Cause and effect diagram showing top level nodes for interview coding

5.2 Policy and Strategy

Following the literature review and analysis of the surveys, the framework was developed prior to starting the interview analysis. This framework consists of a number of headings taken from the EFQM model (2003) that possibly impact the performance of Six Sigma. The interview data will then be used to assess whether a particular factor does have an effect. At this stage, the cause and effect diagram shows possible linkages between the factors, though does not give an indication of the direction or strength of relationship.

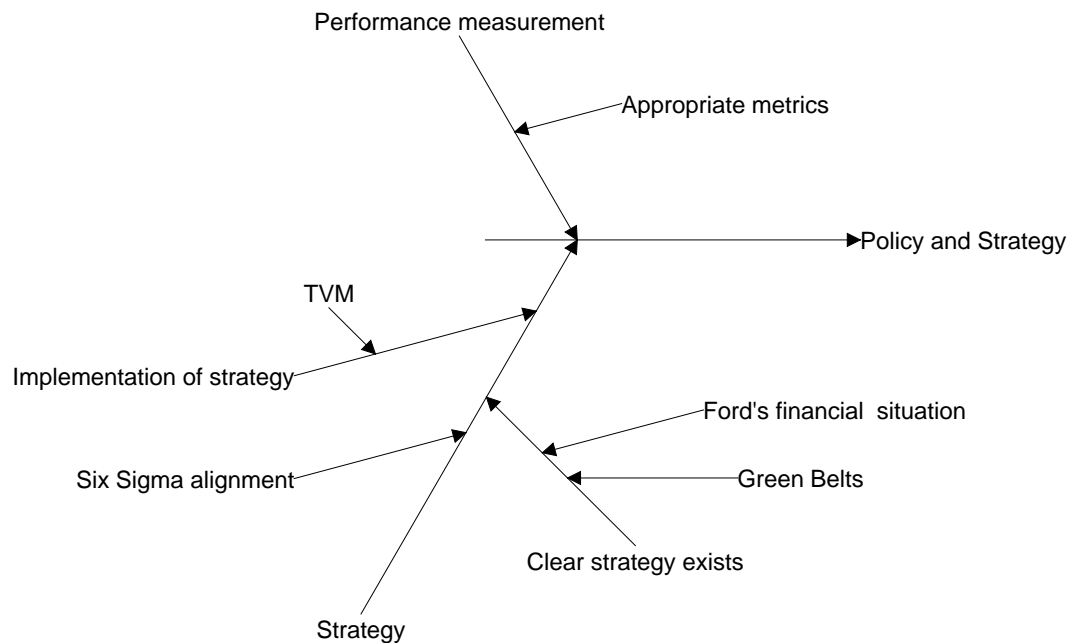


Figure 15. Coding nodes for Policy and Strategy

5.2.1 Strategy

The section on strategy includes the development of the strategy, the alignment of this strategy to the needs of the business and the implementation of this strategy.

5.2.1.1 Clear Strategy Exists

This category is concerned with the way in which the different stakeholders view the strategy of Six Sigma. When analysing the understanding of strategy, there are two aspects to consider; the existence of a strategy and the way in which that strategy is understood.

The answers from the respondents suggest that there was a coherent strategy applied to Six Sigma as indicated by the change in name from Six Sigma to Consumer-Driven Six Sigma which was intended to signal that there was a clear focus on improving customer satisfaction (Six Sigma office, <http://www.6-sigma.ford.com/corporate/overview.html>. Accessed 09/08/2006). [It should be noted that this website can only be accessed from within the Ford Intranet].

There is a strategy that is available for viewing on the Six Sigma website as shown in Appendix VI. The next part of this topic is concerned with how this strategy is implemented.

Q Are you aware of a clear strategy using Six Sigma or to use Six Sigma for customer satisfaction and quality improvements?

BB01 "No, I was, well, I thought we were working towards a clear strategy, but the recent focus on specific cost saving issues have moved that strategy away, I believe, from customer quality. Obviously, there's a focus on warranty, but in terms of say, TGW reduction, the focus is now not on TGW reduction. It's on issues that save hard cash."

This response is representative of the total sample where it appeared that the stated strategy and application differed. Capon et al. (1995) believe that a TQM programme should be the result of a benchmarking exercise investigating performance versus competitors. When the decision was made to deploy Six Sigma within Ford, there was a significant effort made to benchmark different companies; a clear decision was made regarding the strategy for Six Sigma and this was communicated actively. In spite of this, the perception is that Six Sigma is being used to reduce cost. One possible explanation of this is that the pervading culture is extremely strong and one of focusing on cost. The risk associated with not working on customer satisfaction is that Six Sigma fails to deliver the anticipated benefits. At a project level, it is possible that where projects are supported based on cultural values rather than a management strategy; the project may receive limited support and could fail as a result of conflict being introduced.

5.2.1.2 Six Sigma Alignment

This category is concerned with the extent to which Six Sigma is aligned to the organisation. It is written that to improve the chances of a programme succeeding, it is necessary to ensure that the metrics should be aligned to the strategy (McAdam and Bailie, 2002) and in turn to the needs of the organisation (Caudron, 1993) if the actions of that programme are to add value to the organisation (Ghobadian et al., 1999).

Q How much do you think it's [Six Sigma] aligned to the needs of the organisation?

XBB01 Well the current need is to save money isn't it, so I think it's very well aligned, but I think conversely, saving money is very short-termist sort of approach. It may yield this year, and you may struggle again next year, but I think long term change within the company, and the structure and how the company functions and that isn't being addressed."

The response to the alignment of Six Sigma with the needs of the organisation appears to follow closely the discussion that resulted from that surrounding strategy, where the need to improve customer satisfaction has been eclipsed by the need to save money and although the strategy has been communicated regarding alignment to customer metrics, there is conflict in the direction in which Six Sigma should focus and this would add to the risk that projects are not supported.

5.2.1.3 Implementation of Six Sigma

The success of a TQM programme is sensitive to the way in which it has been implemented (Ghobadian et al., 1999), to the point where a poor implementation, could result in the failure of a TQM programme (Gatchalian, 1997). This category aims to report the perception of the implementation of Six Sigma within Ford Motor Company. The Six Sigma office have communicated their intention for the implementation of Six Sigma, "The Consumer Driven 6-Sigma corporate vision over the next two years is "full integration," which means that more and more Green Belts will be trained, helping to ensure that Consumer Driven 6-Sigma becomes "the way we do business. By 2004, we anticipate being the benchmark of the industry." (Six Sigma office, <http://www.6-sigma.ford.com/corporate/overview.html>. Accessed

10/08/2006). [It should be noted that this website can only be accessed from within the Ford Motor Company intranet].

To understand the level of implementation, the question was asked.

Q To what extent in your opinion has Six Sigma become the way we do business?

IMBB01 I think it's becoming more the way we do business, but I still think it's isolated and I think the reason it's not the way we do business is because we go out of our way to create special positions we call BBs

As far as the integration of Six Sigma is concerned, it is still seen as a separate work activity and is something that is done by specialists within the organisation. At the most fundamental level then it would appear that the understanding of what is meant by the way we do business has not been communicated to the point where there is a shared vision, since here the Integrated Master Black Belt believes that when it is the way in which we do business, it will be done by everybody. The Six Sigma office on the other hand had stated that full integration would be achieved by 2004 leaving only two years to achieve full implementation and therefore the Six Sigma office can not have meant that everyone would be skilled in the usage of the tools. Here then it would seem that the communication of the expected progress of the implementation of Six Sigma is not universally understood and this could cause confusion.

5.2.2 Performance measurement

This section deals with the way in which the performance of the organisation is measured.

5.2.2.1 Appropriate metrics

Measuring the performance of a TQM programme is an important part of the quality initiative (Capon et al., 1995) and when done ineffectively can prevent organisations from following their strategy (McAdam and Bailie, 2002, Pyzdek, 2002 [56]). Here we consider how appropriate the different metrics are in assisting the Six Sigma initiative and driving the strategy forward. The key metrics within Ford for Six Sigma are the number of projects completed, hard savings and quality improvement as

measured by the customer quality indices including Things Gone Wrong (TGW) and Repairs per thousand (R/1000). Understanding the appropriateness of the metrics would then seem like an important question to ask.

Q What targets do your BBs have to work to?

IMMB01 Right, the targets they've got is dollars per BB per annum is cascaded down from a Europe wide figure, and they have to work to which I then track, we've got a timeline throughout the year, virtually increasing from 1st Jan to 31st December and that timeline is tracked to see if we're delivering as much as we want....There is also a target for the number of projects closed, which I'm not sure that I agree with, because I think when you look at what customers, the company benefit from, it's anything that results in selling more vehicles and making more profit, yeah, so if we can make a hard save, that's good, that makes better bottom line profitability. If we can reduce TGW {Things Gone Wrong}, then you sell more cars. That would make the company more money. If you close more projects, well, so what? They might, be the wrong sort of projects. You could close a 100 duff projects, but that might not achieve the same as closing 1 really, really good project.

It would seem that the perception is that there is a need for metrics, but often these metrics can be achieved without positively impacting the customer or organisation and as such do not constitute good metrics. The idea that it is possible to close a large number of smaller or less valuable was a recurring theme; however no one interviewed said that they had closed a large number of small projects. In such a way, the impression given was one in which the stakeholders had not internalised the metrics and it is possible that this lack of internalisation could give rise to a situation where the stakeholders felt they were working in spite of the system rather than with it.

5.3 Leadership

Within the EFQM framework identified previously in the projects, one other heading is "Leadership". Here the interview data is coded according to sub-categories that are defined below as per the cause and effect diagram. As described in section 5.2.1, these nodes have come from the questions that were asked in the Six Sigma survey and represent a set of possible causes that could be responsible for Six Sigma performance. The interview data will be analysed with a view to establishing whether in fact they are significant.

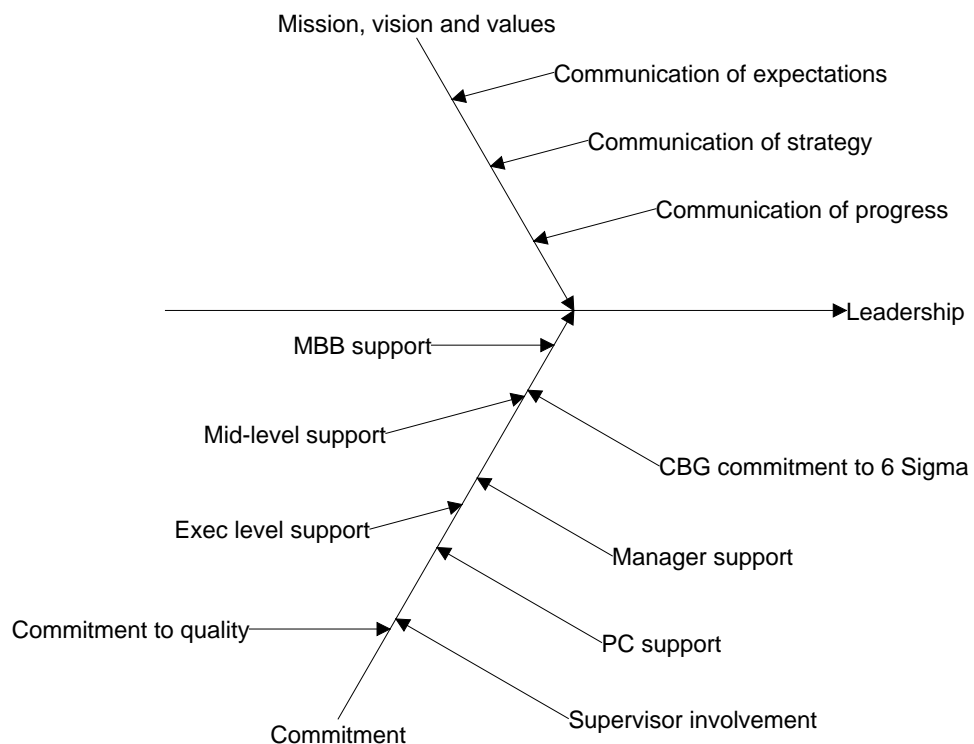


Figure 16. Coding nodes for Leadership

5.3.1 Mission, Vision and Values

Oakland writes that it is necessary for an organisation to have a mission that describes the future translating beliefs into targets and that these should be supported by a vision communicating guiding principles, values and purpose (Oakland, 2000). Mullins (1999 [129]) writes that an explicit strategy is required to foster co-operation and to cope with changing external conditions.

5.3.1.1 Communication of strategy

Without an explicit strategy, it is possible that different parts of the organisation could work at cross-purposes and therefore the successful communication of a strategy is vital (Mullins, 1999 [129]). This section aims to understand the extent to which the strategy has been communicated to members of the organisation and how well it is understood. The process of communication is expressed here as components: the information to be communicated that then forms a message, transmission of the message and receipt of the message. The first part of diagnosing whether there is an issue with communication is to determine whether there is information to be communicated.

Q Do you think there's a clear strategy for using Six Sigma to improve customer satisfaction and improve quality?

NTM01 Bit difficult for me to answer, but there must be a strategy evident, because there are people and there's training and there's a general idea and it does get mentioned in large meetings, but as for a clear definition of it from my perspective, no.

From this response, it seems that the communication of strategy for people who have not been Six Sigma trained has not been well managed, but there is sufficient confidence that if people are acting in a certain way, then there must be a plan.

Q How well do you think the corporate message regarding Six Sigma has been communicated to you?

MBB03 I think the corporate message has been communicated clearly other than the fact that you do get slightly different emphasis from different people, so on one level, I feel very clear what I've got to do with Six Sigma. On another level, I think the boundary of what is Six Sigma and starts and where it stops isn't clear.

When the question of Six Sigma strategy is asked of an MBB, it would appear that the corporate message is communicated in a better way except that the scope of Six Sigma is not well communicated.

These two responses represent the extreme points of Six Sigma involvement from the Master Black Belt whose job is to implement the strategy throughout the organisation as part of a full-time role through to a non-team member who represents the greatest part of the organisation and whose role it is to assist in the application of the tools for the purpose of achieving the strategy. These responses suggest that the cascade of Six Sigma has not yet reached all areas of the organisation. The interview data suggest that a large proportion of the organisation has received a low exposure to Six Sigma, and this could explain some of the issues with gaining the commitment of the organisation to support the initiative and this in turn could lead to conflicting demands as Mullins warns (1999 [129]).

5.3.1.2 Communication of expectations

Breyfogle (1999 [37]) believes that it is important to have goals to work to and that these should be Simple, Measurable, Agreed, Reasonable, and Time-based (SMART). The aspects that surround the appropriateness of the metrics have been covered previously and so this part of the report will address the issue of how the targets have been communicated and how they are related to driving the overall strategy. The first question relates to whether the MBB is aware of specific expectations of the senior leadership.

Q Are you aware of your CBG/GEC leader's specific expectations regarding Six Sigma?

IMMB01 Yes, because when I was when I were a business unit, so did my business unit director, so I know that they had feelings about the fact that they don't want to waste time on bureaucracy, they want to see Six Sigma deliver results.

Again, it is interesting to note that where the interviewee is highly involved in Six Sigma, the response is positive. To assess the penetration of this message throughout the organisation the same question could be asked of someone who has limited involvement in Six Sigma.

Q Have you been made aware of your management's expectations regarding Six Sigma?

GB02 Only the number of projects that we're working on and so on as I said earlier on.

Where the respondent is not involved with Six Sigma on a full-time basis, the awareness regarding the expectations is lessened. The questions asked so far have related to that of what is Six Sigma; one other dimension that is important is why Six Sigma should be used?

Q How well is the role that Six Sigma plays in the company's revitalisation plan communicated to you?

GB02 I know that they look for, actually they look for savings that will go on, [Name of manager] has BB savings, Six Sigma savings which will help the company's revitalisation.

The data suggests that there is a correlation between the level of understanding of what is expected and the level of understanding between Six Sigma and the benefit to the organisation. This lack of understanding of what Six Sigma is and how it can help, could lead to a perception where Six Sigma is seen as being additional work and again could be responsible for the lack in commitment in supporting Six Sigma projects. If this is the case, it will be difficult to institutionalise Six Sigma.

5.3.1.3 Communication of progress

In a change initiative, it is important to review the performance measures and communicate achievements regularly, and this can invigorate leadership commitment (Dale, 1999 [169]). Here, the desire is to understand the extent to which successes have been communicated.

Q How well informed were you through internal communications about Six Sigma?

XBB03 I think being a BB, you get more communication about it than other employees. Certainly, that's my recollection, as in I haven't heard so much as a darn thing about Six Sigma in the last 12-15 months apart from the odd article on FCN and if you pick up the @Ford magazine, there's something in there bi-monthly and the occasional mention by William Clay or Nick Scheele, in passing about Six Sigma, but I've not really heard, about any projects, anything really going on.

It seems then that there is a difference in the amount of information received depending on the role and the proximity to Six Sigma. One possible explanation is that during the assignment, the communication of success is done via the performance management system. Alternatively, it could be argued that the people involved in Six Sigma have already demonstrated that they are committed to the initiative and therefore need less motivation than those who appear more sceptical since they are not involved. Another viewpoint is that while involved in the programme, the need for information is less because of the management of targets. The initiative could benefit from an approach that ensures the right people get the message in the right quantities. One opportunity lies within the people who have been involved in Six Sigma but have finished their assignment, since their enthusiasm for the tools may wane if efforts are not made to maintain the engagement which is enjoyed during the full time role.

5.3.2 Commitment

It is widely accepted that TQM can only be achieved when top management are committed to it (Oakland, 2000; Clinton et al., 1994; Tan, 2002). It is also written that if top management do not learn about TQM this can cause the TQM initiative to fail (Gatchalian, 1997). Additionally, insufficient middle management support can act as a barrier to TQM implementation (Capon et al., 1995) and it is recognised that they can experience a change in both the amount and type of work they are expected to do during implementation of TQM. (Lam, 1996). As part of this project, it is important to understand how supportive management were of Six Sigma.

Q What are the biggest issues [with Six Sigma]?

XBB03 The biggest issues while I was a BB were project selection, project approval, real support from middle management and higher management, and when I say real support, I don't mean kind of offering the lip service and supposed support.

In certain cases, management support is not felt to be genuine and this could lead to further issues with the implementation of Six Sigma.

5.4 People

It is stated by Lam (1996) that quality management often fails, because of the focus on the hard aspects of TQM as opposed to the soft aspect of TQM. It is in this section that the people aspects of the Six Sigma initiative will be covered. Again, the potential causes that are being investigated are displayed on the cause and effect diagram shown below. The potential causes were derived from the literature as described in chapters 2.

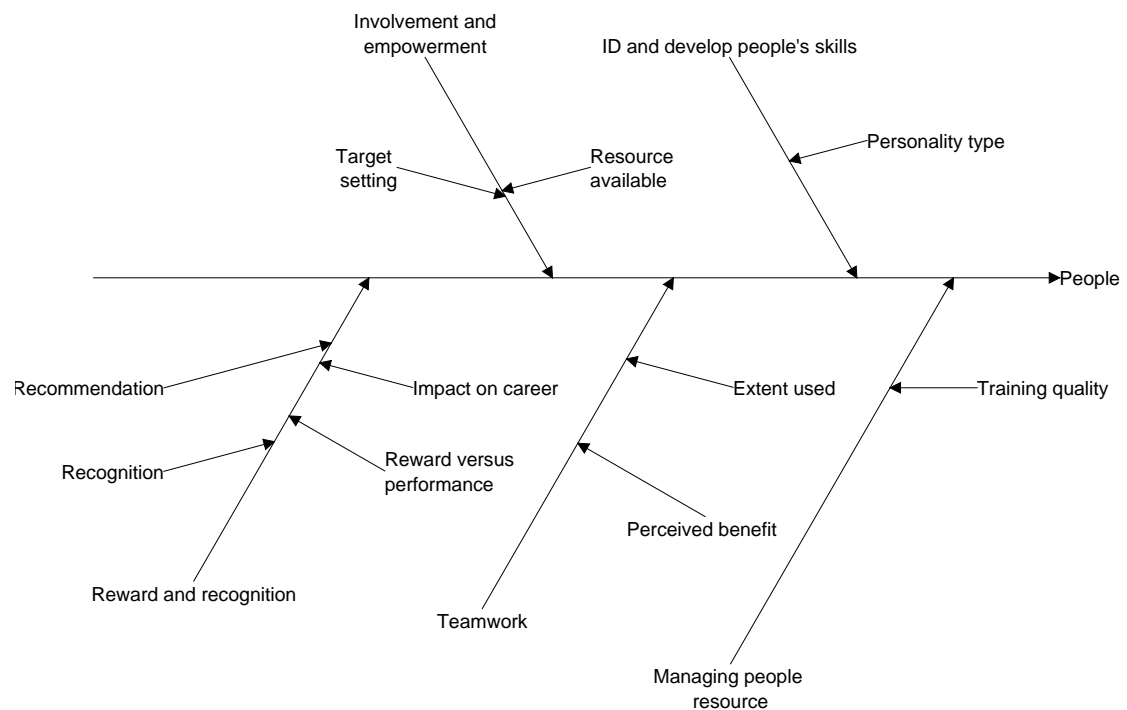


Figure 17. Coding nodes for People

5.4.1 Managing people resource

One way of improving people resource is through training and when training for TQM the focus should be to deal with issues concerning the employee's immediate job (Clinton et al., 1994). This section is concerned with the quality of the training and the applicability of the training given to the employee.

Q How would you rate the training you have received for your role in Six Sigma?

MBB03 The BB training? Initially, I thought it was good training at the time. I can look back at it and see some issues in the particular training I got, which I guess is to be expected. I think probably more could have been done and still should have been done to make sure that the training has been applied.

This suggests that the training for Black Belts is of a high standard, but as the person gains knowledge, the perception surrounding the training changes. As to the applicability of the training, Black Belts come from a variety of different areas within the company and are intended to work full-time on Six Sigma. Therefore, even where the training is not completely aligned with their specific role, it is sufficiently aligned to enable the Black Belt to carry out their intended tasks. In addition to determining the answer for the Black Belts, it is important to review this for the Green Belts.

Q Has the plan for using GBs in the future been communicated to you?

GB01 No. I had GB training two years ago, and I haven't looked at it since.

Green Belts are not involved in Six Sigma full time and therefore if the training is not directly relevant to their role, then the training will not be used as happened in the case above. There is research conducted that demonstrates the benefits of supporting the employee after training (Wally and Kowalski, 1992). It would then make sense to ensure that there is adequate support following the training.

Q And neither at the time nor now has anyone said...[what the plan would be]

GB01 No, no, I was given the impression that we would get involved in projects, we would be utilised within the department or a wider area to help resolve problems, but that hasn't happened. If that was the intention, it's fallen flat on its face.

It appears that in this case, there was no indication of how the Green Belt would get involved after the training. This could explain why Green Belts feel that the training was not useful. It seems then that there at least one case where extra effort would have enabled the employee in question to contribute to the initiative, and possibly generate the virtuous cycle that would get other Green Belts involved. It is clear that the level of commitment for the Black Belt training is significant and that on an individual case, the Green Belt training represents a lower level of investment, but it should be remembered that there are many more Green Belts who will receive this training and therefore, it is important that the Green Belts are also supported after the training course.

5.4.2 Teamwork

For an organisation to function effectively, it is necessary to overcome functional boundaries and encourage co-operation (Chen et al., 1997). The use of a cross functional team is one way of ensuring that organisational boundaries are overcome. To assess the effectiveness of how teams have been used, the responses are decomposed into two separate areas; the extent to which teams have been used and the extent to which teams have benefited the organisation. The first question regards the proportion of Black Belts that use teams in their projects.

Q	How many people [Black Belts] use teams?
MMB02	I'd say 50%.
Q	That have got a team in place?
MMB02	Yes

The results from the interviewees suggest that the use of a team is low. It is therefore important to understand the reasons behind this.

Q	How much have you used a team?
BB01	Very little.
Q	Why is that?
BB01	I suppose in my 1st project, you are asked to really come up with a project idea and then form a team before you've done any training. In my experience the people who had good teams and teams sorted on the training, were people who had basically been given a project and given a team by their champion before the training. People who weren't given a team, specifically...basically never came up with a core team.

This still means that the benefit of using a team is unknown and so the second question regards the benefit of using a team.

Q	Are they the ones who complete projects quicker?
MMB02	Yeah. Those are the projects that are being more significant projects, with better returns that are completed quicker.

Therefore, from the perspective of an MBB, it seems that there are only a few people who actually use a team, but it is obvious that there is a clear benefit to do so. Following on from this it is interesting to understand how the perception varies according to stakeholder groups.

Q	So, is it much more effective having a team?
XBB01	Yes, definitely.
Q	How do you notice? [The benefits of having a team]
XBB01	As a BB the projects you do vary considerably, and you can never be a technical specialist in any of those fields, so you need team members that do know what they're doing to progress the project. Without them, a lot of them would fail.

There appears to be little doubt then that a team would be of great benefit and moreover, when teams are not used the projects are more likely to fail, which is indicative of what is observed. It is then somewhat puzzling as to why teams are not used more often if it is well known that they actually make life easier for the Black

Belt. It would seem that one possible issue concerns the mechanism by which teams are formed.

Q	Did you find it difficult to put the team together?
BB03	No, I'm doing one right at this moment. Again, I have no problem at all.
Q	Everyone was willing?
BB03	Well, my point is this. I take the view that I'm empowered. I know what I want to do. Okay. Now, if I don't get the support, I like to know why. If an individual is key, and I need his support, I expect to get that support. There's no doubt about that.

