A STUDY OF THE IMPACT OF LEAN ON UK MANUFACTURING ORGANISATIONS THAT VIEW IT AS A PHILOSOPHY

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Doctor of Philosophy

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THESIS SUMMARY

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Despite the term "Lean" being invented over twenty years ago by Krafcik (1988) there persist inaccurate representations of Lean as a concept in Britain. Whilst a major evolution has occurred comprising the inputs perceived as imperative for Lean success, endeavours to provide a transparent understanding of the philosophy have been comparatively perplexing. There presently exist methodological and philosophical gaps in the literature to plainly illustrate the unequivocal and definitive requirements an organisation treating Lean as a philosophy should incorporate. Accordingly there were three principal research aims; primarily, Lean is and always should be regarded as a business model as depicted by Toyota who is dedicated towards finding better ways of producing cars; consequently an investigation of whether organisations embracing Lean as a philosophy were indeed more triumphant. An adapted balanced scorecard was used which embraced strategic, operational and indices focused towards the future prospects of an organisation. Secondly, it was obligatory to explicitly and precisely determine whether an organisation espoused "*Lean as a philosophy*" as opposed to another process or strategy. Thirdly, since Lean has to be envisaged as a never-ending journey; it was important to map out the Lean journey and to be able to categorize the juncture an organisation occupies at any particular phase of its overall implementation. This affords an opportunity to advise an organisation of specific requirements it needs to satisfy should it wish to embrace Lean as a philosophy. A comprehensive literature review whilst focusing on the core ingredients of contemporary thinking such as culture, the strategic implications of Lean, the implementation issues, the obstacles and performance measurement, also proceeds to evaluate whether Lean is a panacea to all manufacturing problems and the concept of Lean as a philosophy is also explored further. The methodological approach focussed on the effective deployment of survey questionnaires in sixty eight organisations and seven extensive case studies in manufacturing organisations of varying sizes. The CIMA organisational classification, the Puttick grid and the Product-Process matrix were used to analyse the range of organisations used in this investigation. Whilst there was a requirement to investigate whether Lean indeed equates to success, pertinent performance measurement was considered decisive; the DMP Model (Maltz et al., 2003) was modified to perform this role. An unremitting theme both in literature concerning the implementation of Lean and in the research evolves around the notion of corporate cultures. Its relevance is explored further within the analysis. In accepting the premise that Lean incorporates a journey, it was fundamental to identify the voyage. Prevalent frameworks are deficient in identifying the sustainability and ideological facets of Lean. Consequently, an extensive Lean audit was developed and piloted in twenty disparate organisations. This was tremendously enlightening to organisations since it assisted to clarify the passageway should they wish to embrace Lean as a philosophy. In conclusion, the research objectives are re-visited to assess whether they were indeed tackled. Inherently, probable limitations of the investigation are considered and a proposal for additional future research is also considered.

Key words: Lean, Philosophy, culture, audits, competition

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CHAPTER ONE
INTRODUCTION

1.0 Background

There still exist considerable misapprehensions about the concept of Lean; despite literally hundreds of books and a great deal more papers, not to mention thousands of media articles, and a number of other resources available to a growing audience. In spite of the numerous attempts to provide a clearer understanding of the philosophy, the research findings are ambiguous. While some commentators provide an awareness of Lean, many simply lead to confusion and misconceptions. This chapter provides an insight into the concept of Lean, its brief history and proceeds to provide:

- the focus of the research,
- clarification of the research objectives, and concludes with
- an abstract of the remaining chapters of the thesis.

The basic concept of Lean can be traced back to Benjamin Franklin who in 1733 started publishing "*Poor Richard's Almanack";* almanacs of the era were printed annually and contained material like weather reports, recipes, predictions and homilies; for example, "*a penny saved is two pence clear. A pin a day is a groat a-yea*r" (Smalley, 2006; page 3). He asserts that avoiding unnecessary costs could be more lucrative than increasing sales. Henry Ford cited Franklin as a major influence on his own business practices (Ligus, 2007). Frank Gilbreth persistently highlighted the concept of waste being built into jobs and then taken for granted until his death in 1924. Frederick Winslow Taylor introduced what are currently referred to as standardisation and best practice deployment in his "*Principles of Scientific Management*" (1911). Shigeo Shingo (1989) the most famous exponent of single minute exchange of die (SMED) and error proofing cited Taylor as his inspiration. Henry Ford pursued the focus on waste whilst developing mass assembly. Design for manufacture (DFM) is also a Ford concept articulated in "*My life and work*" (1922). Sakichi Toyoda, in a textile factory with looms that stopped when a thread broke, became the seed for automation and Jidoka. Kiichiro Toyoda, founder of Toyota, recognised the need to stop the repairing of poor quality by scrutinising every process stage.

Consequently, Taiichi Ohno (1988) built on the existing schools of thought and spread their breadth and use; originally within car manufacturing in the 1950s, vehicle assembly in the 1960s and the wider supply chain in the 1970s. It was in the 1970s that supplier manuals were produced and the "secret" of the Lean approach was shared outside Toyota. The term "Lean" was coined by Krafcik (1988), at that time a leading researcher in the International Motor Vehicle Program (IMVP), conducted at the Massachusetts Institute of Technology. In his landmark paper Krafcik used the term "Lean" to describe a production system