Seemingly, where a team has been used, it has been created by the Black Belt and from the responses given; it appears that the Black Belts who have an issue with asking team members to get involved, struggle to get a team. Taking this into consideration, it could be perceived that there is an issue with the leadership capability of the Black Belts and Ehrlich (2002) believes that teams involved in Six Sigma should attend soft skills training in addition to the technical training.

Q	Has anyone tried to recruit you into a project they're working on?
GB01	No.
Q	Have you tried to sort of find out about projects and sort of push yourself in there?
GB01	No, I haven't, no, but I don't really know what projects are actually running.

The other way to view this issue is to examine the perspective of the Green Belts. From this angle, it would seem that the Green Belts do not feel able to join a team. To an observer, the situation is impossible with neither stakeholder group feeling that they can approach the other.

One question that still remains unanswered is the size of a typical team.

Q	How many people are generally involved in your projects?
BB03	Anything between 6 to 12.
Q	Okay, do you feel that having a bigger team has helped you achieve more than if you say if you had a smaller team?
BB03	I think this is a question that I often asked during my training period. What is the optimum number of people to have an effective team? And I think there is no magic number frankly that works best all the time, but I think every situation has to be taken on its merit

From the question asked to determine typical team size, what actually materialised is the notion that people would like to have a team size to aim for rather than a way of identifying the composition of a team.

With regard to the use of teams, it seems that there are a number of issues, namely that it is difficult to get a team, to identify the correct size for a team and to ensure commitment. One possible solution that is identified is the use of the project charter to ensure that there is a clear understanding of who should be involved within the team and a check to ensure that the team members are committed to the project.

5.4.3 Reward and recognition

To reduce the resistance to TQM, it is crucial that there are clear rewards for its implementation (Clinton et al., 1994). The subject of reward and recognition is complex with widely differing opinions as to whether financial rewards generate greater enthusiasm agreeing with Capon et al. (1995), or non-financial perks such as visits to view TQM implementations at other sites act as motivators as espoused by Walley and Kowalski (1992). In addition to the differing opinions on the relative merits of financial versus non-financial perks, the issue of reward and recognition is also likely to vary between the different stakeholder groups. This section is focused on understanding how the perception of reward and recognition varies between stakeholder groups.

5.4.3.1 Performance review process

There is considerable debate over the use of the annual appraisal with critics claiming that it can hinder the adoption of TQM by focusing employees' efforts on short-term objectives (Aldakhilallah & Parente, 2002). At Ford Motor Company, the annual appraisal is the tool used to ascertain the performance of an individual for the purpose of administering reward and recognition. The annual appraisal does represent the start of the reward and recognition process and it would therefore seem logical to understand how the annual performance review process is perceived.

Q	At your annual reviews have you been asked about your GB activities?
---	--

GB01	No. I haven't had an appraisal now for, I don't know four years.
------	--

The response here demonstrates that although this is clearly understood to be the way in which reward and recognition are administered, it is not always done. Where it has been done, it is important that it is done well. To this end, the question was asked.

Q	How successful do you think the performance reviews with BBs have been?
---	---

MBB03	When you say performance reviews, are you thinking ...?
-------	---

Q	The annual appraisals...
---	--------------------------

MBB03	The year end appraisals. I know of cases, where I think it's not been very successful. Even my own case, I thought it hadn't been handled very well, in that, because of organisational issues, I was, my appraisal was done at a manager level. At a supervisor level, it was done by somebody who didn't have direct involvement in my projects. The manager level wasn't even my project champion, which kind of, I didn't realise until after it was too late that it had gone to that person. They could have spoken to others, and they may have got input, but it was unlikely to be a very good appraisal of my position.
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In some cases, where the appraisal has been conducted, it is not always carried out with the right people involved. The response above demonstrates a situation in which the employee does not agree with the outcome since it is not perceived to correlate with the individual's perception of their performance. It is a shame that the MBB does

not agree with the appraisal, even after the counselling session. The most significant point is that although the annual appraisal is the foundation of the reward and recognition system, it is not taken seriously.

5.4.3.2 Reward versus performance

To reduce the resistance to TQM, it is crucial that there are clear rewards for its implementation (Clinton et al., 1994). Here the aim is to understand whether employees believe that they are being fairly rewarded for their performance in the role.

Q	Do you believe that people are rewarded here for doing a good job?
NTM02	Yes, but not everybody...sufficiently. You're only rewarded if someone's made aware of what is being done.

It is clear that not everyone feels that they are rewarded for doing a good job.

Q	In terms of the performance review process, through your time as a BB, did you think it was applicable?
XBB02	Definitely, because, it's all about measuring what you're achieving isn't it and how good a job you're doing.
Q	Were there any issues with the people who you're working for and the people who were actually conducting your performance reviews?
XBB02	No. Well, the person I sort of work for is the manager, which in our case was [Name of manager], but in actual structure, you're below a supervisor who does your pay and rations and does your review, but I had weekly meetings with my supervisor to tell him what I was doing and how I was getting on and what issues were lying about and did do some work on stuff that was in his area as well, so I had a good dialogue with him, so when it came to actually doing the review, he had a good idea of what was going on and a good idea of how to rate me and he also talked to the manager who was more direct, and he was responsible for, in terms of my actual work output, so between the two of them, there wasn't an issue.

It is apparent that where effort was made to communicate the activities that the Black Belt had been involved in throughout the year, the performance review process

worked. Reward and recognition can take many forms, but one key objective of taking part in Six Sigma is to boost one's career potential. A clear barrier to boosting career potential is failing to communicate success relative to objectives. It seems reasonable to make sure that the people responsible for providing input into the performance review are aware of key successes in order to allow them to accurately assess performance.

5.4.3.3 Impact on career

Six Sigma is believed to enhance one's career potential and therefore it is important that the extent to which this occurs is clearly understood.

Q Overall did you have a positive or negative experience of Six Sigma?

XBB03 Career wise, negative. Experience wise, positive. I'm very enthusiastic about what Six Sigma can do.

While people are positive about Six Sigma and what it is capable of achieving, it is the way in which the career progression aspect is handled that is lacking. XBB03 had actually given notice to leave the company and was working out their notice period at the time of the interview therefore the opportunity was taken to gain insight into how Six Sigma fitted into the decision.

Q Okay, one last question. You don't have to answer if you don't want to. Do you think Six Sigma has contributed to you potentially leaving Ford?

XBB03 Yeah in positive and negative ways. Yes, it's a good transferable skill, I'm not leaving because of that, but it is a, may make some people leave to do Six Sigma elsewhere. I think it, career-wise, has wasted some time for me, but I wouldn't begrudge that. I think I had a good set of experiences, which I learned from.

The combination of a highly transferable and desirable skill coupled with poor handling of the assignment could lead to a high attrition rate. Conversely, when the assignment has been well handled, it can lead to a situation where Black Belts recommend the role to others and promote the initiative. Six Sigma could then act as a retention tool rather than as a safe exit strategy.

5.4.3.4 Recommendation of assignment

This section is concerned with understanding the extent to which Black Belts would recommend the assignment to their colleagues.

Q	Would you have recommended becoming a BB to a colleague?
XBB03	Lots of people ask me this and I always gave something along the lines of, "Six Sigma, I would recommend, the challenge. There's a bit of intellectual rigour, it would be a break from whatever they were doing. How Ford was implementing it, I wasn't a fan of. Six Sigma, I was a fan of. In the end, I gave people a pretty neutral endorsement to it. If you fancy doing this, it will be frustrating, it will be, you know, extra hours, it will be bits of this and you will get no pay back and the end of it in terms of your career. It's 2 years out of your career, when you could be getting promoted."

Black Belts are hesitant in recommending the role. It would appear that the decision as to whether they would recommend the role to a colleague creates a great deal of conflict. Six Sigma is generally viewed in a positive way, but the implementation of the initiative is seen as a negative attribute.

5.4.4 Identify and develop people's skills

Ehrlich (2002) writes that when recruiting for Six Sigma, criteria should be applied as rigorously as if recruiting for the organisation itself. Once the right people are selected, it is necessary to provide them with the appropriate skills. This section is concerned with how people are selected for the roles and how the end of the assignment is managed including the integration of the Black Belt into another role.

Q In your opinion, how do you think the selection of BBs has been handled.

MMB02 The current selection process is for the area to be cut up according to the number of managers within that department and for the manager to then supply the candidate.

Q Right and how do you think the candidates are selected?

MMB02 I've absolutely no idea.

This response suggests that if there is a process for selecting potential Black Belt candidates, it is not widely understood and therefore, may lead to employees being sceptical about the way in which candidates are selected. The plan is that the role is a two year fixed term assignment to ensure that the skills are acquired and then that person is integrated within the organisation in an attempt to institutionalise the changes, which is difficult (Klefso et al. 2001).

Q How about the reintegration, how did you think that was handled?

XBB01 I think that was done quite poorly really...I come from an engineering group and I was never integrated back into it. So, that was practically non-existent. I've moved, I'm in quality now, because...BBs are part of the quality group, so really I've just stopped doing BB and taken on another part of that groups role, so in that scenario, I didn't think that was handled very effectively...That bit has probably been the worst part of it.

This respondent clearly felt aggrieved at the way in which the end of the assignment was handled and would appear that the move was a default move that did not consider the wishes of the employee. The risk of this approach to the assignment is that if people are happy in their role, they may feel that leaving the role to become a Black Belt may leave them in a position that is less desirable and could create a barrier to successfully deploying Six Sigma.

Arguably, if support for Six Sigma is to be generated, it is necessary to manage the departure from the role so that at the end of the role, the employees perceive that they are in a better job than they were prior to the assignment.

5.4.5 Involvement and empowerment

To get the most benefit from employees, it is necessary to gain commitment from employees and this requires a high-trust organisational culture (Mathews and Shepherd, 2002). The level of trust within the organisation depends on the experiences of people within the organisation. Where there are issues, this will impact the perception of the role. One aspect of role that could be responsible for affecting motivation is certification.

5.4.5.1 Certification

Certification is the process by which the organisation acknowledges that a certain standard has been achieved by the individual. At Ford Motor Company, the certification process requires that the Black Belt completes four weeks of training, two projects and then achieves a pass in a Black Belt exam. To understand whether this process can influence the perception of the role, it is necessary to gain information on two key aspects of certification: Are there people who do not achieve certification and what impact does this have on the individual? The first consideration must then be people who do not achieve certification.

Q	What percentage of BBs are not reaching certification?
MMB02	We have a target of 14 BBs for 2003. We had 18 in 2002, that would, that says generates base of around 20 and I know of 2 BBs who have gone back into the system and integrated into the system as BB candidates.
Q	So 2 out of 20
MMB02	2 out of 20

From the above response, a significant proportion of the Black Belt workforce does not achieve certification and this is likely to have a negative effect on the motivation of that section of the workforce. Having determined that there are people who fail to achieve certification, it is necessary to understand the impact that this can have on that individual.

Q I guess their perception of Six Sigma would be lower [of those people failing to achieve certification]?

MMB02 Yes, if you've spent 2 years or a year or however long, a significant piece of time within FMC as a BB and you've not achieved certification, then that's going to be not good for your career prospects, because that individual is always going to have to be explaining why they didn't get certification.

It seems then that when Black Belts do not achieve certification this will create a negative perception of the Black Belt experience because of the importance that is placed on certification within the 2 year time span. There are a large number of potential causes that could affect a Black Belt's ability to achieve certification including the opportunity to work on projects.

5.4.5.2 Opportunity to work on assignment

The principle of a Black Belt is that the employee is taken out of the organisation for two years to work full-time on Six Sigma projects (Harry and Schroeder, 2000 [174]). It seems that the link between Black Belt effectiveness and the opportunity to work on projects is well known. What is unclear is the extent to which this is followed. The following quote demonstrates that in this particular case, the Black Belt is fully dedicated to Six Sigma and working on his projects, in fact the Black Belt is able to sum up the entire subject of working on projects in just one word.

Q Have you been able to work 100% on your projects?

BB03 Yeah

Indeed, it seems reasonable that more time spent on projects will result in more projects being completed, but it would be useful to ensure that this feeling is consistent with that of the stakeholders. The following quote is from an MBB who does not share the view that in every case the Black Belt should be able to work 100% on their projects.

Q	How could the speed of Six Sigma projects be improved?
MBB03	Making sure that BBs are dedicated to the projects, whether that's, ...I don't think that needs always to be 100%, but it needs to clearly be their main objective or at least, if it's, if they have other big objectives, that needs to be very clear to everyone, making sure that the projects are being championed by somebody who really wants that issue fixed and better clarity on the teams involved, so, if it really needs to be a team effort, with multiple people working on it, then those people all need to have that clarified in their objectives with their management etc.

In general, the Black Belts are able to work sufficiently on their projects, however this was not always the case and it is argued that this is one area that could have an impact on Six Sigma performance. One other aspect of the assignment that may affect a Black Belt's ability to complete the task is the extent to which the Black Belt is involved in the target setting process.

5.4.5.3 Target setting

In the early 1980s Donald Peterson, then CEO of Ford Motor Company "launched programs in Employee Involvement (EI), participative management training for supervisors, employee involvement teams and total quality management" (French and Bell, 1999). It is reported that these programmes were successful in changing the culture from being autocratic and functionally oriented to a culture with empowered employees (French and Bell, 1999). One indication of the level of empowerment experienced by the employees will be the extent to which they are able to set their own objectives.

Q	Do BBs get involved in setting their project targets in your group?
IMMB01	No, it's cascaded to them. They're told what their task is, what they're meant to do for it.

Targets are cascaded in a prescriptive way and it would appear that the Black Belts are not involved in this process, though it would be useful to understand this in greater detail.

Q How do they set the target? Is that something you're involved with?

XBB01 No, not at all. I think the financial target comes specifically from the sort of core Six Sigma team either in the States or in Germany, so, I think each business group has got its own, own savings target based purely on how many active BBs they've got. So, like myself, although I'm not classed as an active BB, I do contribute to it, so, they can get savings for a lot more than actually they've got working...they've actually got assigned as active. It's a bit of a con.

In consequence, the Black Belt is not empowered in determining a reasonable target that is achievable. The target really is cascaded based on a mechanical process. What is of more concern is that the target is based on the number of Black Belts, and there is at least one Black Belt who is not declared to improve the chance of meeting the target. This is potentially a symptom of a situation in which there is disengagement with the principle of the target, albeit with a strong desire to appear to be performing well against that target. To fully understand the source of this resistance, it is necessary to understand the processes behind Six Sigma and how they are managed.

5.5 Processes

This section is taken from the EFQM framework (2003) and attempts to describe, "How the organisation designs, manages and improves its processes in order to support its policy and strategy and fully satisfy, and generate increasing value for its customers and other stakeholders." It is decomposed into two main categories, process design and management and how products and services are developed as shown below in the cause and effect diagram.

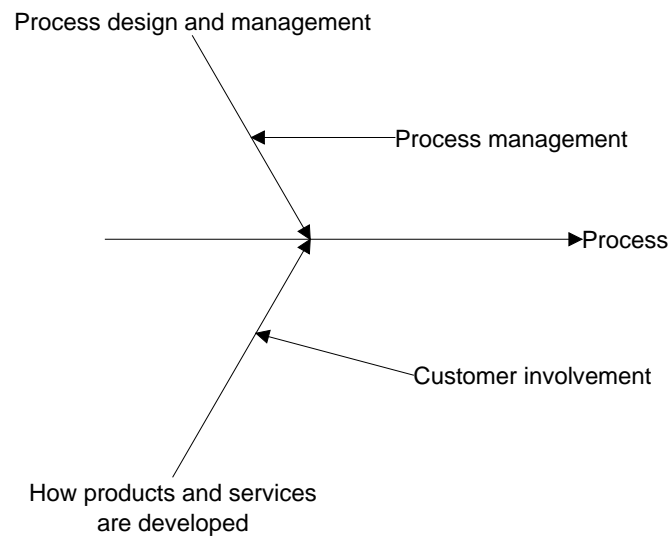


Figure 18. Coding nodes for Process

5.5.1 Process design and management

During this interview, it was necessary to identify the means by which the processes are managed. It would seem reasonable then to observe a process in which data is fed back from to ensure that lessons can be learned and that the process continues to improve.

Q	What's the plan for continuing to deploy Six Sigma in the future?
MBB03	Well, I think mostly, it's more of the same. The numbers of BBs for 2004 is coming down, but somewhat in the line of the organisational reduction. So, percentage wise, it's perhaps the same. We're, for PD, we're now trying to get clarification on what work we're going to do. So, each area has been asked to pull together a list of their expected projects or mega project focus areas and the opportunities and time lines etc. to show how we can meet the targets, so, there's a little bit more communication. Previously, we....the previous year, we had some top down targets in terms of BBs and dollar saves, a bottom up approach, which came up with another set of figures, BBs and dollars and then as numbers were adopted without a clear plan to deliver, and as it happens, we haven't delivered with some other factors thrown in as well. So, this year, there's much more of a drive to come up with a plan that is considered realistic, maybe with some stretch in it. So that's an improvement in the deployment.

This response highlights a situation in which changes are made to the deployment of Six Sigma though there is no indication of how these changes are being made or who is responsible for making the changes or any mechanism for assessing the response to them. The next question is concerned with how changes are made.

Q What is a performance cell?

MMB02 A performance cell is a grouping of bbs who work within an organisation under effectively an [senior level manager] head. They're fronted by a deployment champion or director and controlled by an Mbb. So the mbb is there to project manage the bbs to help them deliver on their projects and to help that grouping of projects succeed against their kind of scorecard in terms of what they've got to do that year. So that enables the system to become more controllable and understandable in terms of what is and what is not working. The key benefit of that was mentioned by [Senior Six Sigma Manager] during recent training suggesting that a performance cell can achieve almost a factor of 10 improvement in terms of throughput of projects or money saved by making the grouping as a whole accountable for what it does and then starting to manage that grouping in a good way. The example in terms of the factor 10 increase was in [Chief Engineer's] organisation. Effectively they prototyped the performance cell concept.

Thus there is a degree of rigour used in determining the changes that are required to the deployment of Six Sigma though the way in which the change is managed appears to reveal inconsistencies in the level of participation. Ehrlich (2002) writes that some organisations conduct a "post-mortem" at the end of a project enabling lessons-learned to be communicated to stakeholders. What is not known is the extent to which this is done at Ford Motor Company.

Q	Do people learn what went wrong with different projects?
XBB03	No. I'd say not. There's no forum for it really as far as I understand it. I think, giving a small anecdote, or cutting a long anecdote short, I, when I started training, we had basically a whole load of trainers from GE who were training all the BBs, and I suggested to my MBB trainer that it would be good that Ford didn't in its initial, say 2 year ramp up and learning curve, didn't really make the same mistakes that GE had made through their formative years, and if you could short circuit that and skip that, that would be great, because it would save us making all the same mistakes and lead to a better process, more robust process. He was very supportive and said, "yeah, that's a great idea. Blah, blah, blah", and he got his other BB trainers enthused about doing it. They had asked that they be paid for their time, which wasn't unreasonable. My manager thought it was a good idea, but when it went to the central Six Sigma deployment [Director] they shut the idea down, said it wasn't necessary, they knew all they needed to know about Six Sigma and sure as eggs are eggs, come the end of our projects, all I could hear our, the number of times, I heard our MBB say, "we made the same mistakes at GM."

The secondary data revealed that there had been extensive benchmarking done prior to the deployment and yet it appears that opportunities to accelerate the Six Sigma process have been missed. Two aspects in particular include a review of previous deployments and formal reviews of Six Sigma projects. This has been a source of frustration for some of the stakeholders and while it could be argued that learning from mistakes alone will not generate excellence, learning from previous mistakes could improve the performance of the initiative. Without the use of stakeholder feedback, it is necessary to consider the extent to which the stakeholders are involved in managing the processes.

5.5.2 Customer involvement

Here, the concern is the extent to which the customers are designed into the organisation. Ehrlich (2002) writes that the "voice of the customer" is one of the most critical components of Six Sigma and consequently, data needs to be gathered, analysed and integrated to current processes. The spirit of the Six Sigma initiative

within Ford focused on the customer and this was signalled by the name, "Consumer-Driven Six Sigma." Here, the goal is to get detailed information on the extent to which the customer has been incorporated into the deployment. The primary reason for carrying out Six Sigma is to improve quality and reduce cost, and it would be of value to understand exactly how this has been implemented.

Q Is there a clear strategy to use 6-sigma for customer satisfaction and quality improvement?

XBB01 No.

Q You don't think there is?

XBB01 I don't think there is. I think customer satisfaction and quality improvement don't necessarily equal financial gains and the target now is purely financial.

It would seem that the desire to focus on the customer and the reality of the situation are at odds with one another. If there is confusion surrounding the strategy, one would imagine that projects are allocated on an ad hoc basis and that adherence to the strategy will depend on the views of the individual managers. One useful means of assessing the adherence to strategy is to determine the extent to which projects adhere to the strategy and therefore satisfy the customer.

Q Are you aware of the metrics that are used throughout the company to measure the Six Sigma process?

GB01 No, I'm not aware of them. I'm only aware of initially, when Six Sigma started, that there seemed to be a lot of guys who were BB trained who were sort of rushing round and asking people if we had any problems that they could resolve. Whether there was a cost benefit in the resolution or not didn't seem to sort of enter into it. There should be some way of evaluating projects and prioritising them, be it in order either to do the best engineering or, you know, for the least cost, and, I think initially, when Six Sigma started, that it didn't have that, that the process just seemed to be a bit haphazard, where guys were sort of finding their own projects, and, trying to get them championed, and I think Six Sigma got a bit of a bad name initially.

Q What, because of the lack of focus on projects?

GB01 Yeah, there was a lack of focus, whether the projects were the correct ones, what the potential benefit was at the end of it.

It seems then that Six Sigma has got a bad name due to the issues with Black Belts securing projects that make a big difference. One aspect that must be considered is the way in which the organisation seeks to learn from people's experience.

Q Is the organisation attempting to find out your feelings on being a BB?

BB01 Not very well. I think, there's been nothing. Well, I think there was a survey shortly before I became a BB, but further than that I'm not aware of anything that I've been asked.

It would therefore appear that Black Belts are questioned through the survey, as analysed previously as part of the secondary data (chapter 3). Although there are no debriefing interviews for BBs or attempts at understanding the sentiments of GBs, it does appear that the organisation attempts to understand how the stakeholder groups feel. What is surprising is that the annual survey was not perceived as such a mechanism.

Q Has the organisation attempted to get your ideas concerning your feelings being a GB?

GB01 No. No. I've had no approaches at all since I've done the training.

When considering the needs of the customer, it is imperative that the internal customers are considered and here, it is suggested that if one takes the approach that the Six Sigma personnel are customers of the initiative, then there is the capacity to improve the situation. One other possibility is that a greater deal can be achieved if one analyses the performance of the deployment by the individual process steps.

5.6 *Review of interview information by process step*

It seems from the review of the interview data by node, that there are a large number of factors that should be improved and would improve the performance of Six Sigma. What is also clear is that there is a great deal of apathy around the responses and this could indicate that the issues highlighted by the interview questions do not cause problems of the magnitude that are expected as a result of the benchmarking. In this way, a new way of looking at the problem is required: a process approach. The questions were developed from the material discovered during the literature search and therefore, detailed questions have not been asked concerning this process approach. The responses here are instead derived from coding other responses that relate to the different steps taken during the process. The process considered here is the project process since the aspects associated with deployment have been covered elsewhere in this report. The project process is defined as being:

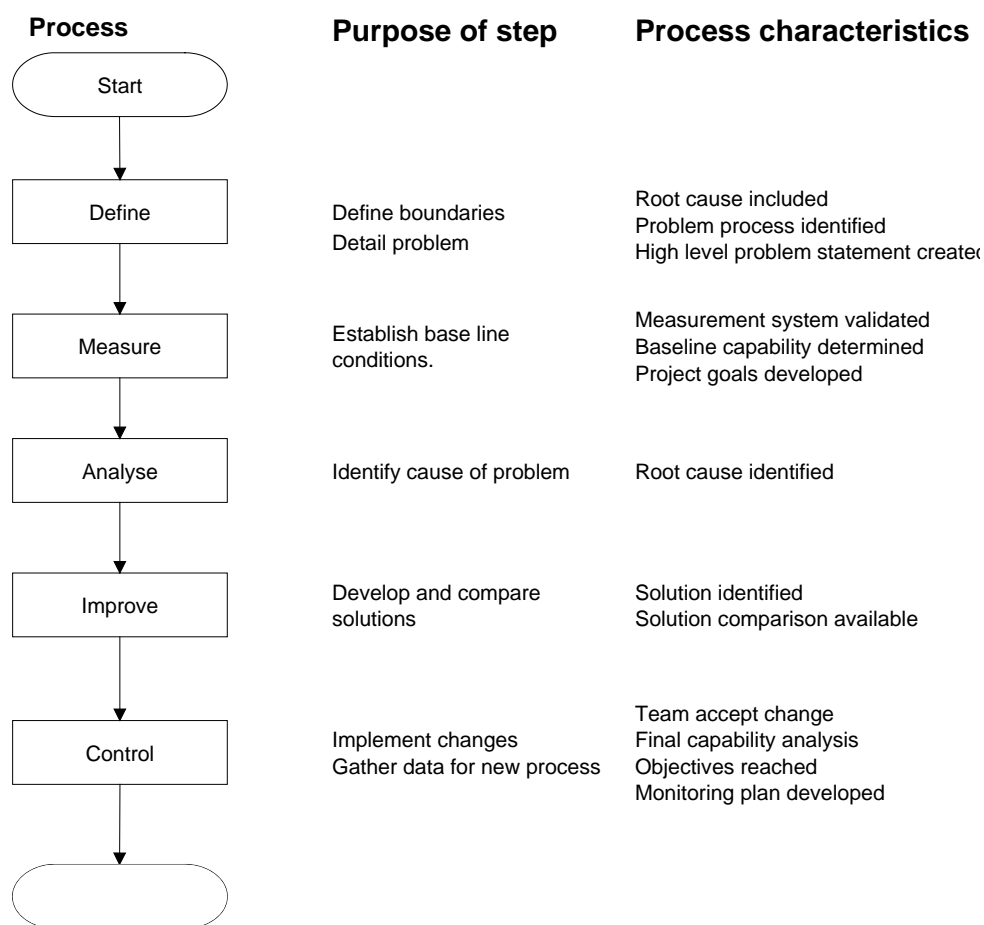


Figure 19. Low resolution process map of Six Sigma process

This section will focus on the different process steps to identify whether there are comments that relate to any particular aspect as being central to that of Six Sigma project performance.

5.6.1 DMAIC steps

Here the individual steps are taken in turn and the responses coded to ascertain whether it is these steps that may have an impact on project performance.

5.6.1.1 Define

Harry and Schroeder (2000 [130]) write that the Define phase is, "Define the processes that contribute to the functional problems." The main output of the define phase is the project charter. The project charter explicitly states exactly what the problem is, what the project will deliver and what is required to do that. To gain an insight into the

performance of the define phase, it is necessary to understand the opinions surrounding the charter.

Q Do you see a difference then, when you see a project with a team and a project without a team, is it noticeable, which one's which?

MBB03 [...] I think the thing that hasn't happened well in the past that has been made more formal in the system is the idea of the project charter. The project charter or document that pertains to be the project charter has to be entered in the system for the project to get the okay to start approval. What we really should be pushing on there is that before we say we are formally going ahead with any project. If it's in the new phase, and not yet ok to start, there's a bit of scoping, data collection, etc., just to define what the issue is and be sure. In order to go through that approved phase, we'd need a project charter.

From the response, it would appear that there is broad agreement that the project charter is the right thing to do, but that currently, the charters are not used correctly.

5.6.1.2 Measure

Harry (1998) writes that the Measure phase is the part of the project in which a Critical to Quality (CTQ) characteristic is chosen, the measurement system validated and then the process is mapped and measured to provide the baseline capability data. Collecting data is resource intensive and here it would be useful to use the team previously formed to collect data. When questioned about the team, the response alluded to the data collection part of the project.

Q To what extent do you think the BBs are working with teams?

MBB03 ...Another area I think that we have suffered from is the data collection, obtaining the data and the methodology and recognising that part of the Six Sigma project is the understanding of data collection, integrity and measurement system analysis. You wouldn't expect that to all come on a plate as it were from someone else. You'd expect the BB to have some involvement in that, but probably, we would make better progress in projects, faster throughput etc., if we had a slightly more organised way of doing that or maybe, if we don't have a dedicated resource doing measurements for Six Sigma projects which may not be realistic at least, have a clear understanding of who we can go to and who can provide expertise on that measurement. So, that's something that I've thought of as a good idea, but not really known, personally how to progress.

Here, then it is interesting to note that the MBB is trying to think how to get better data and even alludes to using dedicated data gathering people. Part of the benefit of Six Sigma is that it works by using a participative management style and aims to increase the knowledge of the teams to a level where the data can be understood to drive changes within the project team as described in chapter 2. Reluctance in asking the team to get involved in gathering data could reveal a fundamental flaw in the project and may suggest that the projects are not deemed necessary by the project team.

Q To what extent do you think the BBs are working with teams?

MBB03 I'm not sure that it's not a reasonable position to be in when you've got limited resources, it might be better to only call people in when you need them for the expertise for their particular topics and then just extract that information and not expect them to be doing other general project tasks. You might get more good will out of them that way than trying to force them to team situation without giving them any, reduction in other workload which might make them antagonistic to Six Sigma.

This response expands on the issues with asking people to get involved with a project. Interestingly there is a feeling that good will is required to get people involved with a project. In fact, the desired situation is one in which project teams want to help a Six Sigma team to assist them in fixing their problem.

What is interesting is that while it is seen as beneficial to have a team, it is not viewed as a problem that teams are not willing to get involved and so there is no attempt to find a remedy.

5.6.1.3 Analyse

The Analyse phase is defined as being the phase in which the performance data is assessed to identify which factors are responsible for the different levels of performance (Harry, 1998). None of the comments received related to determining the root cause of the issue.

5.6.1.4 Improve

The Improve phase of the project is the time during which the product and/or process improvement plan is implemented (Harry, 1998). None of the comments received related to determining the fixing the issue.

5.6.1.5 Control

During the Control phase, the objective is to ensure that the improved performance level will be maintained through documentation and monitoring plans (Harry, 1998).

Q	So, the MBB was responsible for all the project management?
MBB02	The MBB is responsible for ensuring that that cell delivers against its commitment. It's the BB's job to work on the projects and to deliver the projects, sorry to execute the projects. The project is reviewed with the MBB and it's down to the MBB to manage and work with the BB to achieve the closure and successful completion or not of that particular project.

Seemingly, comments relating to the DMAIC process are few and far between. It was however observed that a number of the respondents had spoken of the way in which projects were found. Therefore, the end of the project and the implementation of the

fix is the only section about which there are comments and these only relate to the role of the BB and MBB in relation to closing the project.

5.6.2 Project selection and scoping

The purpose of this section is to study the projects according to the process. Before this can be completed, it is necessary to document the process as below in figure 21.

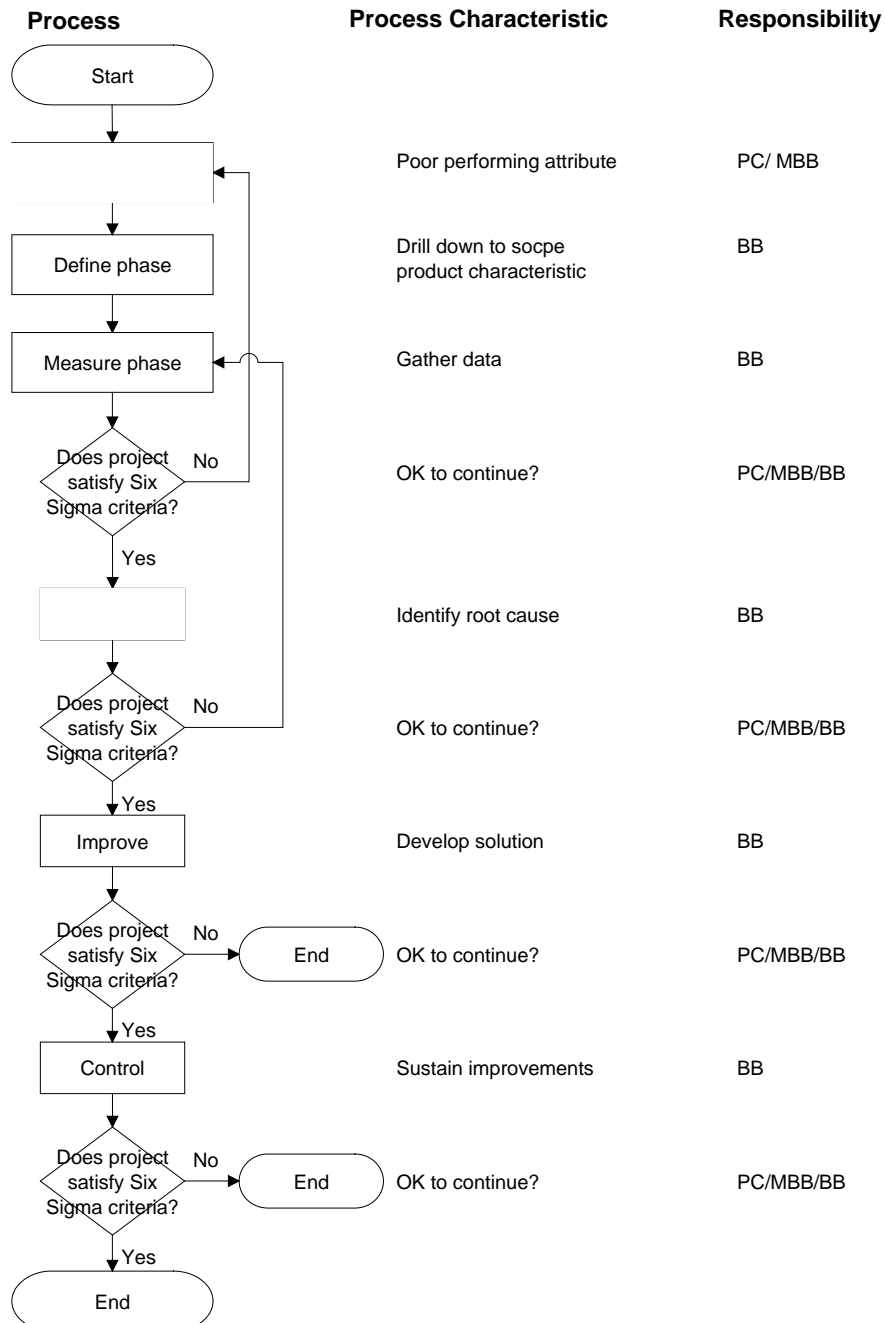


Figure 20. Actual process by which projects are selected and scoped

The project selection and scoping process is the part of the project prior to the point at which a Black Belt officially starts the project. Initially this was coded as project

selection and scoping, but further learning suggested that these should be treated separately.

5.6.2.1 Project selection

According to the process described at Ford Motor Company, the project champion is responsible for providing the Black Belt with a scoped out project. From the interview data, it would appear that initially there were criticisms levelled at the way in which Black Belts came to have projects and so it may be that work is required in this area. Ehrlich (2002) suggests that a process is developed to make decisions regarding the scope, selection, and success criteria of the project. The first step therefore would be to understand the extent to which the current documented process is followed.

When asked about the strategy used to achieve cost savings with Six Sigma, a Black Belt recounts the way in which he received projects.

Q Is there a clear strategy for achieving cost savings using Six Sigma?

BB01 I would say not, but in my case, the things I've been asked to work on...they...I've been asked to work on specific issues where there is a large cost saving opportunity.

Q Is it fair to say then that you're being asked to work on cost savings, but there isn't a clear strategy that's been communicated saying what that strategy is, so it happens by default, effectively?

BB01 Yes, although maybe, I can't say that the strategy isn't there and it's not communication that's the issue.

Q But you're not..?

BB01 I don't feel I'm being specifically directed from every angle purely to save money, it's just a general wash down from the top. "You must focus on money". Perhaps it links into the way I've got projects, in that I've sort of ... there's been a couple of quality issues I've picked up talking to supervisors and my champions been okay for me to continue with them. So far, there's only been one specific hard saving one which he has asked me to do. So from my point of view, I could start a project tomorrow, which didn't have any effect on hard savings, but saved well, helped with customer quality, and I wouldn't be told not to do it.

In this case, it seems that projects are developed by local management on an ad hoc basis. These are then discussed with the project champions to check for validity. This is a departure from the process that is documented and one potential issue is that the supervisors are not necessarily trained as either Black Belts or Project Champions.

Q How far do you think Six Sigma has been incorporated into everyday business?

BB01 I don't think it has in my department. I think we're just starting to do it now. Maybe this is more from a single BB level so I felt my original project wasn't particularly aligned with what we should be focusing on, but it was a project I picked up. I think it's improving, but I think that's something that's got to come from supervisors, who know what their quality issues are and then request in BB assistance and that, I'm working on a project now that is exactly that.

A start issue, high TGW and they asked for my help and another slight improvement I've seen is the... this efficiency project which is obviously very much aligned to everyday work. So, I'd say it's starting to happen, but I'd say the problem is...it's perhaps quite hard for the champions, because, they've got to think of a specific...it's not generally embedded within the way we work. At the moment they're having to think of specific issues for the BBs to work on.

The Black Belt here believes that there is no mechanism for developing projects and that it is up to the Project Champion to merely think of ideas. One question that must be asked then is whether this is the case in every situation.

Q Is there a strategy, is there a communicated strategy that tells all the BBs where the effort should be focused?

BB03 We have what we call the performance cells these days, which, is effectively, gives a little more management structure to BB's efforts, what they're doing. So, the MBB, who, if you like, manages the performance cells, he has an overview of where all the various efforts are being directed and there is also a project hopper effectively, which has new projects listed. Having said that, those of us who have a little bit more experience are able to go out and find projects that will give us direct savings

The process then for getting projects is through a project hopper that the Black Belt can go to and receive the next project to work on.

From this response, the impression is that there is a project hopper from which projects that have been selected and scoped can be picked. It is interesting that the Black Belt goes on to say that the more experienced Black Belts are able to pick better projects. The issue here then is that the projects in the hopper are either not the best projects for the department or that there is disagreement with how a project should be selected.

The issue of the project hopper could be stakeholder dependent and so it is necessary to ask other stakeholders for their opinion. Here a Master Black Belt is asked about the way in which projects are selected.

Q Does your CBG or GEC have a clear strategy to use Six Sigma to improve customer satisfaction?

MBB03 We have a strategy in that we have adopted the fact that we're going to work on quality, and we've adopted the target that half of the TGW {Things Gone Wrong} improvements are supposed to come from Six Sigma. Although that's arguably a strange target, because until you then know what the full amount is, you don't know what you're contributing to, but they're trying to say Six Sigma should be helping on quality as well as addressing the warranty issues that have some customer satisfaction impact. Beyond that in terms of a clear strategy, I guess the point then is we are in the process of identifying what target areas and what projects and with what resource etc., we should be putting in place to achieve our improvements or what areas of customer satisfaction, we're due to work on. And that's the process that we need to lay out now. We're not quite sure. We haven't got a clear methodology yet on how to do that, but that's what we're working to.

There is not a widely accepted process for selecting projects to fill the hopper and so it is important to determine how the next up list for projects is filled. The Master Black Belt states that this is in progress, but that it is not there yet. This is consistent with the response of the Black Belt and suggests that there is an issue with agreeing on a standard way of selecting projects.

Q Would you say, again we've covered this one, the projects are appropriate and do they fit the Six Sigma requirements?

GB02 They are selected. The management team are requested to put forward suitable projects. They are then evaluated by the Six Sigma BBs to see, if it seems to be a suitable one that will fly, then yes, it's selected. So, it is validated and checked to make sure it's suitable.

In this case, it is the responsibility of management team to provide suitable projects and these projects are selected on a logical basis. It is possible that here, there is no process for evaluating the projects.

Q Are the projects appropriate and do they fit the Six Sigma requirements?

NTM02 Well, I could add a bit on that and say again, what I've said is, I think some of them are just dreamt up as being Six Sigma project, when they're not really, they're really part of the everyday work, that, should be being done anyway, so, you end up with a bit of double counting there if you're not careful.

It seems that some members of the organisation are not convinced with the projects that are being worked on and this can influence the perception of Six Sigma itself.

Q The Six Sigma process. Are you aware of the metrics that are used throughout the company to measure the Six Sigma process?

GB01 No, I'm not aware of them. I'm only aware of initially, when Six Sigma started, that there seemed to be a lot of guys who were BB trained and who were rushing round and asking people if we had any problems that they could resolve. Whether there was a cost benefit in the resolution or not didn't seem to sort of enter into it. There should be some way of evaluating projects and prioritising them, be it in order either to do the best engineering or, you know, for the least cost. I think initially, when Six Sigma started, that it didn't have that, that the process just seemed to be a bit haphazard, where guys were sort of finding their own projects and trying to get them championed, and I think Six Sigma got a bit of a bad name initially.

Q What, because of the lack of focus on projects?

GB01 Yeah, there was a lack of focus, whether the projects were the correct ones, what the potential benefit was at the end of it. I mean, someone can surely look at a concern and say, well, there is a problem here. We're measuring this, that or using this process, but what's the likely saving if we show that we can do something that's better. What's the likely benefit? And there didn't seem to be an analysis of that sort taking place. It was just a case of doing a Six Sigma, project, showing that you'd changed something and that seemed to be sort of good enough, without looking at the cost impact.

There is a sign of real conflict here; Six Sigma is supposed to be the way that business is done and yet, when it is applied to everyday work, it is seen as double counting. What does seem to be consistently appearing is the sentiment that there is not a rigorous process for determining projects that meet the needs of the department and should be started.

Q How effectively has your organisation implemented Six Sigma?

IMMB01 Clearly, there are some places where they've done very well, and there are other places that need more attention [.....] In terms of project selection, I think we're getting a lot better at that, and I understand that at the moment, the list from which the projects are selected has got more projects than we can actually deal with at the moment, which I think is a good situation to be in and there's a lot of business units fishing around looking for projects.

Here the Integrated Master Black Belt demonstrates an awareness of the importance of selecting the correct projects and alludes to potential issues with other areas. Having selected a good project, the next step is project scoping.

5.6.2.2 Project scoping

The subject of choosing the right project was tackled in the literature review, and it is clear that the scope is critical to the success of the project. One question is whether this is perceived by the different stakeholders as being an issue. As part of the interview, the stakeholders were asked what the biggest issues were with Six Sigma.

Q What are the biggest issues with Six Sigma at the moment in your opinion?

BB02 Six Sigma is having different success in different areas depending on how well its been used and how well its been rolled out....In terms of what is the biggest thing in the area that we are doing in the [name of department], I think it's generally whatever the company is getting projects, getting sensible projects, taking the large,... the high level ideas and breaking them down into projects, say for things like the,, taking, TGW {Things Gone Wrong}, that says there's an issue...and actually coming down to actually being a project. I think there's a lot of that and some big level issues that are not easy projects to break down. That doesn't seem to be happening....So it's going from the big issue down to the project... a lot of the time is the biggest thing that's missing.

Here it is stated that the identification of a project with an appropriate scope is one of the biggest issues with Six Sigma. There is still a question of why it is so difficult to get a project with an appropriate scope. To proceed, it is important to understand whether the idea of an appropriately scoped project is understood by all the people involved.

Q To recap, your individual targets then are?

BB03 For 2004, is to deliver 3 projects and we're expecting on average at least 100 000 dollar savings per project.

Q And each project to last 90 days.

BB03 Approximately. Approximately 90 days. That's the focus and we are expecting that each BB should have at least 2 projects open on the go. 1 working on, and the other one being scoped. It's very well trying to be very organised and be very administrative in terms of getting everyone to follow this set pattern. In reality, it's not like that. I think the reality is totally different. You can be stuck with 1 project maybe several million dollar savings and should he be focused on that project or should he say, "well I haven't got my 3, so I'll get another 2 projects." So I think the reality is slightly different and I try to say that to my MBB, that I don't particularly agree with this kind of policing or martialing. You've got to look at the individual on its own merit and say, "well what is the work the person doing?"

Interestingly, this Black Belt believes that the notion of an appropriately scoped project is unrealistic and that the work and savings of an individual is more important than the number of projects. The idea that it is not possible to scope projects is an extreme view. It is then important to understand the extent to which this view is held and so the question of scoping was given to another Black Belt.

Q Setting you projects, do you solely scope them out?

BB01 Yes

Q Is there any influence from anyone else with that?

BB01 Yeah, I suppose there is.

Q And who would that be from?

BB01 It varies project to project, but 3 projects at the moment. 1 is a very high level task given to me by my champion, so, no, there's no scoping in there, it's a title.

Q Did you help with that title?

BB01 No. But as a workstream, I agreed with it. Although I didn't agree with it as a project title. It was a good area to look at, but it's too large to consider a project. It may be a scoping project. The results of that will be months down the line.

Q And your other projects, did you pick those yourself?

BB01 No, they were. The first one I picked myself. The 2nd one, was one, quite a simple project handed over to me, but then very shortly after it was handed over to me, the scope was changed, against my will, I have to say.

Q Did you protest?

BB01 To a degree, yes. I protested, but not, not a maximum protest.

Q Why did you not protest as what you deem is maximum?

BB01 2 reasons, partly, it was my boss saying it, so, to a degree, I work for him, so that was 1. and what made that slightly easier to accept, was, I agreed with the, how do I say this. I agreed with the new scope, although, I think the first one should have been done first.

Q So you think it should have been 2 separate projects.

BB01 Yeah, and especially, for me, the 1st one was possibly an easy training type project that I discussed earlier, so would have been quite a nice confidence enhancer, as the new scoped project is a high level, "solve this problem".

The Black Belt here was not always given projects from a hopper and did not feel that the original projects were sufficiently scoped. It is then asserted that the understanding of what constitutes a well scoped project varies enormously. The training material does have a section on what constitutes a well scoped project and it

would help to understand why this has not led to a greater understanding of an appropriately scoped project.

Q	How much have you used a team?
BB01	Very little.
Q	Why is that?
BB01	I suppose in my 1st project, you are asked to really come up with a project idea and then form a team before you've done any training. In my experience the people who had good teams and teams sorted on the training, were people who had basically been given a project and given a team by their champion before the training. People who weren't given a team, specifically...basically never came up with a core team.

In this response, it is suggested that there is a major discrepancy between the time at which the project scoping section is taught and the time at which the Black Belt must have an appropriately scoped project. This does depend on how the projects come about. As part of this study, it is important to determine the way in which a project comes about.

Q	How do people start projects at the moment?
MMB02	The way projects are started is down to the individual project champions to identify a need or to ask the BBs to identify a project and for the system right now, a BB will simply raise a new project. So we don't have a system prior to getting the projects onto the tracking system to establish, "Is this a worthwhile project? Do we have the resources to complete it? What is going to be the timeline? What is the benefit of doing this project?" So, all the good things that you would use within a scoping type session to eventually get the project charter, we need to establish a strategy, a system to put in place, that isn't bureaucratic that ensures that we can put in place a means that we get projects kicked off that we're not going to cancel in the future that are doable and is a system that can identify early up front, "is this going to be a good project or do we have an issue with it?"

One question that could materialise is who is responsible for providing scoped out projects.

Q So how do you see the role of the MBB?

XBB02 The MBB should be getting projects, A, from various supervisors if they've got specific issues, B, from taking the high level issues and working with BBs and specialists to break them down into new suitable projects for the BBs to take on, ... supporting particularly the new BBs when they're struggling through with their first projects.

If project scoping is seen as the role of the Master Black Belt, then it is important that the Master Black Belt has a process for scoping projects.

Q What process do you use in your area to scope out projects?

MBB03 We don't have a clear process at the moment. There was something of a process that existed which PD core quality had in place, which you could say we should be adopting. We perhaps have never properly adopted it. There's another part of a process that we were looking to adopt from diesel engineering, where they use etracker and follow it through that way. In reality, we haven't really got a formal process.

Considering that project selection and scoping are known to be critical to the success of Six Sigma, it is somewhat surprising that this has not been tackled at an organisational level. Where solutions have been found, these have not been investigated by other areas.

5.7 Conclusions from interview data

The greatest single conclusion from the interview data is that the majority of preconceptions held by the researcher have been dismissed through the application of the interview technique. Following the literature review and investigation into the secondary data, the interviewer had expected that the key issues with Six Sigma lay within the cultural and political arena, but following the analysis of the transcriptions, it became clear that while improvements could be made in these areas, they were not responsible for the suboptimal performance level of Six Sigma within Ford Motor Company. The review of the interview data suggests that improvements could be made under all four categories:

5.7.1 Strategy

The responses demonstrate that the strategy is not clearly understood. There are cases in which the communicated strategy appears to be in conflict with both the actual way in which Six Sigma is used and the pervading culture and this leads to confusion. This is an indicator that there is insufficient communication surrounding the deployment and therefore the projects will not necessarily be aligned to the needs of the organisation. Further, within Ford Motor Company, there is a very sharp focus on cost and when projects are aligned to cost reductions, the perception is that the projects are aligned to the needs of the business, although this is not the communicated strategy.

The deployment of Six Sigma often leads to a more participative style of management, but within Ford Motor Company, the targets are cascaded to people from a central office. This is a missed opportunity to signal to the organisation that the culture is changing since it shows that the Black Belts are not fully empowered within the Six Sigma initiative. This supports the belief that Six Sigma is still seen as an incremental initiative and not as part of the way in which normal business is achieved.

As far as the use of metrics is concerned, the Black Belts agreed that it was necessary to have metrics, but there was concern that many of the metrics could be achieved without satisfying the intended requirement of the initiative.

From the interview data, it emerged that there is a major opportunity for improvement. Six Sigma works through achieving a succession of projects and each project represents an opportunity to learn. Many people fail to take advantage of this and this suggests that the deployment will not develop as quickly as it could.

5.7.2 People

There is still work to be done with correctly identifying the right candidates to take part in the initiative. The recruitment of the Six Sigma Black Belts does not appear to be transparent which could lead to scepticism regarding the selection process. The reintegration process appears to have little regard for the Black Belt and this can have a serious effect on the future availability of people willing to volunteer for the assignment. Having recruited the correct people, it is necessary to ensure that the roles and responsibilities are clearly defined and applied consistently throughout the training, projects and documentation.

Once recruited, the performance of the Black Belt will depend on the training. In general, the standard of the training is high. There are potentially issues with the application of the training. Additionally, within Ford Motor Company, the Black Belts are the only group who have to achieve certification within their role. Approximately ten percent of Black Belts fail to achieve certification which is likely to affect the willingness of people to volunteer for the role.

As far as the impact on career is concerned, there are opportunities for improvement. There is a perception that Six Sigma can mean that one is passed over for promotions for two years and while it is a good experience, it is not as beneficial for a Black Belts careers as they are led to believe. The organisational structure of Six Sigma has meant that in certain cases, the person responsible for carrying out the annual performance review has not been involved with the Black Belt through out the year.

It appears that the strategy regarding the use of Green Belts to assist in projects is not fully developed and a large number of Green Belts have been trained, but have not been involved in projects. There is a feeling that the use of a team would increase the project throughput, but only half of the Black Belts use a team. What is interesting is that there is a general feeling that the use of team can help prevent the failure of many

projects. It seems that one variable that affects the use of a team is the ease with which different Black Belts are able to pull together a team. The Black Belts interviewed had different experiences regarding the recruitment of team members. Some Black Belts waited for people to volunteer themselves while some Green Belts waited to be recruited. Curiously, the Green Belts appeared frustrated that they had not been involved in the project teams.

5.7.3 Process

For the sake of credibility, it is important that Six Sigma applies the same rules that it aims to apply to the rest of the organisation and therefore, it is important that the processes within Six Sigma are adhered to rigorously and that data is used in the justification of changes to the process. Moreover, every effort should be made to ensure that errors present within the initiative are kept to a minimum with a consistent drive to achieve Six Sigma performance.

There is a conflict in the project selection and training process. A Black Belt is asked to come up with a project prior to the training. The Black Belt is at a loss as to what would constitute a good project, because they have not yet been on the training course. Originally, the way in which projects are selected lead to a situation in which Six Sigma developed a bad name, because of the way in which Black Belts rallied around trying to find projects. With changes to the system, the projects are selected according the performance cell. This could indicate that there is not an accepted process for determining which project should be worked on, since some projects are scoped by the Champion and Black Belt. That the projects are thought up specially again would suggest that there is not an accepted means of scoping out the projects.

As to the way in which project performance is measured, the Black Belts did not buy in to the targets and would present arguments that would prove the limited value of the target. This happened with the number of project closed, where a Black Belt would state that one big project might be worth the same as one hundred smaller projects, although no one had closed a large number of small projects.

5.7.4 Leadership

To ensure that Six Sigma within Ford Motor Company gains momentum, it is critical that successes are shared with the engineering teams. Equally, where there have been issues with a project, then it is important that this is dealt with to prevent rumours of failed projects proliferating.

The communication of the Six Sigma strategy appears to suffer from a yield issue in that as it is cascaded from the senior management, the accuracy and volume of the message decreases. The people closely involved in Six Sigma get the greatest volume of information regarding successes. A key opportunity then would be to get the right information to the right people in the right quantities.

5.7.5 Interview data

The use of interviews has provided much needed information to take the survey data to a level of understanding where the root causes can be identified and tackled effectively.

The decision to learn continuously throughout the interview collection process has required increased effort to manage the data, but has ensured that benefits are generated as soon as improvements are realised.

The inclusion of different stakeholders in the sampling has provided a number of different perspectives and this has assisted the interviewer in maintaining a distance from the perspective of the Black Belt which could have provided a bias because of personal experience in the role.

5.7.6 Project selection and scoping

When analysed using a process approach, the responses from the interviewees pointed to a situation in which it appeared there were different opinions about how a project should be selected and what a well scoped project would look like. It appears that there is even a debate as to whether it is possible to scope a project and define what a project should look or indeed whether it is necessary to consider projects as a unit of measure or savings should be used as the metric of someone's performance.

What emerges then is that if the lack of processes for project selection and scoping can be corroborated by other means, then it is likely that these will be the largest issues with Six Sigma performance. While other issues should be addressed, the generation of processes for project selection and scoping could generate the largest improvement. One possible way of confirming whether this is true is to look at the Six Sigma project database and assess the performance of different groups of projects.

6. Project Data Review

6.1 *Introduction*

This chapter will present the findings of the process analysis. Since this chapter deals only with the analysis of the process of Six Sigma, the results will be presented as per the headings of the analysis used and not according to the headings of the EFQM.

6.2 Baseline capability analysis

To demonstrate how the projects are performing, the baseline capability data has been calculated for projects up to 2006. Within the Six Sigma literature, there is a strong emphasis on defining accurately anything that is to be measured. Here it is necessary to determine what is meant by a successful project and a defective project.

6.2.1 Project performance data

A successful project is one that has achieved either "Close" or "End – Sustained" status on the Project Tracking System and that was open for 128 days or less. Possible defects include a project that did not close successfully and therefore ended up as "Cancelled" or "End – Unsustained".

Table 46. Six Sigma yield by year

Year start	No. of failed projects	No of projects	Proportion of failed projects	DPMO for successfully finished projects/ PPM
1999	1	14	0.07	71429
2000	46	267	0.17	172285
2001	151	607	0.25	248764
2002	210	614	0.34	342020
2003	217	773	0.28	280724
2004	316	979	0.32	322778
2005	215	896	0.24	239955
2006	26	308	0.08	84416
Average	148	557	0.22	220296

Table 46 shows that the defect rate for projects closing successfully without considering the time constraints is 220,296ppm. The data sample was taken part way through 2006 and this is why the number of projects closed is low.

6.2.2 Cost of poor quality – Failing to meet time requirements

This is calculated as being the amount of time spent on successful projects that run over 128 days. Calculated by using cost per BB per day, which is \$8,293m per annum.

Table 47. Cost effect of Six Sigma projects overrunning

Sum of Time over spec.		Cost of project over time spec
Year start	Total	/ \$000s
1999	4061	1113
2000	48390	13258
2001	60026	16445
2002	35662	9770
2003	24669	6759
2004	38863	10647
2005	29646	8122
2006	843	231
Average successful	30270	8293
Total successful	242160	66345

Table 47 shows the number of days that were spent on successful closing projects that overran. The cost is based on a Black Belt costing \$100,000 per year and working for 235 days per year. It should be noted that 2006 has low number of days because of the low number of projects that had been completed.

6.2.3 Final yield

To understand the initial process capability, it was necessary to interrogate the Project Tracking System (PTS) to understand the final yield for all Ford of Europe projects ever conducted.

Table 48. Six Sigma project performance by year from PTS

Year start	Failed	Pass	Grand Total	Final yield/%	DPMO/PPM
1999	1	13	14	93	71429
2000	46	221	267	83	172285
2001	151	456	607	75	248764
2002	210	404	614	66	342020
2003	217	556	773	72	280724
2004	316	663	979	68	322778
2005	215	681	896	76	239955
2006	26	282	308	92	84416
Grand Total	1182	3276	4458	73	265141

Source: PTS Project data for Ford Motor Company Europe downloaded 18/09/2006 from www.6-sigma.ford.com

Table 48 shows the number of projects successfully closed versus those not successfully closed. From the data, it is possible to determine the Defects Per Million Opportunities (DPMO) for the final yield. The target for yield is ninety percent which is equivalent to a DPMO of less than one hundred thousand parts per million. 2006 has had a good start and if the data collected is representative of the whole year could meet the target.

6.2.4 Cost of Poor Quality – Cancelled Projects

Based on BB costs alone

Cost of cancelled projects = proportion of cancelled projects * BB no. * annual cost of a BB to the company

The number of Black Belts in Ford of Europe is 342 (PTS Project data for Ford Motor Company Europe downloaded 18/09/2006 from www.6-sigma.ford.com).

The number of Black Belts has remained approximately constant since the strategy is one of replacing those that finish the two year assignment and reintegrated into the business. This process is known as ‘rolling off the scheme’.

The annual cost to the company of employing a Black Belt is approximately \$100,000.

Table 49. Six Sigma yield from PTS with cost information

Year start	No. of failed projects	No of projects	Proportion of cancelled projects	BB cost for cancelled projects/ \$000s
1999	1	14	0.07	2443
2000	46	267	0.17	5892
2001	151	607	0.25	8508
2002	210	614	0.34	11697
2003	217	773	0.28	9601
2004	316	979	0.32	11039
2005	215	896	0.24	8206
2006	26	308	0.08	2887
Average	147.75	557.25	0.22	7534
All projects	1182	4459	0.27	9066

Table 49 presents the data from cancelled versus successful projects in Europe. The average is an unweighted average of the yearly data. All projects include the total number of projects closed versus the total number of projects not closed. The difference between the results measured by ‘Average’ and ‘All projects’ is related to the different number of projects undertaken in each year. The Black Belt cost for cancelled projects for all projects is based on the yield taken from all projects run, 0.27. The cost is the yield multiplied by the number of Black Belts in Europe, 342 multiplied by the cost per Black Belt per year, \$100,000. It can be seen then that the average cost of cancelled projects in Europe when calculated for Black Belt labour cost only is \$7.534m per annum.

6.2.5 Cost of poor quality – Benefit per project

While it is possible to get information detailing the benefit of each individual project, this has not been done, because the benefit per project is an outcome and therefore can not be managed.

6.2.6 Scope of research

The scope of the project was reduced to “reducing the number of cancelled projects”. This will generate savings as a direct result of eliminating waste in the form of work carried out on projects that do not close successfully.

6.3 Root cause analysis

According to Bhote and Bhote (2000 [111]), the variability can occur at 3 levels, between families, between parts and within part. Variability between families refers to the variability that is accounted for by batch, or by type or some other discreet identifier that will group a number of projects together. Variability between parts refers to issues that occur on an individual by individual basis. Here there is no grouping, and the variability occurs as a result of uncontrolled noise within the process. Variability within part describes the failure of a part under certain conditions or at a certain point during operation.

6.3.1 Conducting the analysis

The data was analysed to locate the source of variability. Bhote and Bhote (2000 [111]) write that there are three sources of variability: positional, cyclical and temporal. These three sources of variability give rise to family to family variability, part to part variability and within part variability. To understand the sources of variability in Six Sigma performance, the analysis was conducted for family to family variability, project to project and within project variability. Here, a family is taken to be a group within which projects are run such as a country, business unit or organisational function. Project to project variability is that variability that occurs within a family and within project variability would indicate a propensity for projects to encounter problems at a particular stage within a project. The different possible sources of variability are shown using a cause and effect diagram.

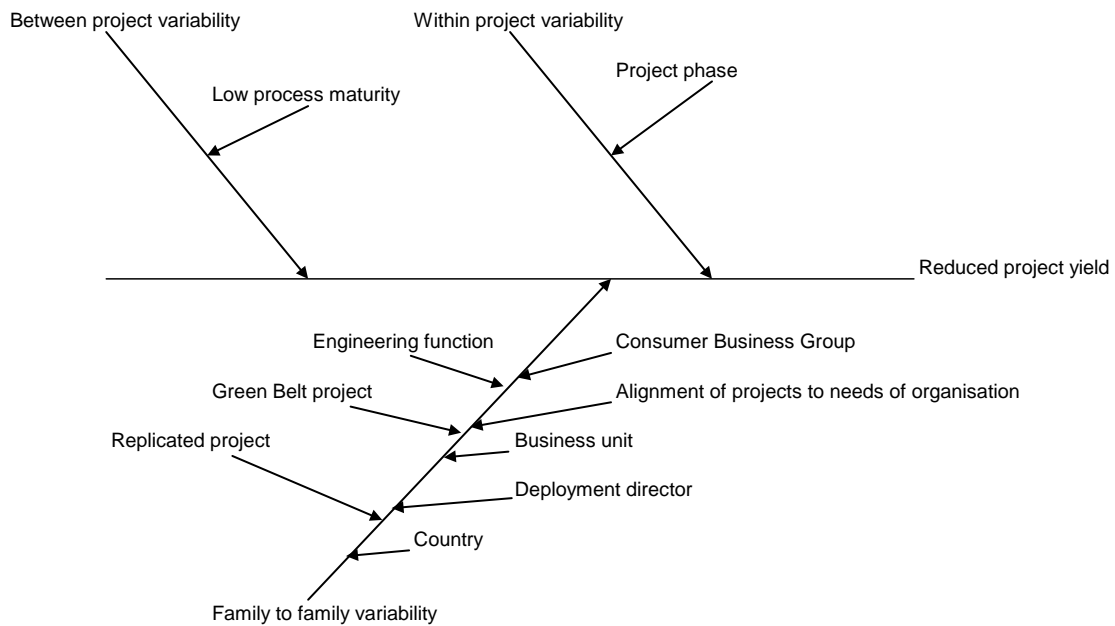


Figure 21. Cause and effect diagram showing possible sources of variability

In each case, the analysis was summarised to indicate whether there was a significant difference in which case, this could indicate an issue or whether there was no difference and the factor under consideration could be eliminated from the research. Tables containing the detailed analysis have been placed in the appendices.

6.3.2 Family to family variability

This section is concerned with identifying whether a change in yield performance can be attributed to a particular factor or number of factors. This is tested via a chi-square test for association. Morris (1989 [222]) points out that the number of each expected value should exceed 5 before chi-squared can be used safely. In the analysis, categories in which there are insufficient samples to meet this criteria have been removed to ensure that the results are not unduly influenced by small sample sizes.

6.3.2.1 Ford Global versus Ford Europe

One question that is critical is whether there is a difference in performance between Ford of Europe and Ford Global. The yield for Ford of Europe is 69.5% while Ford Global is at 66.4%. What is important is whether this is a statistically significant difference (shown in appendix VII). When analysed using a 2 proportion test, it becomes clear that there is a statistically significant difference between the yield performance of Six Sigma projects within Ford of Europe and Ford Global. There are two salient points here. The first is that with such a large sample size, the likelihood is

that there will be a statistically significant difference and the greater question is whether there is a practical difference between the two samples. Here the difference is between 66.4% and 69.5%, and this is not deemed sufficiently large a difference to account for the reason behind the failed projects. The second point is that Ford of Europe has a proportionally higher yield than Ford Global. From this point, using Ford of Europe as a vehicle to improve the project yield would allow a benefit to be gained from the whole organisation.

6.3.2.2 Year of project start

This section is concerned with understanding whether the yield performance varies by year of the project starting.

There is a significant difference in the yield performance of projects by the year in which they were started (as shown in appendix VIII). Six Sigma was deployed at the end of 1999. The reason for not including 1999 in the analysis is that the number of projects completed is too few to allow reasonable analysis. What emerges is that the yield has decreased since the initial implementation as shown below in figure 22 (data shown in appendix VIII).

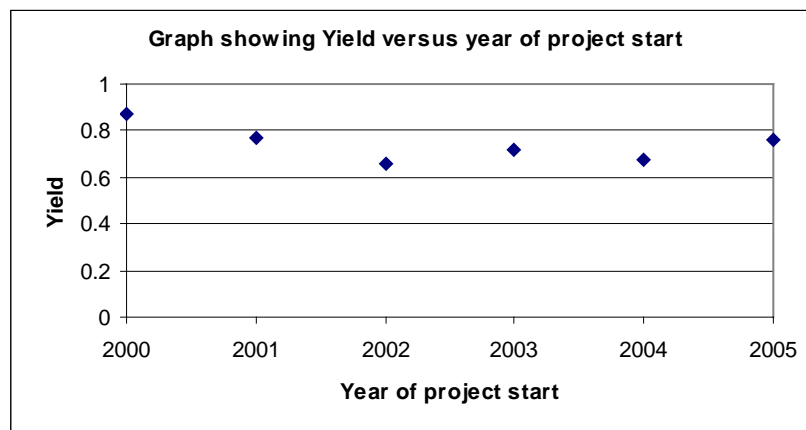


Figure 22. Graph of project yield versus year

Basu and Wright (2003 [3]) report the findings of Turner (1999) stating that quality programmes have a typical life cycle of two and a half years. This is consistent with the data gathered here that shows a substantial decreases in performance over the first two years. Initially, the yield decreases, but settles at approximately seventy percent. From this data, it would appear that the initial deployment was handled well with an accordingly high initial yield. One possible explanation of the decrease in yield is that

the expansion of the programme led to a decrease in focus on project selection and scoping, or that the projects that were easily identifiable with the early tools had been completed leading to a situation where it was more difficult to select appropriate projects. Either of these explanations would be consistent with the output from the interviews which points to poor project scoping as being a reason for poor yield. In most situations, it would be expected that the initial attempts at scoping projects would be haphazard with a new quality tool and that as experience is gained, then the success rate would improve since the organisation would learn about the critical factors in selecting and scoping projects successfully. What is curious is that this is not the case.

Here there is a decline in project yield, and yet the processes have not deteriorated, so there must be a different reason for the variability. One possible explanation is that the as the size of the deployment increases, it is not possible to identify obvious projects as easily using the original techniques. To counteract the decline in project yield, it is proposed that the maturity of the selection and scoping process is grown to allow management of that process.

6.3.2.3 Consumer Business Group

Here the impact of the Consumer Business Group (CBG) is analysed as a possible cause of varying yield rates. A chi-square test for association (shown in appendix IX) reveals that there is no significant difference in yield for the different CBGs. In this way the likelihood of a project succeeding does not vary across different divisions of the organisation. This result is important since it is an indication that the performance across the organisation is consistent.

6.3.2.4 Alignment of projects to the needs of the organisation

This test assesses whether the yield performance of projects is dependent on the alignment of such a project. In analysing the data, the projects in which the alignment was blank were removed, since this could indicate a project in its infancy or a project that is not aligned. When tested, it was revealed that project alignment is not significant (as shown in appendix X). Turner (1999 [9]) suggests that the scope of the project is an essential aspect of the management of a project. The most interesting aspect here is the priority of the categories.

What is clear is that of the four most popular categories, two are “Base Initiative Other” and “None” and in fact these two categories account for 48% of all projects completed. This suggests that while project alignment is seen to be critical, the project alignment categories themselves are not aligned to the subject area of the majority of projects.

6.3.2.5 Business unit

Within Ford Motor Company, different functions are arranged to create business units that are able to run as autonomous organisation that are either profit or cost centres depending on their role within the organisation. The statistical analysis aims to assess the significance of the business unit on the yield performance. A large proportion of the variability observed in the performance of project yield is displayed when yield is calculated by business unit (as shown in appendix XI). There are some business units that appear to have been neglected as is the case with “No Business Unit”, where projects have been open for as long as 983 days. The business unit that stands out in as having a consistently high yield is FoE-Manuf-VO in which the time taken to finish projects has decreased and in 2006, the median time open was 21.5 days.

One possible explanation of this difference is that where the project is not aligned to a business unit, then for the reasons of support and commitment, the project is likely to take longer. One additional issue is that the business units have different sample sizes and that where there are small sample sizes, this can affect the results.

An alternative explanation of the difference in performance is that Six Sigma is more applicable to manufacturing. Basu and Wright (2003 [43]) believe that this is a fallacy that has come about because historically, service organisations have not viewed their business using a process perspective.

The performance of Six Sigma varies from one business unit to another and therefore, it is necessary to include this result as a potential cause of Six Sigma performance variability.

6.3.2.6 Deployment director

The Deployment Director is the head of Six Sigma within a business unit. This question ascertains whether the project yield performance varies with deployment director. Here there is a great deal of variability in performance for yield between deployment directors (as per the calculations in appendix XII). This variability can be shown below.

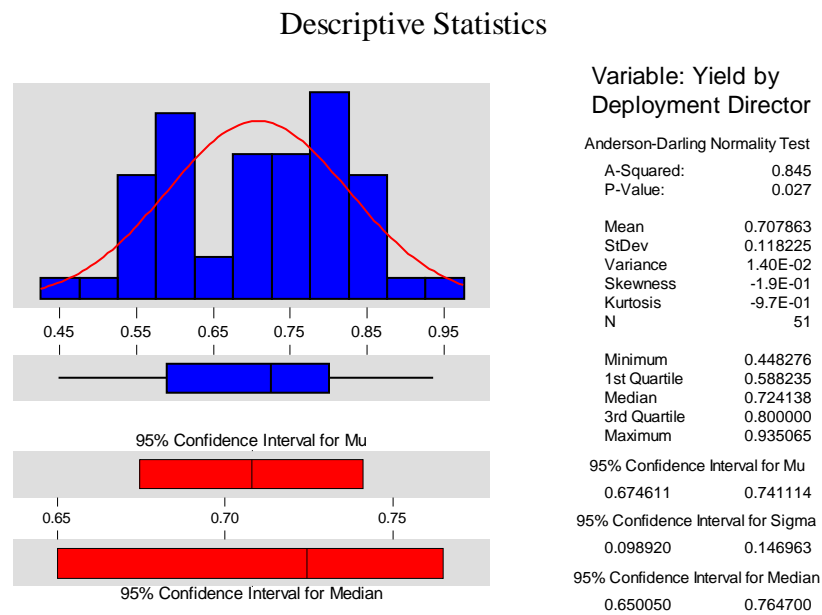


Figure 23. Histogram of yield by deployment director

Deming (1986) argues that the systems are responsible for the majority of variation and that it is not due to the people. Here is evidence showing that yield varies with deployment director. The author presents a viewpoint that in fact, while this data would suggest that the yield performance of projects varies with deployment director, the trained deployment director is an output of a deployment director selection and training process. This suggests that while there is a correlation between the two factors, there is not sufficient evidence to demonstrate whether this relationship is causal or otherwise. Should further improvement be required, this is an area in which further investigation could be conducted.

6.3.2.7 Country

The analysis will be conducted to assess whether there is a difference between the ways in which different countries perform Six Sigma projects. As can be seen in appendix XIII, there is a significant difference between the yield performances of different European countries.

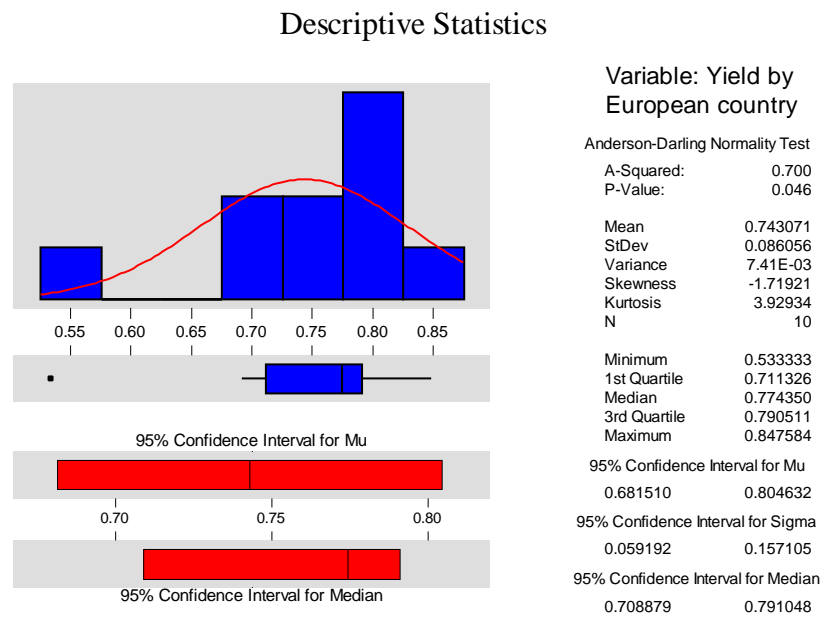


Figure 24. Histogram of yield by country

It seems that the Russian Federation has a lower yield than other countries and furthermore, this is a peculiar situation due to the small size of the Six Sigma deployment in the Russian Federation and there is not a Master Black Belt resident within the Russian Federation. Consequently, the low yield could in fact be attributed to the lack of a Master Black Belt in that country. If the Russian data were removed, the variability would be reduced dramatically and the greater part of the variability would then be individual differences rather than systematic differences.

6.3.2.8 Engineering function

Here the analysis is conducted to understand whether there is a difference between the different groups. As suggested in chapter 2, it is possible that different groups of individuals display different personality types and therefore different functions could demonstrate a difference in the way projects are managed. The test shown in appendix XIV has identified that there is a significant difference between engineering functions. This result however is dominated by the number of projects that do not have this field filled in. When the blank fields are removed, there is in fact no significant difference between the engineering function groups.

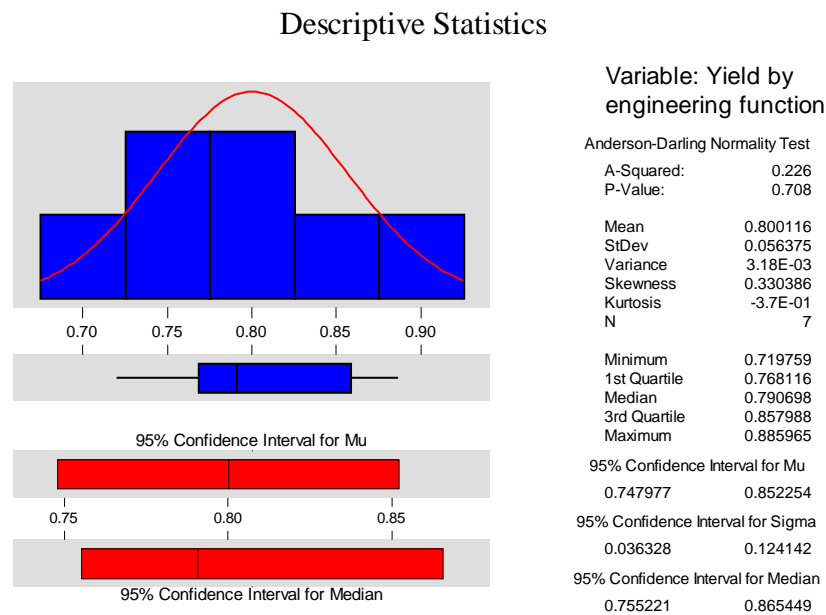


Figure 25. Histogram of project performance by engineering function

What actually emerges is that the yield performance is varying as part of a larger distribution which is present in all engineering functions. Here, it is necessary to look for a source of variation that could exist across engineering functions.

6.3.2.9 Green Belt projects

A Green Belt project is a project that is led by a Black Belt, but which uses a team of Green Belts to carry out the project tasks. The question here is whether projects identified as Green Belt projects had a higher yield than those that were not identified as Green Belt projects. The projects that are identified as Green Belt projects have a higher yield than those that are not identified than Green Belt projects (as shown in appendix XV). This difference is statistically significant from projects not identified as Green Belt projects. One possible explanation for this is that Green Belt projects are selected by potential team members and therefore, the team have identified a real issue that is important enough to warrant their effort. In reality with only six percent yield between the two figures, it does raise the question whether this result is of a practical significance.

6.3.2.10 Replicated projects

This section deals with ascertaining whether replicated projects have a higher yield than those projects that are not replicated. Here it is identified that replicated projects have a higher yield than those projects that are not replicated (as shown in appendix

XVI). The fact that a project is replicated means that a successful project has been used as a basis for the project. This means that in addition to having a technical precedent, there is also a project that satisfied all the elements required to drive a change project through the organisation. This suggests that there is a benefit to be gained from ensuring that every opportunity is taken to learn from previous projects and apply successful practices where possible.

6.3.3 Within project variability

One example of a cause of within project variability for project cancellation would be a part of the project process that had a particular high failure rate. E.g. If an audit occurred at a particular stage of the project that was extremely difficult to pass, then this could lead to a higher occurrence of project failure and could therefore account for a higher cancellation in certain projects.

To test for within project failure, a test will be conducted to understand whether projects get cancelled at a particular point. The data at this level of detail is extremely sparse, so it is only possible to understand how the length of time open varies with status.

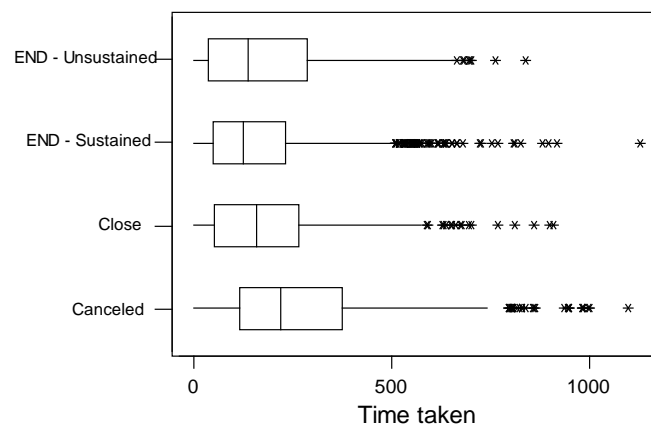


Figure 26. Box plot showing time open versus status of the project

Mood Median Test: Time taken versus STATUS

Mood median test for Time taken

Chi-Square = 131.25 DF = 3 P = 0.000

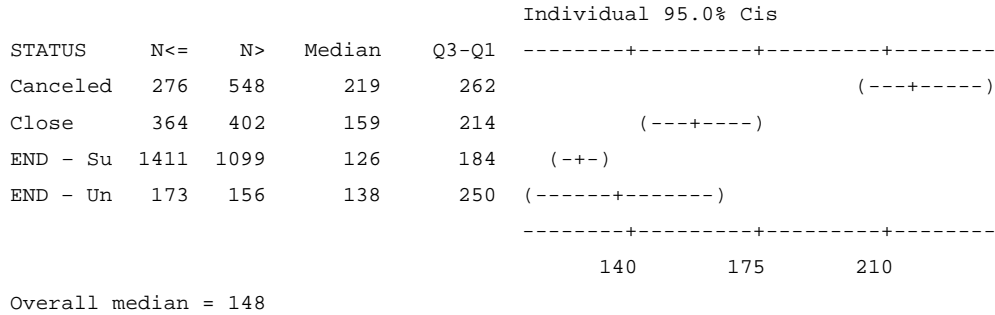


Figure 27. Results from Mood Median test

It can be seen from figure 26 that the cancelled projects are open for longer than closed projects and un-sustained projects remain open for longer than sustained projects. What is important here is that this would suggest that there is an opportunity to monitor the progress of projects to identify those projects that are not making sufficient progress and reduce the cost to the organisation of failed projects. This could be achieved by using an effective project management tool. It is proposed that the longer term aim should be to identify the source of the variation and tackle this to improve the yield performance of the Six Sigma projects.

The key conclusion here is that the successful projects close more quickly and have far less variability in the time to complete than failed projects do.

6.3.4 Project to project variability

The third type of variability after family to family and within project variability is that of project to project variability. As previously stated, the way in which Six Sigma works is to eliminate potential causes until one is left with the few potential causes that could be responsible for the variability.

The interview data from chapter 5 suggested that it was the project selection and scoping process which was reported as having the biggest effect on the performance of Six Sigma.

The project data when analysed suggested that the following factors are significant: year of project start, project alignment, business unit, deployment director, country, Green Belt projects and replicated projects. What is clear is that while there are differences, it is not possible to isolate one or two key factors that are able to explain the majority of the difference in performance between good and bad projects.

Green Belt projects are run in the same way as other projects, so the only difference from other projects is that the project is started with a team. Replication projects are also run in the same way as other projects, so the only difference between a Replication project and another project is that the first projects was shown to be aligned to the business and successful. The year of project start could also be accounted for in the fact that as time passes and more projects are completed, it is more difficult to find the so called, “low hanging fruit.” As for the business unit, deployment director and country, these too could be accounted for by variation in the project selection and scoping process. The fact that no single factor accounts for the majority of noise means that evidence from the interview data and process data is not refuted. When considering the processes for selecting and scoping projects, it is identified that there are not defined processes. Barney and McCarty (2003 [76]) believe that project selection and scoping will be key areas for future innovation indicating that this is an area in which improvement is desperately needed. From a critical realist perspective, the evidence taken together suggests that the project selection and scoping processes are likely to be the root causes for varying project performance within Ford Motor Company.

6.4 Conclusion

The project yield varies according to almost every variable when subjected to the chi-square test. The sheer sample size means that very small differences can be observed. The bigger question is whether these differences are systematic differences or represent an uncontrolled noise factor in the DMAIC process.

One other aspect identified is that projects that are cancelled are open for longer than projects that are not cancelled. This would suggest that in addition to an issue with project selection and scoping, the projects are not controlled in such a way as to facilitate early identification of unsuccessful initiatives and this is a source of wasted effort in projects that continue long beyond a time when they should be stopped. One way of reducing the waste would be to adopt effective project management techniques.

Where there is remote support for projects as appears to be the case in the Russian Federation, the project yield is lower than where the support for projects is local. This suggests that even when the project selection and scoping processes are fixed, it is still necessary to ensure that the other critical factors such as training, support and coaching are in place and working.

Replicated projects have a higher yield than projects that are not replicated. This could be due to the scope of the project in addition to the technical precedent. In this situation, it may be possible to use case studies during the training to demonstrate the way in which replication can occur.

Projects that are led by Black Belts, but run by Green Belts fare better than projects that are not run by Green Belts.

The majority of the variation observed concerning the success of projects lies between projects. This is consistent with the idea that the selection and scoping processes are not clearly defined as was identified from the interview data and the review of the training material. Analysing the project selection and scoping processes according to the Gardner process maturity continuum (Gardner, 2001) revealed that these is at level

1: unknown, a lower level of maturity than other aspects of the Six Sigma problem solving process, which are at level 2: defined. The next step then is to review the training material to confirm that this is indeed the case.

7 Review of training material and execution of process as documented

7.1 Introduction

Having focused the research onto the processes used within the Six Sigma approach, then it is necessary to investigate how the processes relate to the training material, since this is the most detailed reference source for the DMAIC processes and is the most complete form of documentation of the way in which the processes should be used. The training material that will be investigated is the 2006 version of the training material that is available on the Ford intranet. Additionally, this section will critically analyse the way in which the processes described in the training material have been implemented. Again the EFQM framework will be used to structure the section.

7.2 Policy and strategy

This section is concerned with the training material regarding strategy and the performance measures used to monitor this in line with the EFQM framework (EFQM, 2003). In this section, the strategy is used to depict the concept that defines the way in which Six Sigma is used within Ford Motor Company.

7.2.1 Strategy

"Project selection and scoping is the role of the Performance Cell, specifically the Project Champions and Master Black Belts" (Ford Six Sigma Office, 2003). Within Ford Motor Company, the project champions continue to carry out their day to day job and in addition they have the added responsibility of scoping projects and driving those projects to a successful conclusion. This setup creates a powerful driver for ensuring that the Project Champions align the Six Sigma effort with department objectives to avoid the incremental effort of carrying Six Sigma in a parallel fashion (Eckes, 2001 [16]). Turner (1999 [74]) writes that a lack of shared vision caused by failure to communicate priorities to involved parties are potential pitfalls observed in managing projects as are project plans that do not support the business plans.

Turner (1999 [21]) also believes that there are four types of management that can be represented in a two by two matrix. It is argued here that as maturity is increased within an organisation and precedents become available, then it is possible to migrate from management by projects to process management.

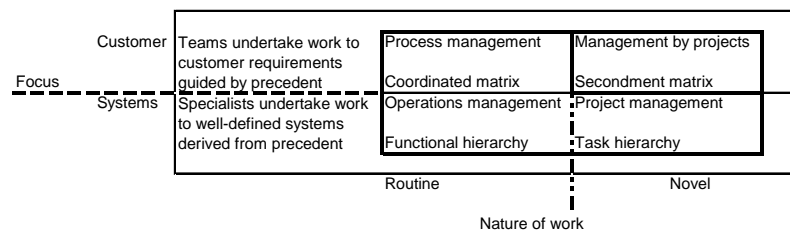


Figure 28. Difference between project and process management

Source: Turner, 1999 [21]

The inclusion of the Process Owner and Project Champion in the project selection and scoping process ensures that the needs of internal customers are met (Eckes, 2001 [20]). Even if the project selection and scoping processes are not well defined, the

fact that the stakeholders are required to carry out these steps should ensure that support for the project is guaranteed.

7.2.2 Performance Measurement

The Six Sigma Academy training material (2005a [12]) does not provide a project selection process, but does include a list of attributes that make a good project. One aspect that could be responsible for issues within the project selection and scoping process is that it is defined in terms of the finished project and this could drive a final inspection approach.

The Six Sigma Academy (2005a [6]) suggest that projects can be derived from Strategic plans, Critical To Satisfaction (CTS) inputs, Performance metrics, Cost Of Quality (COQ), or Sweet to Low Hanging Fruit, but that projects should not be the biggest problem. One recommendation for identifying these types of projects is through the use of "dashboards" which are top level summaries of key process performance, (Eckes, 2001 [21]; Henderson and Evans, 2000).

Arguably, when organisations tackle the biggest problems, this is symptomatic of an ad hoc approach and typifies an organisation that has a process maturity level of level 1 (Gardner, 2001). Moreover, this type of project drives a focus on product attribute projects rather than process projects.

Harry states that the first step is recognising functional problems that cause organisational issues (Harry and Schroeder, 2000 [130]). The statement is open to misinterpretation and could lead projects being selected based on attributes rather than process performance.

Oakland (2000) writes that, "It is not possible to manage what cannot be measured", and having determined a TQM implementation strategy, it is important to measure the progress and consequently the impact of TQM on business performance. Capon et al. (1995) have found that measuring the performance of a TQM programme and displaying the results improved the chance of success by between ten and fifteen percent, while McAdam and Bailie (2002) state that inappropriate metrics can prevent implementation of the strategy. If useful metrics are used, it is possible to audit the

process, but care must be taken to ensure that the measurement does not become way of avoiding progress (Capon et al., 1995). Whichever measures and indicators are used, they should reflect the true performance of the process in customer-supplier terms, emphasising continuous improvement (Oakland, 2000) and in the same way that they need to be appropriate at the start of a programme, they must be re-evaluated to maintain alignment with strategy (McAdam and Bailie, 2002).

7.3 People

This section is concerned with the management of the human resources as described in the EFQM framework (EFQM, 2003).

7.3.1 Managing People Resource

The project champion is ultimately responsible for project selection (Ford Six Sigma Office, 2001 [2]; Ford Six Sigma Office (a), 2005 [3]), but the Master Black Belt is expected to assist (Six Sigma Office, 2003). Part of the Project Champion and Master Black Belt training involves project selection, so the issue is not a lack of training. One potential issue is that people are not suitable for carrying out the project selection process.

7.3.2 People's knowledge and competencies are identified, developed and sustained

While personality type is a potential source of variability in project selection, personality type should be regarded as a potential noise inherent within the Six Sigma process and therefore any project selection process must be robust to personality type.

7.3.3 Teamwork

McAdam and Evans (2004) identified a link between issues with the deployment of Six Sigma and the lack of involvement of the process owners in the project selection and scoping process. Within Ford Motor Company, there is support from the project owners, though the consistency of this is unknown and therefore, the concept of stakeholder involvement can not be disregarded as a potential cause. Turner (1999 [74]) writes that failing to have a structured process for setting up a team quickly is a potential pitfall observed in managing projects, although it is still necessary to treat individual projects as novel entities.

7.3.4 Involvement and Empowerment

The project selection process within Ford Motor Company includes local management and therefore ensures that the decisions made by the organisation are made by those with the greatest interest in them. Turner (1999 [80]) notes that a situation in which there is responsibility without authority, creates an "impossible position for any

manager." Within Ford Motor Company, the Performance Cell Leader is responsible for the delivery of Six Sigma, but it is the Master Black Belt who is measured against performance cell delivery. This can create a difficult situation for the Master Black Belt who often does not have authority over the Black Belts.

7.3.5 People are rewarded, recognised and cared for

The project selection and scoping processes use a team approach and this reduces the sensitivity of the process to the quality of the workforce. It is possible however, that projects are selected in line with performance metrics and this could create conflict with the organisational requirements if there is a risk of misinterpretation of the objectives.

Turner (1999 [333]) writes that at the end of a project, the team morale will depend on the perceived benefit of future opportunities and therefore it is important to manage morale within the team. It is suggested that the current level of project and resource planning does not provide sufficient detail to facilitate management of the morale and may account for any lack of willingness to get involved in further projects.

7.3.6 Organisational Structure

One aspect that may affect project selection is the organisational structure. If the organisation is structured in a hierarchical functional structure as in the role culture or in a way that focuses the organisation by product or project as is the case with the task culture (Handy, 1993 [185]), then it is argued that it is unlikely that quality issues will be considered as the result of process performance while, if the organisation is organised by process, then this will increase the likelihood of projects focusing on process improvements. Here it is argued that the way in which an organisation is aligned to process is an indicator of process maturity.

7.4 Leadership

This section addresses issues including the development and implementation of the mission, vision and values via appropriate actions and behaviours. Additionally this section is concerned with the extent to which leaders are personally involved in ensuring that the organisation's management system is developed and implemented (EFQM, 2003)

7.4.1 Mission, Vision and Values

To identify areas in which the organisation is not performing in line with expectations requires that the expectations are known and clearly expressed. In carrying out the recognise phase, one question that needs to be asked is whether this is the case.

At Ford Motor Company, the business strategy is cascaded down to a department level and provides a source of information that describes the desired performance of different aspects of the company.

7.4.2 Commitment

The Project Champion Training Material (Ford Six Sigma Office (a), 2005 [3]) highlights that Project Selection and Scoping are the key responsibilities of the champion operating within a performance cell (Ford Six Sigma Office, 2003). The Project Champion Training provides a Project Selection Process that explains how a vehicle level issue can be cascaded to a Single Element Variation Source (Ford Six Sigma Office (b), 2005 [20]).

Throughout Ford Motor Company, there has been a significant amount of training for managers in Six Sigma and this has led to a massive involvement in the Six Sigma process. The middle managers particularly are almost all trained as project champions and this shows tremendous commitment on behalf of the organisation regarding Six Sigma. A potential risk to their commitment is that the project champions must continue their day to day work and have the additional responsibility of scoping projects and driving these to a successful conclusion. To reduce the risk of misalignment between the business leaders and the organisation, senior leaders within the business are held accountable for the Six Sigma performance of their areas and the level of engagement regarding their involvement is communicated through the bonus scheme.

7.5 Process

This section contains a review of the Six Sigma process. The Six Sigma process here is defined as the RDMAIC process as shown below in Figure 29, where R stands for the Recognise phase and is the phase in which the project is selected and scoped.

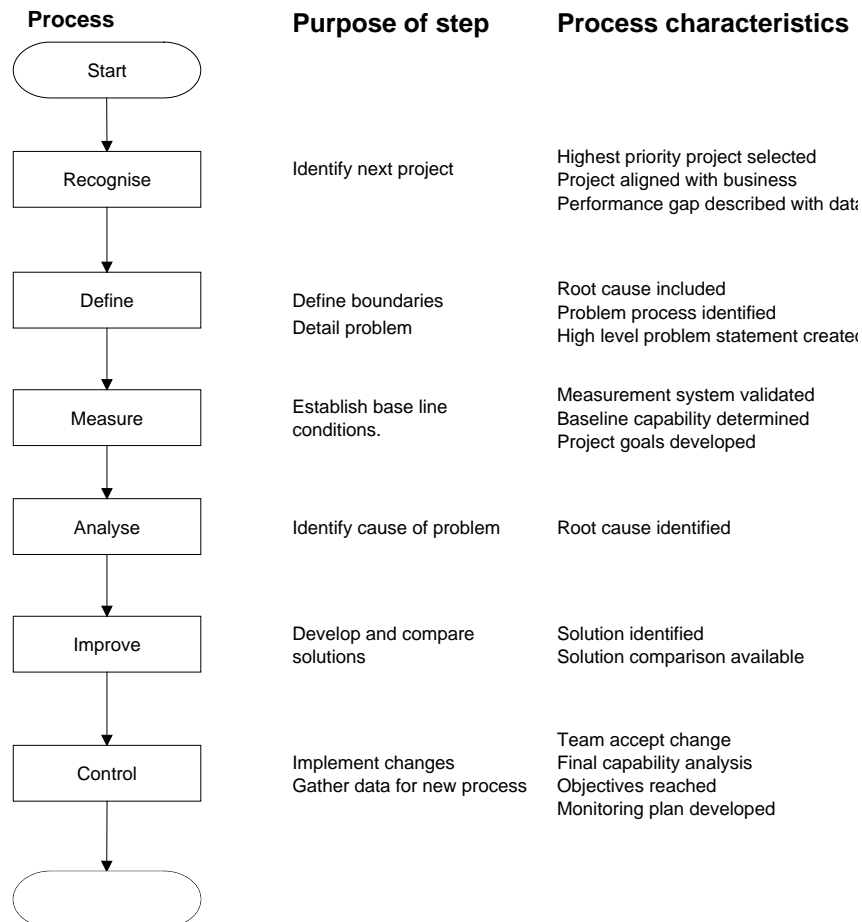


Figure 29. Six Sigma RDMAIC project process

To simplify the analysis, the steps are analysed according to the Recognise phase, the Define and Measure phases and finally, the Analyse, Improve and Control phases.

7.5.1 Recognise phase – project selecting and scoping

As far as the project selection and scoping process is concerned, there are processes that are documented, and yet, there is a paucity of documentation describing exactly how to select and scope projects. Breyfogle (2003 [34]) advocates the use of a project identification sub-process shown below:

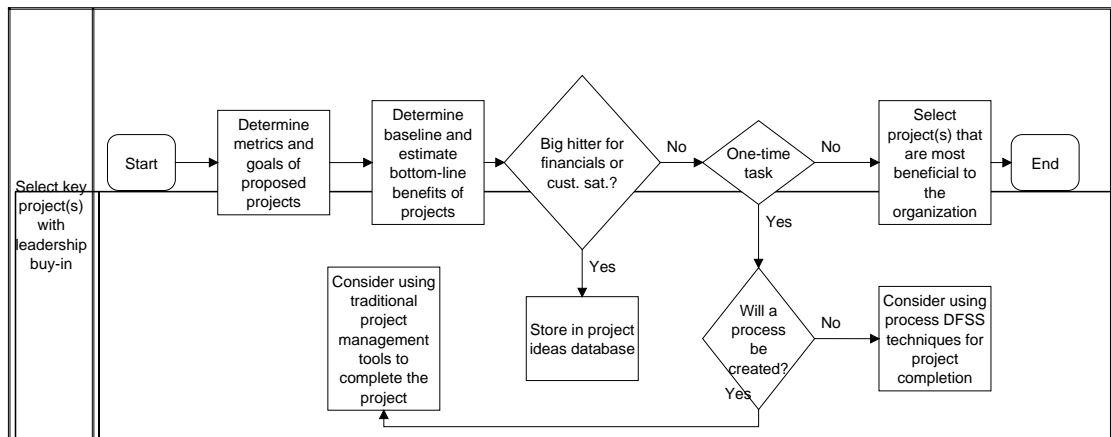


Figure 30. Suggested process for selecting projects

Source: Breyfogle, 2003 [34]

It is noteworthy that the start point is “select key projects with leadership buy-in”, so in fact, even the project identification sub-process does not propose a process for selecting projects. Pyzdek (2003 [190]) maintains that project selection is an art as well as a science, and Rath and Strong (2003 [351]) write that the initial project selection will never be perfect, but it is important to watch for an increase in failed projects. This is in keeping with the idea that project selection is an ad hoc process which suggests that it is a level 1 process according to Gardner’s process maturity continuum. That said, at a high level, there are attempts to document the steps that are required and this would suggest a desire to increase the process maturity to a level 2 process.

Within project management literature, the issue of selecting appropriate projects is treated as an important theme. Turner (1999 [43]) notes that often, there will be more possible projects than the organisation can support and therefore it is important to have a way of assessing which projects are carried out.

A notable weakness in the Six Sigma literature concerns the process for selecting projects, although the literature describes in detail the anatomy of a successful project: impacting quality, capacity, cost, yield or cycle-time (Ingle and Roe, 2001); saving an average of \$175, 000 (Harry, 1998) \$200,000 - \$250,000 (Coronado and Antony, 2002), at least \$1 million (Basu and Wright, 2003 [40]); and reducing defects by 70% (Harry and Schroeder, 2000; Six Sigma Academy, 2005a).

It would seem that projects should benefit the organisation (Breyfogle and Meadows, 2001; Ingle and Roe, 2001; The Six Sigma Academy, 2005a), which can be done by tracking "satellite level" metrics and using a drill down process to provide a "well-scoped project" which is not too large or small (Breyfogle, 2003) while Basu and Wright (2003 [91]) describe two approaches to scoping projects: a top-down approach that can create large projects and a bottom up approach that results in smaller projects. Goldstein (2001) proposes four "approaches for identifying projects:

- A) Gather field quality data. Rank the significant problems and group the data. And assign projects that were strategically grouped.
- B) Develop a comprehensive process map of operations that describes the steps to deliver your product or service. Measure the first pass yield at each step of the map.
- C) Benchmark your critical processes (core competencies).
- D) Determine the cost of poor quality. A high cost of failure for a particular defect can elevate the priority of a project in spite of a low frequency of occurrence."

Within Motorola, it is local management who are responsible for project selection and typical projects focus on areas that could yield significant competitive advantage for the company (Ingle and Roe, 2001). At GE, the project selection process is different and the site managers are told how many Black Belts they must provide and are advised as to which projects to work on (Ingle and Roe, 2001). The training material at Ford Motor Company does not present a project selection process (The Six Sigma Academy, 2005a; The Ford Six Sigma Office, 2000 [3]) although The Ford Six Sigma Office (2001 [2]) describes the process step "Select and Assign Project".

The Project Champion Training Material (Ford Six Sigma Office (a), 2005 [3]) highlights that Project Selection and Scoping are the key responsibilities of the champion. The Project Champion Training provides a Project Selection Process that explains how a vehicle level issue can be cascaded to a Single Element Variation Source (Ford Six Sigma Office (b), 2005 [20]).

While not providing information on how a project should be selected and scoped, the outcome of the selection and scoping process is well defined in the training material at

Ford Motor Company. The project should focus on an ongoing process that is creating defects (Six Sigma Academy, 2005a [12]), which is measurable (Six Sigma Academy, 2005a [12]; The Ford Six Sigma Office, 2000 [3]) and has an impact on customer satisfaction (Six Sigma Academy, 2005a [12]; The Ford Six Sigma Office, 2000 [3]). The result of applying Six Sigma to such a project is that the number of defects will be reduced by 70% (Six Sigma Academy, 2005a [12]; The Ford Six Sigma Office, 2001 [2] saving approximately \$250,000 (The Ford Six Sigma Office, 2000 [3]; The Ford Six Sigma Office, 2001 [2]).

The Six Sigma Academy training material states that projects should not be the biggest problem (Six Sigma Academy, 2005a [3]). When shown on a run chart, the biggest problem appears as a "spike" in the defect rate. Using a problem solving methodology to fix a spike in defects is symptomatic of the "fire fighting" phenomenon and indicates that the process maturity is not at a level where fire fighting is kept to a minimum. A potential issue does exist within the Project Champion Training Material that illustrates the project selection and scoping process with an example that explains how a vehicle level issue can be cascaded to a Single Element Variation Source (Ford Six Sigma Office (b), 2005 [20]). If this method of scoping is used, then it means that only special cause issues will be identified and this will reduce the impact of the Six Sigma methodology, since it prevents the tools from identifying process issues. The reason for this is that the process will remain unchanged; this is known as "fire fighting".

Pande et al. (2002 [36]) present a project selection process that suggests that it is possible to select projects from a review of the internal and external data from the organisation. A shortfall here is that it does not say how this should be achieved and again Pande et al. (2002 [40]) suggest that the list of potential projects should be reviewed against criteria that have been determined.

It therefore seems that while there have been many attempts to develop a way of effectively scoping projects, these fall short of providing a prescriptive process that works consistently.

7.5.2 The Define and Measure phases

The define phase process map is shown below in figure 31.

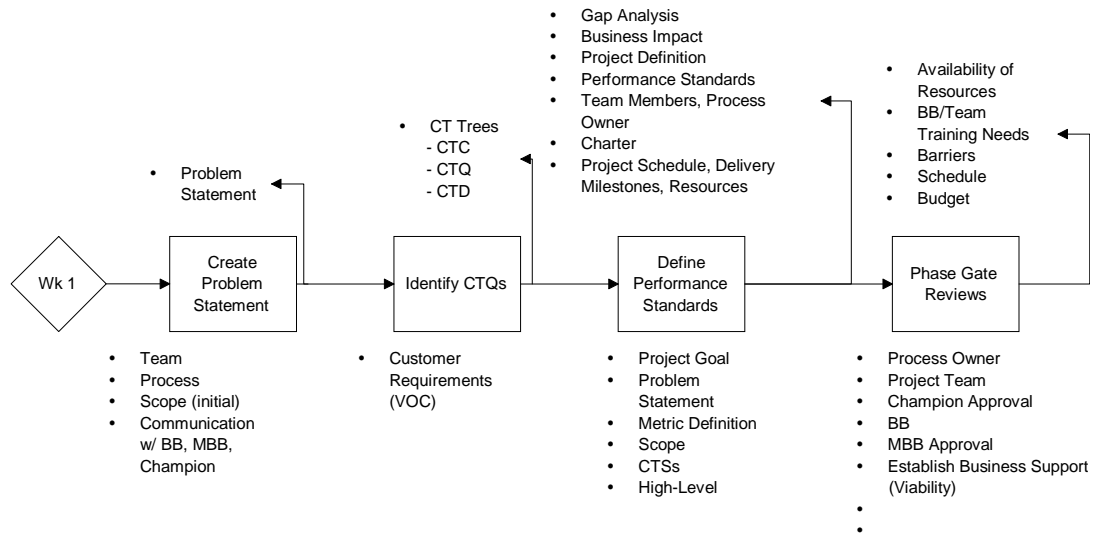


Figure 31. Define phase process map

Source: Six Sigma Academy, 2005a [Module 218 – Review of Define phase]

The high level process map is identified and for each step, there are output measures to guide the user through the process. There is not however in place a corrective action system, nor are there internal effectiveness measures and therefore, the process is at level 2: defined.

Below is a process map of the measure phase, which is considered to be at the same level of process maturity as the Define phase.

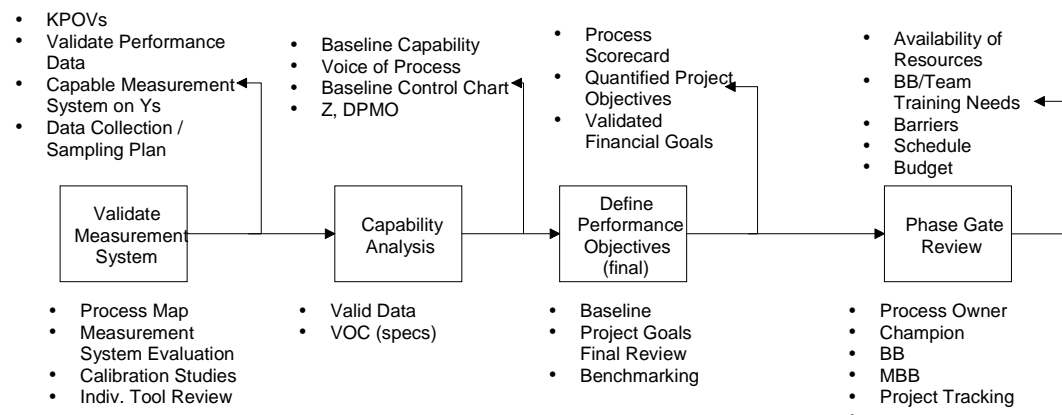


Figure 32. Measure phase process map

Source: Six Sigma Academy, 2005a [Module 219 - Review of Measure phase]

It seems then that the Define and Measure phases are at least part of the way along the journey of process maturity. To understand further the process maturity of the Six Sigma process, it is necessary to review the processes of the other phases of the Six Sigma process.

7.5.3 The Analyse, Improve and Control phases

The purpose of this section is to understand the process maturity of the whole Six Sigma process. There are no process maps for the Analyse, Improve and Control phases, and here the process could also be described as a level 1 process. The difference with Analyse, Improve and Control, is that there are a large number of tools and with each case, there is in fact a roadmap to drive decisions regarding which tool to use.

The largest part of the Analyse phase is hypothesis testing and here is shown the hypothesis testing roadmap. In this case, the hypothesis testing phase would constitute a level 2 process where there is a course grained procedure in place as shown below.

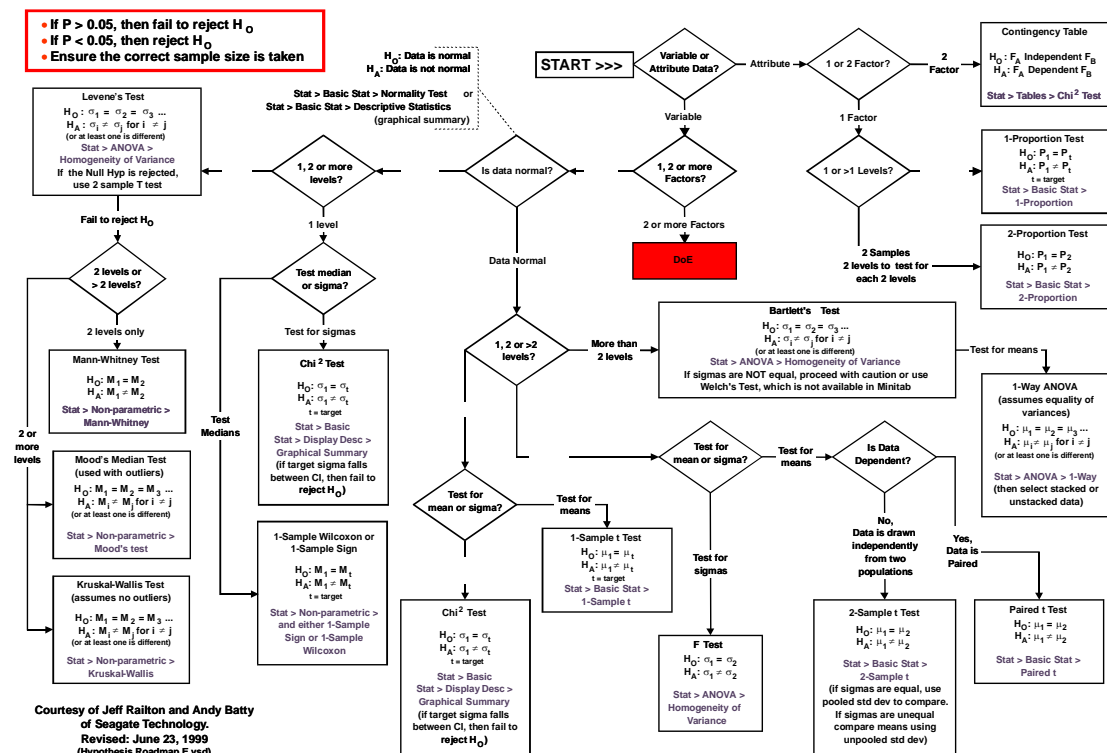


Figure 33. Hypothesis testing roadmap

Source: Six Sigma Academy, 2005a [Module 306 - Intro to hypothesis testing]

The Improve phase has a similar approach to the Analyse phase. The largest single part of the Improve phase is the use of Design of Experiments (DoE), which allows the testing of different combinations of factors to provide the optimal settings for the process. Here, the use of DoE's can be complex and to ensure that there is sufficient guidance, a 17 seventeen step instruction guide is provided as shown below in table 50.

Planning Phase	Execution Phase
1. Define the problem	9. Run the experiment, collect data
2. Set the objective	10. Analyze data
3. Select the response(s), Ys	11. Fit and finalize the model
4. Select the factors(s), Xs	12. Validate results
5. Select the factor levels	13. Evaluate conclusions
6. Select the DOE design	14. Revise SOPs
7. Determine sample size	15. Train affected workforce
8. Plan the experiment	16. Document results
	17. Consider next experiment

Table 50. Seventeen step instruction set for running a DoE

Source: Six Sigma Academy, 2005a [Module 403 – Intro to DoE]

The final phase of Six Sigma is the Control phase and here, the largest single tool is Statistical Process Control (SPC), which is a tool that takes the output of a process and uses the information to assess whether a process is performing consistently. When the process stops performing consistently, SPC can indicate to operators that there is an issue and this can lead to resolution of the issue. The use of SPC is again complex and the training material does provide a roadmap to ensure the correct application of the tool as shown below in figure 34.

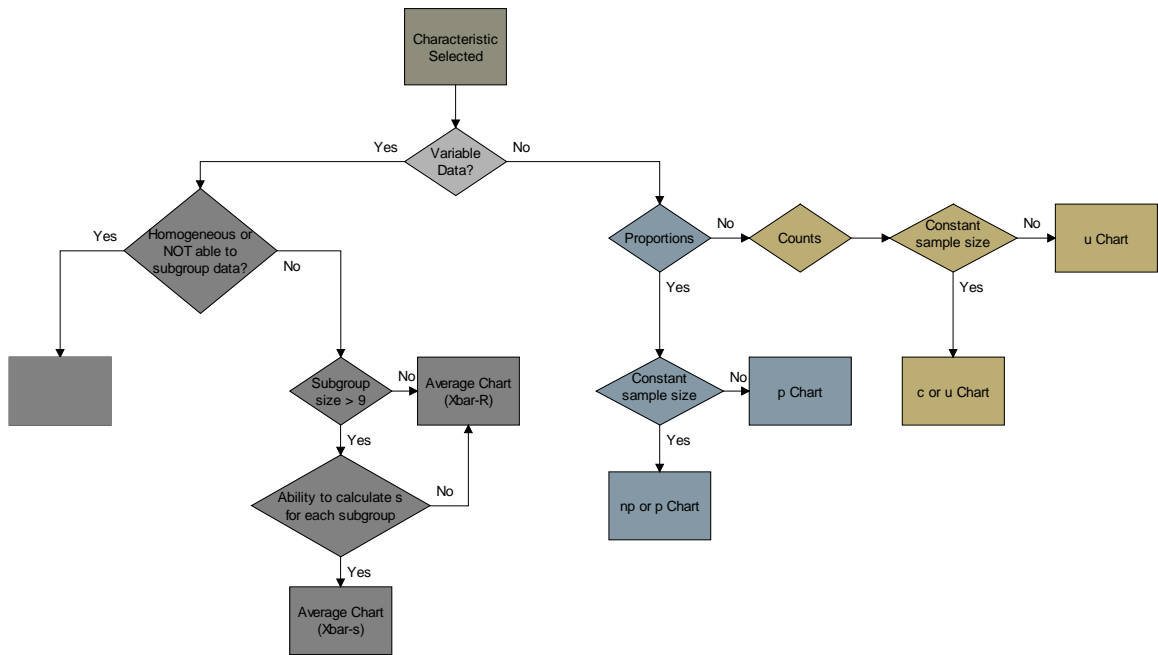


Figure 34. SPC roadmap

Source: Six Sigma Academy, 2005a [Module 513 – Intro to SPC]

Again the roadmap and training would suggest that the control phase is a level 2 process.

7.6 Conclusions

The critical issue then is that the Define, Measure, Analyse, Improve and Control phases of Six Sigma are level 2 processes, with most of the processes defined within the training material, but the Project selection and scoping phases are at level 1. Since all projects depend on the quality of the selected projects upon which to work, it is important that the selection and scoping processes are at least of the same level of maturity as the other phases. The processes for the project selection and scoping phase are weak and in some cases contradict the literature.

8. Data analysis summary, conclusions and recommendations

8.1 *Introduction*

At the start of the thesis, the desired outcomes of the project were presented. The desired outcomes were to answer the question, “Why is Six Sigma performance at Ford below that achieved in other companies and how can it be improved?”, specifically using the Six Sigma change management technique, and it was stated that the objective of the project was to develop recommendations that would improve the performance of Six Sigma at Ford Motor Company.

In addition to identifying a means of improving Six Sigma performance within the company, this thesis answers the following questions:

- What is achievable with Six Sigma?
- How can the reasons for poor performance be investigated?
- Why is Ford not achieving best in class performance with Six Sigma?
- How could the implementation of Six Sigma within Ford be improved?

In this section, the outcomes of the research will be assessed against these statements. The conclusions in turn gave rise to recommendations that will be detailed in addition to limitations of the research and further work

8.2 Data analysis summary

At the start of the research, the author had a preconception that the cause of poor performance and therefore the improvement laid within the political and cultural aspects of the deployment. As the research continued, these aspects were identified as being symptomatic of an environment in which processes are at a low level of maturity. The research identified that the processes for selection and scoping out Six Sigma projects are at the lowest level of process maturity.

The development of selection and scoping processes necessarily means that the solution is prescriptive so this requirement is fulfilled.

8.2.1 What is achievable with Six Sigma

To answer this question, it is necessary to refer back to the Six Sigma literature concerning Six Sigma process improvement both in chapter 2. When operating a Six Sigma project, the estimated benefit is a reduction in defects of between 50% and 90%, though 70% is the typical number.

Using the data from the start of the implementation up to 2006, the proportion of cancelled projects is 27%, which is estimated to cost \$7.534m per year in Europe alone. Achieving a 70% reduction in cancelled projects would bring these numbers to 8.1% of projects being cancelled, which in turn would cost approximately \$2.26m. This does assume that all other factors are held constant. This assessment of what can be achieved is based on determining and fixing the root cause. Here the corroboration of the interview data, the project data and the training material is presented as providing sufficient evidence that a \$2.26m saving is possible. Since the causes of poor performance have been identified, this saving should be realised if the recommended improvement actions are implemented. The next step is to understand how the causes of poor performance can be measured to facilitate further improvement.

8.2.2 How the reasons for poor performance can be measured

At the start of the research, survey data was used to understand the causes of poor performance. These data provided little information, and so interviews were

conducted to understand how the different stakeholders viewed Six Sigma. The interview data in conjunction with secondary data were enlightening and suggested other causes that had previously not been considered. When these data were used in conjunction with project data, and analysed using a process framework, the issues behind poor results with Six Sigma projects became clear.

Before it is possible to determine how reasons for poor performance can be identified, it is necessary to understand what is meant by poor performance. Once this had been defined, it was possible to then conduct research and then use this data to assist in the creation of a survey that allowed exploratory investigation. The survey data then lead to the identification of sources of poor project performance.

8.2.3 Why Ford Motor Company is not achieving performance seen in other companies with Six Sigma

There are two aspects to this question, the first being what is best in class performance and the second being why is Ford Motor Company not achieving this level of performance.

Best in class performance is a relative measure, is dependent upon the scope of who is included within the comparator group and their objectives. What makes it difficult is that ultimately, the desired performance will depend upon the goal of the process and how it is aligned to the strategy of the organisation. In this respect, the author would advocate a different goal, using absolute targets. This would reduce the level of confusion surrounding what is meant by the phrase Best in Class and can therefore inspire greater levels of performance.

As to why Ford Motor Company is not achieving greater levels of performance, this is due to the low level of process maturity that is existent within the phases of the Six Sigma process. Improving the maturity of the Six Sigma process is the responsibility of the Six Sigma deployment office. Once the process maturity is grown, then there is no reason why Six Sigma can not achieve much higher levels of performance.

8.2.4 How the implementation of Six Sigma within Ford could be improved

The answer here lies in growing the performance of the Six Sigma process to ensure that it is aligned with the goals of the organisation. The proposals given tackle the immediate issue, namely that there are not accepted processes for selecting and scoping projects.

To improve the performance of Six Sigma within Ford Motor Company, the author has challenged the current thinking regarding Six Sigma project selection. In section 7.5.1, the thoughts regarding project selection and scoping were discussed, namely that Pyzdek (2003 [190]) maintains that project selection is an art as well as a science, and Rath and Strong (2003 [351]) write that the initial project selection will never be perfect. This is strong evidence that Six Sigma project selection is an ad hoc process which suggests that it is a level 1 process according to Gardner's process maturity continuum. What makes this interesting is the same resistance observed in organisations resisting change are observed within the Six Sigma literature.

The key contribution is to use the Six Sigma methodology combined with an understanding of the concept of process maturity and develop tools that actually increase the process maturity of the project selection and scoping process of Six Sigma. This is exactly in line with what process improvement methodologies are trying to achieve. The tools then developed take Six Sigma to a level 2 process and this allows the process to be managed and improved further. Improving the maturity of Six Sigma has required a number of different factors to come together.

8.2.4.1 Identification of the root cause of poor performance

To make it possible to solve the issue of poor performance, it is necessary to understand what the issue is at a root cause level. This means that while inappropriate metrics, leadership support and resource availability are often cited as reasons for the poor performance of Six Sigma, these are symptomatic of the underlying cause, namely that the issue of selecting appropriate projects that are of a suitable scope is not done well, which in turn is caused by inadequacies in the process. To determine the root cause, it is necessary to adopt a structure within which to analyse the information, namely the EFQM and the process maturity model. Using this approach

with interviews made it possible to create distance between the researcher and the problem. This in turn dispelled many preconceived ideas and allowed a more objective investigation of the issue.

8.2.4.2 Solving the issue of poor performance

Having identified the cause of poor performance, it was necessary to then analyse what would be required to raise the process performance from level 1 to level 2 and develop the appropriate process steps. To achieve this, it was necessary to decompose the idea behind what Six Sigma could achieve to provide a procedure for analysing projects using existing process performance data. The use of these tools allows the objective identification of the highest priority issue.

In addition to identifying processes to select and scope projects, it is desirable to provide other tools that allow a further growth in maturity of the process. Here the control plan, FMEA and reaction plan are created specifically for the Six Sigma process. This is new and while the application of an FMEA to manage risk is not a new concept, the concept of using an FMEA on a Six Sigma project is new. Furthermore, while the last part of the Six Sigma training is the Control phase, there is nothing in the literature that facilitates the management of Six Sigma using cycle time and yield, since these metrics are only used on processes and up until now, the work conducted using Six Sigma are viewed as projects which are seen as unique and individual pieces of work as is described in chapter 7.2.1. Through increasing the process maturity of Six Sigma, it is now possible to view Six Sigma as the application of a process and therefore the idea of yield and cycle time can now be applied.

One further question that should be considered is whether any of the outcomes of this research would benefit other companies or users of Six Sigma. It appears from the literature that project selection and scoping remain the largest undefined areas within Six Sigma and therefore the application of the process maturity model to assess the performance and drive improvement are relevant.

It is believed that unless other companies have developed systematic and rigorous processes for selecting projects, then the approach here will produce dramatic improvements to their project yield performance. Even where companies have

rigorous processes for selecting and scoping projects, the approach taken here of identifying the process maturity of different steps through the use of the techniques here will allow the performance of Six Sigma to be improved.

Henderson and Evans (2000) note that Six Sigma has been described as the “Rolls Royce” of quality improvement systems. However, in line with Six Sigma principles, even Six Sigma can be improved. Following this philosophy, adaptations to the system are not indicative of a system failure, but instead demonstrate that the methodology is improving and therefore working.

8.2.5 Measuring project performance

When Six Sigma is viewed as a set of processes, the performance of Six Sigma can be measured in terms of Six Sigma metrics. This in turn allows the performance of Six Sigma to be managed with a view to improving performance of the Six Sigma processes themselves.

8.2.5.1 Revised Six Sigma metrics

In chapter 2, the issue of metrics for driving Six Sigma performance was discussed. It seems that while much is written about the use of metrics and the importance of aligning metrics with the strategy of the organisation, Six Sigma as a process is not subject to process metrics. It is instead recommended that the number of projects completed and resulting savings are measured.

Joiner (1994) writes that there are measures of performance including customer satisfaction, total cycle time and first time through yield. Focusing on yield and cycle time will necessarily ensure that the Six Sigma team improve their performance and demonstrate to others that everyone needs to improve. Using process metrics is an excellent way of communicating that Six Sigma is a process and as such can be improved using the same Six Sigma tools that can be used on other processes within the business. Using process metrics also means that the results of decisions regarding Six Sigma can be managed and this in turn will drive a further growth in the process maturity of Six Sigma. As Harry (2000) writes, you can not manage what you do not measure and therefore if Six Sigma is to be managed as a process, then it is critical that it is measured as a process.

8.3 Recommendations

In chapter 7, it was identified that the greatest factors responsible for reduced Six Sigma performance at Ford Motor Company are the project selection and scoping processes, and the fact that they are at a level of maturity of 1 as defined by Gardner [2001], which is low. Interestingly, there are some aspects of the level 2 process maturity such as output measures identified, but there is not a feedback system and there is not a procedure.

The purpose of the project selection and scoping phases is to ensure that each project is linked to the performance of the organisation as discussed in chapter 2.

In addition to making sure that the project is aligned to the performance of the organisation, there are some other considerations. In chapter 2, it was identified that leadership support is critical to the success of an initiative such as Six Sigma. At Ford Motor Company, this support was secured using performance cells whereby the head of the organisation was responsible for project delivery. It is suggested that if the highest priority projects for the organisation are selected, then the leadership support will be automatically given to the projects and this will largely negate the need for using additional management techniques to drive this. Within the literature, a further potential issue lay with the risk of the hierarchical nature of the organisation masking the way in which work is done. Here, if the idea of process maturity is used, then the process approach will ensure that the way work is carried out is not hampered by organisational boundaries.

The interview data analysed in chapter 5 suggested that there were issues with securing the assistance of a team on a project. Here it is proposed that if the highest priority projects are selected, then this will warrant the appropriate level of resource required to complete the task.

It seems then that in addition to resolving the largest issues associated with Six Sigma, the development of appropriate methods for selecting and scoping projects would eliminate a large number of the other issues observed within the deployment of Six Sigma both at Ford Motor Company and identified within the literature.

This section describes the actions that will be taken to improve the causes of poor performance identified from this research, proposes recommendations for further improvements and then states areas in which further research would be beneficial. The areas that will be covered include the updated process documentation, process Failure Mode and Effects Analysis (FMEA), process control chart, selection process and project scoping calculations. Additionally, this section defines what will be required to increase the maturity of the project selection and scoping process using the classification defined by Gardner (2001).

8.3.1 How to grow the process maturity

Currently the scoping and selection processes do have output requirements defined. The method of selecting a project is ad hoc, in that there are a number of different ways in which people receive a project as described in chapter 5. Additionally, the performance of the process relative to requirements is unknown, since the results are unmanaged. Hammer and Champy (1993 [26]) write that successful companies know how to improve and this means knowing how their work gets done.

To achieve level 2 maturity, it is necessary to have a course grained procedure detailing what is required from the process. It is also necessary to ensure that there are feedback systems in place and that customer requirements are effectively translated into output requirements. Additionally, at this level, results are managed by post-process inspection.

A level 3 process is characterised by fine grained work procedures with feedback systems that are linked to corrective actions. The output effectiveness of a level 3 system is used to indicate repeatability and internal effectiveness measures are defined.

To improve the situation regarding project selection and scoping it is necessary to grow the maturity to at least level 2. Where possible, the aim should be to create process steps that would satisfy the requirements of level 3, however, the Software Engineering Institute (SEI) warn about the dangers of attempting to jump maturity levels (Carnegie Mellon University, 1995 [20]). Where information is available to

improve the maturity, this will be documented here. It should be noted that documentation to achieve level 3 maturity will not be introduced until the maturity is stabilised at level 2. Hammer and Champy believe that it is not good practice to improve parts of a process, but rather tackle the whole process at one time (Hammer and Champy, 1993 [27]). In this case the author believes that, since one part of the process is deficient, it is possible to focus the improvements to the problem area.

8.3.2 Process documentation

To allow the process to be managed effectively, it is necessary to document the process describing what the process is and how it works. One of the first steps in documenting a process is to create a process map.

8.3.2.1 Process mapping

Process mapping is a tool that allows a process to be represented in a graphical form (Pyzdek, 2003 [254]). The purpose of this section is to describe the current process and highlight areas that require improving. Eckes (2001 [66]) believes that there are four different versions of a process: what the team thinks it is, what it really is, what it should be and what it could be. The “should be” and “could be” are used while the process improvements are taking place. Here the current and improved map will be shown since these represent the start and end points of the improvement.

8.3.2.2 Current process map

For the current process map, it is important that the process map is representative of the true process (Eckes, 2001 [66]). As far as the current process is concerned, a process for project selection and scoping at the working level does not exist, since there is not an agreed process.

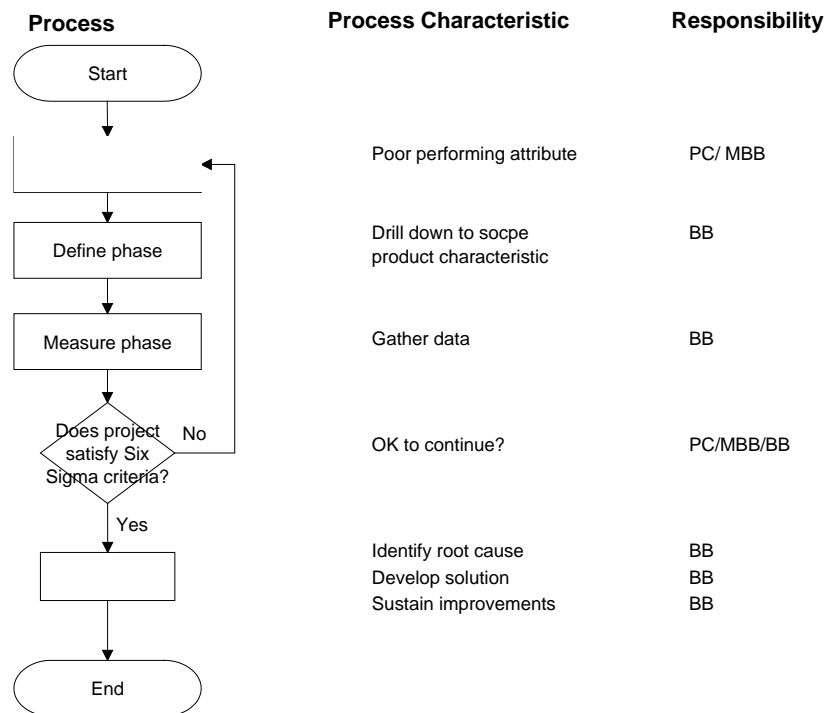


Figure 35. Current process map of the Six Sigma process

As shown on the process map above, projects are selected based on the opinion of the Project Champion and the project starts on this basis. If the project later does not appear to be valid, then it must be cancelled and another one started. This process will ultimately lead to a high level of waste since a great deal of work must be completed before it is possible to comment on whether or not the project will be successful.

8.3.2.3 Revised process map

The revised process map reflects the “should be” state which is what the project team believe can be achieved at the end of the improve phase (Eckes, 2001 [66]). Once the process has been developed, the revised process map will describe the improved process. As a minimum, this should be consistent with the definition of a level 2 process, in that it should be documented with a course grained map. If more information is available then this too will be presented, however this will not be used in the Six Sigma deployment until the process maturity has stabilised at level 2 for the reasons described above. To manage a process effectively it is necessary to express the customer requirements in terms of output requirements including the desire to complete projects in less than 128 days, which was the original target of the Ford Motor Company Six Sigma office.

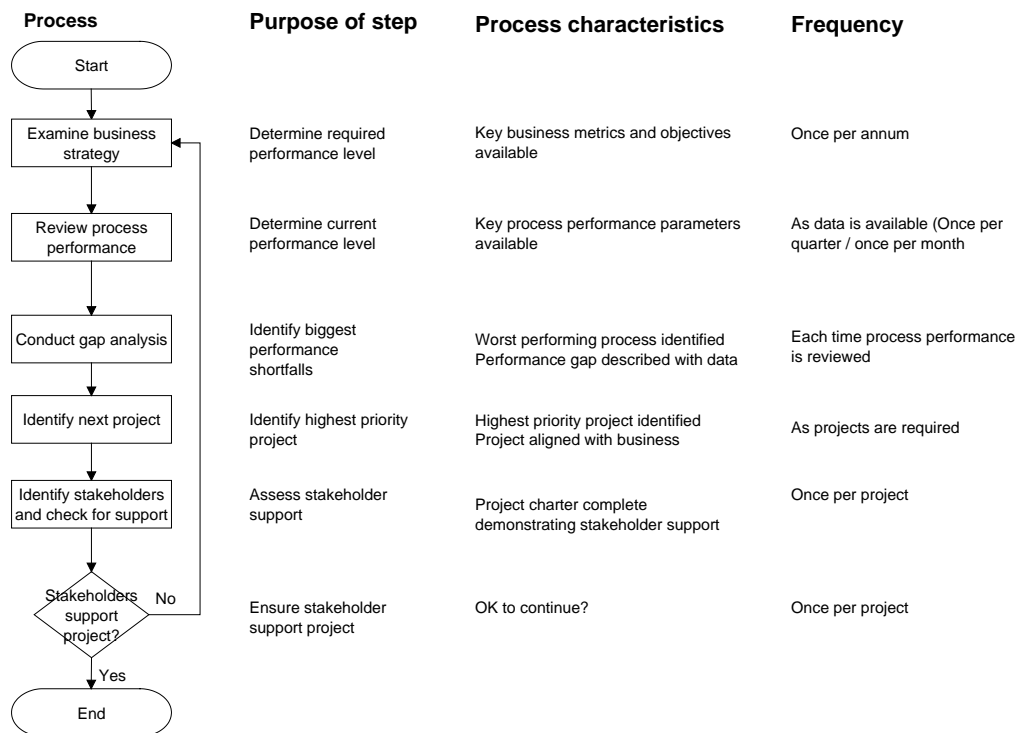


Figure 36. Improved process map for selecting and scoping a Six Sigma project

In the original process, the project was selected by the project champion. In the improved process, the project is developed following a review of the strategy and current performance before checking that the stakeholders would support the project. Additionally, the process ensures that at each step it is possible to trace back the development of the project to the business strategy. An added feature is that the stakeholders are involved before further work is carried out and so even if the project selected is not suitable it is cancelled with a lower level of effort expended.

8.3.3 Project benefits

As discussed in chapter 2, the standard metric for a Six Sigma project is the sigma value and Defect Per Million Opportunities (DPMO). The Six Sigma academy (2005a) write that a Six Sigma project will typically yield a reduction in defects of approximately 70%, and Rath and Strong (2003 [196]) believe that improvement ranges between 50% and 90% reduction in defects. Harry (1998) writes that the average company has a level of process performance at between 3 and 4 sigma. This section will present a means of assessing the potential benefit of a Six Sigma project. For the purpose of describing the calculation, the assumption will be made that the initial process performance is 3.5 sigma, although, once the data are available, actual

values can be used. With this information, it is possible to estimate the benefits of running a Six Sigma project in a particular area.

8.3.3.1 Statistical analysis of metrics

Here the anatomy of a project is shown using the normal distribution with average (\bar{X}), a Lower Specification Limit (LSL) and Upper Specification Limit (USL). In terms of assessing the projects, the simplest case to assess is that where there are two specification limits and the process must operate between the two limits as shown below.

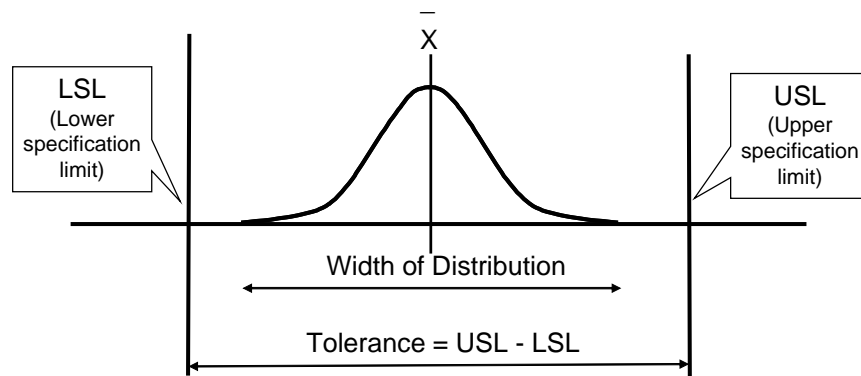


Figure 37. Graph showing process capability with regard to specification limits

In this situation a sigma value indicates the number of standard deviations between the average value, \bar{X} and the nearest specification limit. This is made simpler again, when the process is centred and so this distance is the same.

As a process that is operating at 3.5 sigma, the DPMO will be 460 Parts Per Million (ppm), because in this situation, the defects will be symmetrical on each side of the specification limits. Taking the statements that a Six Sigma improvement project will typically bring about a 70% reduction in defects means that the final DPMO will be 138 ppm, which is 3.8 sigma. The width between the specification limits is the same, so therefore the size of the standard deviation must have reduced.

The improvement can therefore be calculated as $(3.8-3.5)/(3.5)*100\% = 8.57\%$

What has actually been achieved is an 8.57% reduction in the standard deviation. Using this information, it is possible to estimate the scale of improvement that can reasonably be expected when the Six Sigma process is applied to a variability issue.

8.3.4 Project selection

In the last section, the process for quantifying the improvement of a project was described. What this means is that if there is historical data describing the performance of a process, then it is possible to calculate the potential opportunities of applying Six Sigma to that process.

To allow an objective selection process for projects, it is necessary to use metrics within the organisation, which at a process level represent Key Performance Indicators (KPIs). It should be noted that it is possible to estimate the cost impact of failing to achieve each KPI, but for the purpose of identifying the correct process level, only the KPIs should be used. The use of such metrics ensures that there are data available and that the projects are aligned to the organisation. Using the above calculations, it is possible to estimate the relative benefit of applying the Six Sigma process to each of the possible processes displaying excessive variability within the organisation, using historical data for each process and a simple spreadsheet.

If the cost of failing to achieve the metric is known, then this in turn will allow each project benefit to be quantified in terms of cost and therefore this will allow comparison between KPIs as well as within KPIs.

To illustrate this principle, the example of a factory will be used. If a factory has 10 production lines operating with different waste levels and different Operating Equipment Efficiencies (OEE), then the data can be gathered for waste and OEE. In this situation there are 20 possible projects. The benefit of running each project can then be assessed for the two metrics. Ideally, the cost benefit of each project is also assessed. At the end of the analysis, it is possible to rank the projects based on the opportunity or cost benefit of each project.

Pyzdek (2003) writes that for the purpose of choosing an appropriate project, it is necessary to develop a project selection criteria matrix, however it is argued that through the application of Six Sigma tools to the Six Sigma process, it is possible to prioritise projects purely on the estimated benefit of the project rather than a selection criteria matrix. Using the concept of process maturity, the idea is that for an immature

process, projects are run on an ad hoc basis, but as maturity is increased, the process metrics become more clearly defined. Therefore, with increasing process maturity, the variability of the Six Sigma process will reduce and ultimately can be assumed to have the same nominal cycle time. With this assumption, it becomes possible to choose a project based only on the level of the opportunity that will be delivered without having to assess project complexity as is done by Pyzdek (2003 [190]). If this is completed for each of the critical to criteria or Key Performance Indicators (KPIs); safety, quality, cost, delivery, morale, environment, then it makes it possible to compare project benefits for a particular KPI using only the improvement in a metric. If the cost of failing to achieve in each of the major performance areas is known, then it is also possible to compare these metrics against each other and so identify which of the 20 OEE and waste projects considered here would be the highest priority.

With a process in place for selecting projects, it is necessary to document the steps within the project selection and scoping process.

8.3.5 Process control plan

Within the Six Sigma process improvement training, part of the Control phase requires that the process is recorded and controlled. There are a number of different tools available to record, store and communicate output requirements, however perhaps the most popular method of doing this is via a control plan (Six Sigma Academy, 2005f). Pyzdek (2003 [652]) advocates that a process control plan should be developed for each critical process. The fundamental idea behind a control plan is that for each process step, the output requirements are described along with limits that determine whether these are satisfied or not. With the process documented, developing the control plan is possible as shown in Appendix XVIII. The control plan shown can be used as a template for the rest of the process and this is currently being developed with the assistance of other stakeholder groups as possible failures arise.

Once a control plan is developed, it is possible to extend the application of the control plan to include a feedback system which would satisfy the requirements of a level 2 process. To grow the maturity to level 3, it is necessary to develop a reaction plan which would allow outputs to drive correction actions. Before this can be done, it is necessary to anticipate the possible risks to the process.

8.3.6 Process FMEA

Within Six Sigma, an extremely popular tool for assessing and managing risks is the Failure Mode and Effects Analysis (FMEA) (Pyzdek, 2003 [597]). The FMEA has a variety of applications including, design, concept, process and project (Dale, 1999 [353]). Here, a process FMEA will be used, since it is applied to a process.

Having determined possible risks to the process, the next step is to develop pre-determined responses to risks that may be encountered as shown in the Appendix. As time continues and experience is gained, it is possible to use the FMEA to manage the risks throughout the process and extend this to other areas of the process.

8.3.7 Process reaction plan

The reaction plan is an extension of the process control plan that uses information developed in the FMEA to anticipate possible problems that may be encountered. The reaction plan, also known as the response plan allows corrective action to be taken based upon pre-determined decisions (Pande et al., 2002 [363]). The reaction plan ensures that the correct action can be taken quickly since it allows the responses to be managed. The reaction plan is currently shown on the control plan, since this is a convenient place to store the information and reduces the level of documentation required.

8.4 Contribution to knowledge

This thesis uses the Six Sigma process and principles to identify issues with the performance of Six Sigma itself. It appears that the greatest issues with the Six Sigma approach are:

Projects are viewed as individual projects rather than subjects of a process

Extensive use of ad hoc processes and therefore a low level of process maturity

Through the use of the Six Sigma problem solving process, the shortfalls in the Six Sigma process itself were identified and actions were taken to improve the process maturity of the DMAIC process. The principle results of these changes are that Six Sigma projects are managed with a standard project management template, the project yield and cycle times are managed and the projects are selected according to benefit. This ensures that the effort is applied to managing the inputs of the Six Sigma project process and is therefore consistent with the Six Sigma philosophy.

In particular, this thesis challenges the ideas that the project selection and scoping processes are an art and introduces the notion that process maturity should be used as an indicator of the readiness of an organisation to adopt a particular quality tool.

8.5 *Limitations of the research*

This section details limitations identified with the research. These will be dealt with under the headings, scope, resources, results and applicability of the research.

8.5.1 Scope

The initial scope of the project was to manage the political and cultural aspects of change. This was a considerable task and one that turned out not to be necessary to the completion of the aims of the thesis. Subsequently, the scope of the project was revised to improving the performance of Six Sigma.

8.5.2 Resource

All interviews and transcribing was done by the author. This put a natural limit on resources and meant that the number of interviews was limited. Additionally, Ford Motor Company is a global company and so it would have been interesting to gain additional information from different countries to assess the homogeneity of the culture and application of the Six Sigma processes. It was only possible to interview people from the UK and this could have limited the applicability of the research in the wider company context. With the approach taken and using triangulation to assess the validity of the results and conclusions, it appears that this did not pose a limit to the applicability of the project since it appears from the literature that the root cause is a general issue within Six Sigma. In future research, the author would attempt to plan the research to incorporate all sources of variation from the start.

The author is a novice interviewer and is a Black Belt within Ford Motor Company in the UK. This means that there is the potential for bias in both asking the questions and interpreting the responses. While every effort was made to look at the results objectively, there are risks since the author may have been too close to look at the data objectively. Where there are issues with objectivity, these may appear to others as a lack of willingness to seek corroboration or contradiction. In developing the questions and in following up the questions during the interviews, this closeness to the issue may manifest itself as skewing the questions or in asking leading questions. In this the author did not seek to skew the results, and through triangulation, it appears that the

answers obtained are valid. In future, the author would seek to work with an additional researcher who has no ties with the subject area to minimise the risk of bias.

8.5.3 Results

Here the results were obtained using a single case study and were based on a considerable amount of data from Ford Motor Company. Only using one case for the research does limit the means for assessing external validity of the results, and this is a potential limitation.

The fact that the literature from other Six Sigma sources identified the same issues meant that the validity of the conclusions could be checked to a limited extent and in this case, it appears that the results are not unique to Ford Motor Company.

8.5.4 Applicability of the research

It seems that in the case of this research, the root cause of poor Six Sigma performance is the low maturity of the processes to select and scope projects and in this area, there is a great deal of corroborating evidence. The question that remains is whether the recommendations could be applied to other organisations or Six Sigma universally. In this research, it is not possible to answer this question, since this was not considered within the scope of the project. This does represent a limitation of the work, however it is possible that this creates an opportunity for further work in which the applicability of the solutions can be tested.

8.6 Further work

This research has identified that the low level of process maturity within the Six Sigma process is a key reason for the variable performance of the deployment in different areas and this thesis has taken the project selection and scoping processes to those of level 2 processes. The foundations are set to grow the maturity of the whole Six Sigma process further and use Six Sigma as a case to demonstrate what can be achieved by growing process maturity.

To progress this work, there are opportunities to begin collecting data surrounding Six Sigma projects and using these to manage the process. The intention here is that Six Sigma uses data from a process to drive further improvements in that process. Six Sigma itself has a large amount of data available, but as yet, this data has not been used to drive further improvements to Six Sigma. This project has begun to do this, but there still remains a great deal of opportunity to apply Six Sigma principles to the Six Sigma methodology.

There are further opportunities to continue work on the use of process maturity as an indicator of the likely success of a quality initiative. On one level, it appears that there are a large number of choices to be made when selecting a quality initiative. It is proposed that if the current level of process maturity is known, then the appropriate tool can be selected and if this work were done, then it could lead to an increase in the success rates of quality initiative deployments.

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Appendix I – BB Survey result



Black Belt Survey Summary Report April, 2001

Survey Process

An evaluative Survey was distributed to all Company Black Belt employees via the Ford Web Survey System from April 09 - 19, 2001. The purpose of the survey was to determine, at a macro level, the support the Black Belts are receiving in implementing their projects. The feedback from the survey then allowed senior management to begin formulating corrective actions at the Global Leadership Meeting.

Demographics of Respondents

- 1423 Black Belt employees took the survey (70% response rate).
- 57% of the respondents were from North America, 34% were from Europe, 5% from Asia Pacific and 4% from South America.
- Of the 482 employees from Europe, 58% were part of Ford Blue Oval, 24% from PAG-Volvo, 16% from PAG-Jaguar and 2% from PAG Aston Martin and Land Rover.

Summary of the Data at Corporate Level

Six Sigma Projects

- Nearly half of the respondents believe that a reasonable time to complete a Six Sigma project is 6 months or longer.

Management Support

Strength

- More than 75% of the respondents report their direct manager/supervisor and project champion support them on their role as a Black Belt.
- Two thirds of Black Belt respondents say they receive support from Executives in their role (66%).

Weakness

- Almost half of the respondents indicated that mid-level management does not support them in their role as a Black Belt (46%).

CBG/GEC

Strength

- 70% of Black Belt stated that their CBG/GEC leader is a strong visible supporter of Six Sigma.
- Almost two thirds of respondents say that they are aware of their CBG/GEC leader's specific expectations regarding Six Sigma (63%).

Weakness

- 75% of respondents reported that their CBG/GEC does not have a clear strategy for utilizing Green Belts to significantly improve customer satisfaction and quality.

Time

Weakness

- 44% of the respondents report that they are working less than 40 hours a week on Six Sigma.

Value of Assignment

Weakness

- 60% of the respondents would recommend becoming a Black Belt to their colleagues at Ford Motor Company.
- 57% of respondents believe being a Black Belt will positively enhance their career potential at Ford Motor Company.

Appendix II – GB Rollout Strategy

Ford Context

Consumer-Driven 6-Sigma Rollout Strategy

- ◆ Consumer Driven 6-Sigma tools will be used to attain World Class performance in both short-term and long-term customer satisfaction.
- ◆ Progress toward these performance goals will be made as Green Belts and Black Belts apply 6-Sigma tools to correct issues that impact customer satisfaction.

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Rollout Strategy

The strategy for rolling out Consumer Driven 6-Sigma is straightforward: Train Green Belts and Black Belts in application of 6-Sigma tools and have them apply those skills to issues impacting customer satisfaction.

Appendix III – GB Role

Ford Context

Role of Green Belts

- ◆ Participate in larger Black Belt DMAIC or DFSS projects
- ◆ Lead Green Belt level 6-Sigma Projects
- ◆ Apply 6-Sigma problem-solving tools and principles to daily work

Specific details regarding the deployment and role of Green Belts are determined by each organization.

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Role of Green Belt

Green Belts assist Black Belts with expediting and completing 6-Sigma projects. They may take the lead in small projects of their own. They should also look for ways to apply 6-Sigma problem-solving methods within their work area.

Appendix IV – List of interview questions round 1

General

Q How is Six Sigma going generally? What are the biggest operational issues with Six Sigma at the moment?

Strategy

Q Is there a clear strategy to use Six Sigma for customer satisfaction and quality improvement?

Q To what extent is the corporate message regarding Six Sigma communicated to you? Q How was the strategy developed?

Q To what extent in your opinion has Six Sigma been incorporated as part of the everyday business?

Q How well is it aligned to the needs of the organisation?

Q How well is it aligned to the needs of the department?

Q How is Six Sigma performing against other problem solving techniques? Eg. 8D, find and fix. TVM

Q If TVM is required to address the cost problem rather than customer satisfaction, do you think that Six Sigma has got the right emphasis at the moment, or should the strategy be changed?

Q What is the plan for using Green Belts in the future?

Q What are the targets that you have to work to? How have these targets been developed?

People

Q Why did you become a BB?

Q How do you feel about being a BB?

Q Are you certified?

Q How do you feel about not being certified?

Q How does the organisation get feedback concerning your feelings on being a BB?

Q How successful are performance reviews with BBs in their opinion?

Q Does the annual appraisal incorporate Six Sigma performance?

Q Are you able to work 100% on projects?

- Q To what extent have you used a team
- Q Why haven't you used a team?
- Q Have you had any feedback from Green belts?
- Q Do you think there's a difference between the expectation of people going into GB training and what they actually receive in general terms?
- Q Are Green belts trying to get onto projects?
- Q Is there any focus on satisfying the BB/PCs/MBBs organisation?
- Q How would you rate the training you have received for your role in Six Sigma?
- Q Do you assist in setting your objectives?
- Q Do you believe that being a BB will positively enhance your career potential?
- Q Would you recommend becoming a BB to your colleagues?
- Q Do you believe people are rewarded for doing a good job?
- Q How do you feel about the recognition you are receiving for your work?

Leadership

- Q Is your CBG/GEC leader a strong visible supporter of Six Sigma?
- Q Are you aware of your CBG/GEC leader's specific expectations regarding Six Sigma?
- Q How well is the role that Six Sigma plays in the company's revitalisation plan communicated to you?
- Q How well informed are you about Six Sigma through internal communication?
- Q Do you think the champions have embraced Six Sigma?
- Q Are you aware of the company's values regarding quality?
- Q Do the champions ask for BB/MBB support?
- Q How appropriate do you believe the management style is for Six Sigma?
- Q How supportive is your management of Six Sigma? Do different levels of management show different levels of support?

Process

- Q Are the projects appropriate and Six Sigma projects?
- Q How good are the metrics in your opinion?
- Q Do you communicate your work to the local area?
- Q Has your area implemented a performance cell setup?
- Q What process do you use in your area to scope out projects?

Q Do you think your project champion is aware of the resources required to complete the project?

Q Do you have an issue in getting priority?

Q Is there a difference between projects run prior to certification and projects run after certification?

Q How would you rate the level of bureaucracy involved in working through projects?

Q Is there a process for learning from projects?

Q Would you describe the process as slick or bureaucratic?

Q What do you believe would be a good target for project timing?

Background

Q Background information

- How long as BB?

- How long at company?

Q Can you summarise your experiences?

Q Did you have any negative experiences?

Q What would you change about Six Sigma?

Appendix V – List of interview questions round 2

Context statement

This project is concerned with the deployment of Six Sigma within the Product Development area of Ford UK in an engineering environment.

Please answer the questions from your perspective. All information will be treated as confidential and you will be given an opportunity to read the project with quotes to ensure that you are satisfied that your identity will not be revealed from anything written down.

If there is anything you are not happy discussing, please let me know.

I will be stopping after 1 hour to change the tape in the machine.

General

Q How do you think Six Sigma is going generally and what are the biggest operational issues with Six Sigma at the moment?

Q What would you change about Six Sigma?

Strategy

Q What are the main areas that Six Sigma is aiming to improve?

Q What is the strategy to achieve that?

Q How would you rate the level of communication that you receive about the Six Sigma strategy?

Q Do you agree with the current Six Sigma strategy and if not, what would you change about it?

Q In your opinion, how far has Six Sigma been incorporated in everyday business?

Q How well is it aligned to the needs of the organisation?

Q How well is it aligned to the needs of the department?

Q Do you believe that Six Sigma is competing for resource with other initiatives?

- Q How is Six Sigma performing against other problem solving techniques? Eg. 8D, find and fix. TVM
- Q What is the plan for using Green Belts in the future?
- Q What are the targets that you have to work to?
- Q Do the targets help?
- Q Would you change the targets?

People

- Q Why did you become a BB?
- Q How do you feel about being a BB?
- Q Are you certified?
- Q How do you feel about not being certified?
- Q Do you feel about being the only group in Ford to get certified in your current job role?
- Q Has an area been identified for you when you finish your assignment?
- Q Would you recommend being a BB to a colleague?
- Q How does the organisation get feedback concerning your feelings on being a BB?
- Q How successful has the performance review process been throughout your time as a BB?
- Q Does the annual appraisal incorporate Six Sigma performance?
- Q Are you able to work 100% on projects?
- Q How many people generally work on your projects
- Q Do you feel that you could achieve more with a bigger team?
- Q Was it difficult to put a team together?
- Q Have you used Green belts to achieve project goals?
- Q Have you found Green belts useful?
- Q Are Green belts trying to get onto projects?
- Q Is your PC and MBB happy with Six Sigma?
- Q How easy do you find it to report issues to your MBB and PC?
- Q How would you rate the training you have received for your role in Six Sigma?
- Q Do you assist in setting your objectives?
- Q Have your projects got clear targets?
- Q Do you believe that being a BB will positively enhance your career potential?

- Q Do you believe people are rewarded for doing a good job?
- Q How do you feel about the recognition you are receiving for your work?

Leadership

- Q Who do you report to?
- Q Is it accepted that you work for this person?
- Q Is your supervisor a strong visible supporter of Six Sigma?
- Q Is your manager a strong visible supporter of Six Sigma?
- Q Are you aware of your CBG/GEC leader's specific expectations regarding Six Sigma?
- Q How well is the role that Six Sigma plays in the company's revitalisation plan communicated to you?
- Q How well informed are you about Six Sigma through internal communication?
- Q How would you rate the volume of information about Six Sigma?
- Q How would you like to be informed about Six Sigma?
- Q Do you think your management have embraced Six Sigma?
- Q Are you aware of the company's values regarding quality?
- Q Do leaders use Six Sigma as the tool of choice for solving problems?
- Q How appropriate do you believe the management style is for Six Sigma?
- Q How supportive is your management of Six Sigma? Do different levels of management show different levels of support?

Process

- Q Are the projects appropriate and Six Sigma projects?
- Q How good are the metrics in your opinion?
- Q Have you ever had a project that was open ended?
- Q How do you communicate your work to the local area?
- Q Has your area implemented a performance cell setup?
- Q What process do you use in your area to scope out projects?
- Q How effective is the project scoping process?
- Q Do you have an issue in getting priority?
- Q How would you rate the urgency of the projects that you are given?
- Q Is there a difference between projects run prior to certification and projects run after certification?

Q How would you rate the level of bureaucracy involved in working through projects?

Q Is there a process for learning from projects?

Q What do you believe would be a good target for project timing?

Background

Q Background information

- How long as BB?
- How long at company?

Q Can you summarise your experiences?

Q Did you have any negative experiences?

Q What would you change about Six Sigma?

Appendix VI – Overview of Consumer Driven Six Sigma

What is Consumer Driven 6-Sigma?

Ford has named its deployment of Six Sigma “Consumer Driven 6-Sigma,” emphasizing that projects begin with the customer in mind. Ford is using Consumer Driven 6-Sigma to significantly improve customer satisfaction and shareholder value by reducing variability in every aspect of the business, and so far is the only automotive company to have deployed Six Sigma. (<http://www.6-sigma.ford.com/corporate/overview.html>. Accessed 09/08/2006)

Appendix VII – Ford Global versus Ford Europe

Table 51. Project yield performance data of Ford Global versus Ford Europe

	Passes		Observed		Total	
	Counts	Percent	Counts	Percent	Counts	Percent
Ford Global	12696	66	6419	34	19115	100
Ford Europe	5923	70	2591	30	8514	100
Grand Total	18694	67	9025	33	27719	100

Test and CI for Two Proportions

Sample	X	N	Sample p
1	12696	19115	0.664190
2	5923	8514	0.695678

Difference = p (1) - p (2)

Estimate for difference: -0.0314873

95% CI for difference: (-0.0433340, -0.0196405)

Test for difference = 0 (vs not = 0): Z = -5.21 P-Value = 0.000

Figure 38. Minitab output for the test for two proportions

Appendix VIII - Year of project start

Table 52. Project yield performance data by year of start

Yield by year of project start	Passes		Failures		Total
	Observed		Observed		Observed
	Counts	Row %	Counts	Row %	Counts
2000	221	87	33	13	254
2001	456	77	140	23	596
2002	404	66	209	34	613
2003	556	72	217	28	773
2004	663	68	316	32	979
2005	681	76	214	24	895
Grand Total	3276	74	1153	26	4429

Table 53. Analysis of project yield performance data by year of start

Chi-square =	68.71
d.f. =	5.00
P-value =	0.00

Appendix IX - Consumer Business Group

Table 54. Project yield data by Consumer Business Group

Yield by CBG	Passes		Failures		Total	
	Counts	Row %	Counts	Row %	Counts	Percent
Ford of Europe	2772	74	963	26	3735	100
Powertrain Operations	261	74	93	26	354	100
Ford Customer Service Division (FCSD)	159	71	65	29	224	100
Ford Financial	74	76	24	24	98	100
Ford of Europe-PD	6	67	3	33	9	100
Grand Total	3276	74	1153	26	4429	100

Table 55. Analysis of project yield data by Consumer Business Group

Chi-square	1.56
df =	4
p-value =	0.82

Appendix X - Project alignment

Table 56. Project yield performance data by project category

PROJECT ALIGNMENT	Pass		Fail		Total
	Counts	Row %	Counts	Row %	Counts
High Mileage (3 YIS)	12	92	1	8	13
DISTRIBUTION - Dealer Network Optimization	19	86	3	14	22
DISTRIBUTION - Customer Relationship Management	28	82	6	18	34
Base Initiative Other	1470	82	317	18	1787
Vehicle Line - Top 25	105	82	23	18	128
None	285	81	65	19	350
Warranty	21	81	5	19	26
COST - GAP/Commonality	159	81	38	19	197
COST - Asset Intensity and Spending	398	79	108	21	506
DISTRIBUTION - Order Fulfillment	33	79	9	21	42
PRODUCT - Product Strategy & Cycle Plan	60	77	18	23	78
PRODUCT - Brand Enhancement	51	74	18	26	69
Mega Project	38	72	15	28	53
PRODUCT - Revenue Management	22	71	9	29	31
Alignment to Business Objectives	75	68	36	32	111
Single Agenda for Quality (SAQ)	8	67	4	33	12
DISTRIBUTION - Brand & Product Fulfillment	18	62	11	38	29
Affinity /Cross-Carline	9	60	6	40	15
Grand total	2811	63	692	16	4429

Table 57. Analysis of project yield performance by project alignment category

Chi-square	240.20
D.f.	17
P-value	0.00

Table 58. Ranked yield performance by project alignment

PROJECT ALIGNMENT	Total Counts	Yield %
Base Initiative Other	1787	82
COST - Asset Intensity and Spending	506	79
None	350	81
COST - GAP/Commonality	197	81
Vehicle Line - Top 25	128	82
Alignment to Business Objectives	111	68
PRODUCT - Product Strategy & Cycle Plan	78	77
PRODUCT - Brand Enhancement	69	74
Mega Project	53	72
DISTRIBUTION - Order Fulfillment	42	79
DISTRIBUTION - Customer Relationship Management	34	82
PRODUCT - Revenue Management	31	71
DISTRIBUTION - Brand & Product Fulfillment	29	62
Warranty	26	81
DISTRIBUTION - Dealer Network Optimization	22	86
Affinity /Cross-Carline	15	60
High Mileage (3 YIS)	13	92
Single Agenda for Quality (SAQ)	12	67
Grand total	4429	63

Appendix XI - Business unit

Table 59. Project yield performance data by business unit

BUSINESS UNIT	Pass		Fail		Total
	Observed	Row %	Observed	Row %	Observed
PD-GBD-R&A-Forschungszentrum Aachen	9	100	0	0	9
Ford Financial Other - FMC Proj	6	100	0	0	6
FCSD European Business Development	26	90	3	10	29
zPTO Manual Transmission Operations GETRAG	16	89	2	11	18
PTO In-line Gasoline Engines Business Unit	86	86	14	14	100
FCSD European Technical Service Operations	13	81	3	19	16
FoE - Manuf-VO	655	80	162	20	817
FCSD European Customer Service-Germany	11	79	3	21	14
FCSD European Parts Supply & Logistics	54	78	15	22	69
Ford Financial Intl	74	77	22	23	96
FoE - Manuf-PTO	418	76	129	24	547
zPTO V-Engines, Castings & Auto Trans Business Uni	68	76	21	24	89
FoE - Product Development	548	75	178	25	726
FoE - MS&S	121	75	40	25	161
PTO In-Line Gas Engine Engineering	9	75	3	25	12
PTO Manufacturing Engineering	64	74	23	26	87
IT - Europe	25	74	9	26	34
FCSD European Vehicle Service & Programs	35	73	13	27	48
No Business Unit	785	70	336	30	1121
FoE - Quality & Central Staff	31	67	15	33	46
FoE - Finance/IT	53	65	28	35	81
MP&L - Program & Pre-Production Mgmt	11	65	6	35	17
FoE - Purchasing	35	63	21	38	56
MP&L-Production Planning & Scheduling	13	62	8	38	21
MP&L-Supply Chain Management	16	62	10	38	26
MP&L - NA Operations	14	54	12	46	26
PD-GBD-GCE-Product Analysis and Verification	9	45	11	55	20
FCSD European Customer Service-Britain	12	40	18	60	30
Grand total	3217	73	1105	25	4429

Table 60. Analysis of project yield performance by business unit

Chi-square	98.73
D.f.	27
P-value	0.00

Table 61. Minitab output of time taken by year start for Ford of Europe VO

Descriptive Statistics: Time taken by Year start for FoE – Manuf-VO						
Variable	Year start	N	Mean	Median	TrMean	StDev
Time taken	2000	2	335.5	335.5	335.5	96.9
	2001	1	212.00	212.00	212.00	*
	2002	8	279.1	268.5	279.1	148.8
	2003	121	126.9	112.0	112.6	130.2
	2004	236	143.04	107.50	132.51	124.06
	2005	315	115.68	74.00	105.37	118.37
	2006	134	41.10	21.50	36.38	46.06

Appendix XII - Deployment director

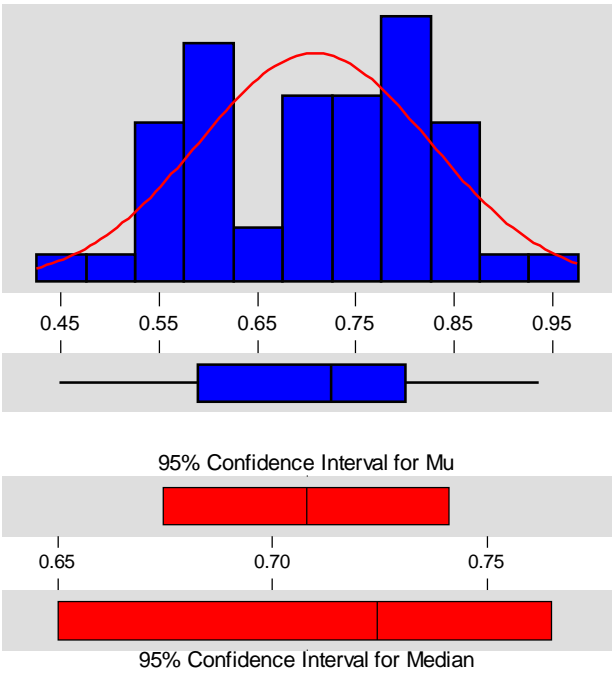
Table 62. Project yield performance by deployment director

Yield	Pass		Fail		Grand Total
	Observed	Row %	Observed	Row %	
DD CDSID					
DD30	40	100	0	0	40
DD56	9	100	0	0	9
DD58	8	100	0	0	8
DD59	8	100	0	0	8
DD68	6	100	0	0	6
DD46	18	95	1	5	19
DD13	72	94	5	6	77
DD39	24	92	2	8	26
DD08	99	90	11	10	110
DD36	26	90	3	10	29
DD63	7	88	1	13	8
DD29	41	87	6	13	47
DD31	37	86	6	14	43
DD40	24	86	4	14	28
DD53	12	86	2	14	14
DD25	47	85	8	15	55
DD23	50	85	9	15	59
DD17	60	85	11	15	71
DD19	58	84	11	16	69
DD44	20	83	4	17	24
DD28	42	82	9	18	51
DD33	32	82	7	18	39
DD02	235	81	54	19	289
DD27	43	81	10	19	53
DD05	104	80	26	20	130
DD38	24	80	6	20	30
DD60	8	80	2	20	10
DD62	8	80	2	20	10
DD07	102	80	26	20	128
DD03	202	80	52	20	254
DD04	157	79	43	22	200
DD34	31	78	9	23	40
DD37	26	76	8	24	34
DD14	64	76	20	24	84
DD01	254	76	80	24	334
DD18	60	76	19	24	79
DD10	78	75	26	25	104
DD67	6	75	2	25	8
DD69	6	75	2	25	8
DD26	44	75	15	25	59
DD09	91	74	32	26	123
DD42	21	72	8	28	29
DD49	15	71	6	29	21
DD55	10	71	4	29	14
DD16	62	71	25	29	87
DD52	12	71	5	29	17
DD45	18	69	8	31	26
DD57	9	69	4	31	13
DD54	11	69	5	31	16
DD06	104	68	50	32	154
DD11	78	65	42	35	120
DD21	52	63	31	37	83
DD12	76	62	46	38	122
DD32	33	62	20	38	53
DD70	6	60	4	40	10
DD41	22	59	15	41	37
DD50	13	59	9	41	22
DD22	50	59	35	41	85
DD35	30	59	21	41	51
DD43	21	58	15	42	36
DD64	7	58	5	42	12
DD65	7	58	5	42	12
DD20	55	57	41	43	96
DD15	63	57	47	43	110
DD61	8	57	6	43	14
DD48	17	57	13	43	30
DD66	7	54	6	46	13
DD47	17	53	15	47	32
DD24	47	49	48	51	95
DD51	13	45	16	55	29
Total	3167	72	1089	25	4429

Table 63. Analysis of project performance by deployment director

Chi-square	289.14
D.f.	69
P-value	0.00

Descriptive Statistics



Variable: Yield by
Deployment Director

Anderson-Darling Normality Test

A-Squared: 0.845
P-Value: 0.027

Mean 0.707863
StDev 0.118225
Variance 1.40E-02
Skewness -1.9E-01
Kurtosis -9.7E-01
N 51

Minimum 0.448276
1st Quartile 0.588235
Median 0.724138
3rd Quartile 0.800000
Maximum 0.935065

95% Confidence Interval for Mu
0.674611 0.741114

95% Confidence Interval for Sigma
0.098920 0.146963

95% Confidence Interval for Median
0.650050 0.764700

Figure 39. Histogram of project yield by deployment director

Appendix XIII - Country

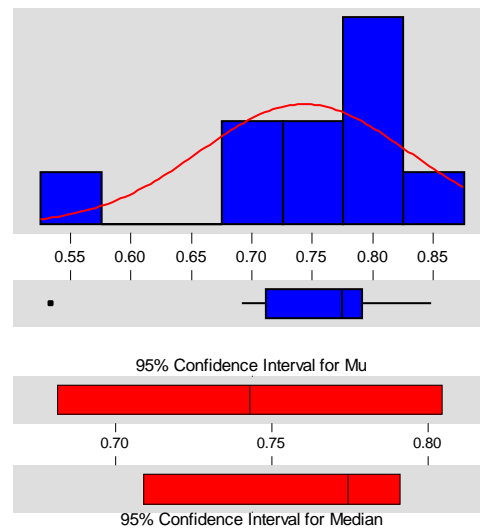
Table 64. Project yield performance data by country

PROJECT COUNTRY	Pass		Fail		Total
	Observed	Row %	Observed	Row %	
CZECH REPUBLIC	15	94	1	6	16
PORTUGAL	7	88	1	13	8
HUNGARY	17	85	3	15	20
SPAIN	228	85	41	15	269
FRANCE-METROPOLITAN	9	82	2	18	11
Europe	31	79	8	21	39
GERMANY	1197	79	320	21	1517
FRANCE	64	78	18	22	82
BELGIUM	183	78	52	22	235
TURKEY	318	77	95	23	413
DENMARK	16	73	6	27	22
ITALY	28	72	11	28	39
GREECE	9	69	4	31	13
UNITED KINGDOM	1125	69	502	31	1627
RUSSIAN FEDERATION	8	53	7	47	15
Grand Total	3255		1071		4429

Table 65. Analysis of project yield performance by country

Chi-square	72.07
D.f.	14
P-value	0.00

Descriptive Statistics



Variable: Yield by European country

Anderson-Darling Normality Test

A-Squared: 0.700
P-Value: 0.046

Mean: 0.743071
StDev: 0.086056
Variance: 7.41E-03
Skewness: -1.71921
Kurtosis: 3.92934
N: 10

Minimum: 0.533333
1st Quartile: 0.711326
Median: 0.774350
3rd Quartile: 0.790511
Maximum: 0.847584

95% Confidence Interval for Mu
0.681510 0.804632

95% Confidence Interval for Sigma
0.059192 0.157105

95% Confidence Interval for Median
0.708879 0.791048

Figure 40. Histogram of project yield by country

Appendix XIV - Engineering function

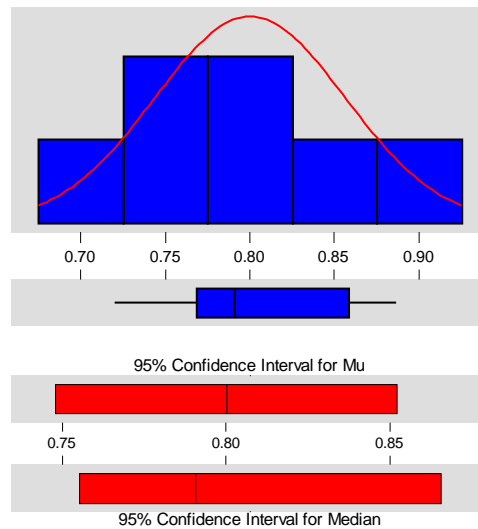
Table 66. Project yield performance data by engineering function

Count of PROJECT ID ENGINEERING FUNCTION GROUP	Pass		Fail		Total
	Counts	Row %	Counts	Row %	Counts
Body Exterior	101	89	13	11	114
PTSE	290	86	48	14	338
Body Exterior, EESE	6	86	1	14	7
Chassis, Vehicle	13	81	3	19	16
Chassis	58	81	14	19	72
Electrical	16	80	4	20	20
Body Exterior, Body Interior	68	79	18	21	86
EESE	34	77	10	23	44
Body Interior	53	77	16	23	69
(blank)	2630	72	1024	28	3654
Grand total	3269	74	1151	26	4420

Table 67. Analysis of project yield performance by engineering function

Chi-square	49.40
D.f	9
P-value	0.00

Descriptive Statistics



Variable: Yield by engineering function

Anderson-Darling Normality Test

A-Squared: 0.226
P-Value: 0.708

Mean 0.800116
StDev 0.056375
Variance 3.18E-03
Skewness 0.330386
Kurtosis -3.7E-01
N 7

Minimum 0.719759
1st Quartile 0.768116
Median 0.790698
3rd Quartile 0.857988
Maximum 0.885965

95% Confidence Interval for Mu
0.747977 0.852254

95% Confidence Interval for Sigma
0.036328 0.124142

95% Confidence Interval for Median
0.755221 0.865449

Figure 41. Histogram of project yield by engineering function

Appendix XV - Green Belt projects

Table 68. Project yield performance data by green belt project identifier

2 Proportion test	Pass		Fail		Total
	Counts	Row %	Counts	Row %	Counts
Green Belt	426	79	112	21	538
Non Green Belt	2850	73	1041	27	3891
Total	3276	74	1153	26	4429

Test and CI for Two Proportions

Sample	X	N	Sample p
1	426	538	0.791822
2	2850	3891	0.732460

Estimate for $p(1) - p(2)$: 0.0593620

95% CI for $p(1) - p(2)$: (0.0223422, 0.0963819)

Test for $p(1) - p(2) = 0$ (vs not = 0): Z = 3.14 P-Value = 0.002

Figure 42. Minitab output for two proportion test comparing yield data for projects

Sample 1 above is the yield for projects that were completed as Green Belt projects and sample 2 is the yield for projects that were not completed as Green Belt projects.

Appendix XVI - Replicated projects

Table 69. Project yield performance by replicated project identifier

2 Proportion test	Pass		Fail		Total
	Counts	Row %	Counts	Row %	Counts
Replication	161	83	32	17	193
Non-replication	3276	74	1153	26	4429
Total	3437	74	1185	26	4622

Test and CI for Two Proportions

Sample	X	N	Sample p
1	3276	4429	0.739670
2	161	193	0.834197

Estimate for $p(1) - p(2)$: -0.0945265

95% CI for $p(1) - p(2)$: (-0.148563, -0.0404897)

Test for $p(1) - p(2) = 0$ (vs not = 0): Z = -3.43 P-Value = 0.001

Figure 43. Minitab output for two proportion test for projects by replication

Sample 1 is the yield data for projects not carried out as replicated projects and sample 2 is the yield data for projects carried out as replicated projects.

Appendix XVII - Process FMEA

POTENTIAL
FAILURE MODE AND EFFECTS
ANALYSIS
- PROCESS FMEA -
Process Responsibility: Steve Thompson

DRAFT

FMEA Number: Six Sigma Process

Key Date: 3 Oct 2004 Define

Prepared by: Steve Thompson, Individual
Assignment

FMEA Date (Orig.) 3 Oct 2004 (Rev.) 21 Nov
2004

Model Year(s)/Vehicles: Six Sigma
Core Team: Steve Thompson, Individual Assignment

Process Function/Requirement	Potential Failure Mode	Potential Effect(s) of Failure	Severity	Potential Cause/ Mechanism of Failure	Current Controls		Detection	Recommended Action	Responsibility and Target Completion Date	Action Results			
					Prevention	Detection				Actions Taken	Severity	Occurrence	Detection
[1] Operation: 10 Station: 6S Review Data High priority project selected	[2.1] No project selected	BB has no project to work on Unable to complete project Negative impact on BB career No project benefit Project customers do not see benefit		[2.1.1] Process teams have insufficient data to identify problems				[2.1.1.1]					
				[2.1.2] Process teams unwilling to admit to problems				[2.1.2.1]					
				[2.1.3] No process for selecting projects				[2.1.3.1]					
				[2.1.4] Project selection criteria impossible to satisfy				[2.1.4.1]					
	[2.2] Projects selected are not high priority	Difficult to recruit team Project difficult to implement BB does not gain leadership skills Project customers see Six Sigma as slow Six Sigma loses favour		[2.2.1] No means of assessing priority				[2.2.1.1]					
				[2.2.2] Project selection process uses inappropriate metrics to assess priority				[2.2.2.1]					
				[2.2.3] No process for selecting high priority projects				[2.2.3.1]					
	[2.3] Project selected does not remain highest priority	Project benefits diminish Team are pulled on to other tasks BB becomes frustrated Project remains open for a long time Project customers fail to see benefit Six Sigma seen as not delivering		[2.3.1] Project takes too long				[2.3.1.1]					
				[2.3.2] Issue resolved by other means				[2.3.2.1]					
				[2.3.3] Project selection based on noisy data				[2.3.3.1]					
				[2.3.4] Other projects gain priority				[2.3.4.1]					
	[2.4] Projects selected are not always highest priority	Increased risk of having problems identifying team Increased risk of suffering from low commitment Increased occurrence of project cancellation Project customers dissatisfied Six Sigma gains poor reputation		[2.4.1] Project selection process not reliable				[2.4.1.1]					
[2.4.2] Project selection process is not applied consistently							[2.4.2.1]						
[2.4.3] No means of assessing priority							[2.4.3.1]						
[2.5] Project selected is inappropriate for Six Sigma	Project does not fit within Six Sigma framework Project experiences problems during audit BB viewed as floating resource Project viewed negatively by peers Project customers satisfied Six Sigma gains reputation as double accounting or being everyday work		[2.5.1] BBs are seen as spare resource				[2.5.1.1]						
			[2.5.2] No established definition of what a Six Sigma project is				[2.5.2.1]						
			[2.5.3] Six Sigma used as a means of implementing a pre planned project				[2.5.3.1]						
[2] Operation: 20 Station: 6S Project Define phase Project defined and scoped 1. With data 2. With metrics 3. With targets	[3.1] Project not defined and scoped	Data gathering process takes too long		[3.1.1] Data not available to scope project				[3.1.1.1]					
		Project takes too long											
		BB gathers data											
		Project can end up with unclear goals											

		Project customers do not see results		(3.1.2) Insufficient process knowledge to put together system/process diagrams				(3.1.2.1)						
		Six Sigma seen as not delivering		(3.1.3) Scope seen as emerging from project work. Team believe that data will allow project scoping				(3.1.3.1)						
				(3.1.4) Project started to implement known solution rather than fix problem				(3.1.4.1)						
	(3.2) Project scope changes over time	Measure phase takes too long		(3.2.1) Use of stretch objective to increase project benefit				(3.2.1.1)						
		Goals do not get defined												
		BB throughput reduced												
		Project outcome not aligned with original purpose												
		Project customers dissatisfied												
	(3.3) Some projects change scope	Six Sigma seen as not delivering		(3.2.2) Poor project selection process. Initial scope does not provide sufficient benefit				(3.2.2.1)						
				(3.2.3) Project scoping process is not reliable				(3.2.3.1)						
		Measure phase can take a long time		(3.3.1) Use of stretch objective to increase project benefit				(3.3.1.1)						
		Project performance reduced												
		BB throughput reduced												
		Project can take too long		(3.3.2) Project scope too large to allow closure in 150 days				(3.3.2.1)						
				(3.3.3) Initial scope does not include problem				(3.3.3.1)						
		Project customers can become dissatisfied		(3.3.4) Initial project scope does not provide sufficient benefit				(3.3.4.1)						
			(3.3.5) Project insufficiently scoped at start				(3.3.5.1)							
Six Sigma not viewed as effectively as it could be			(3.3.6) Project team unable/unwilling to say no to extra work				(3.3.6.1)							

Appendix XVIII – Process control and reaction plan

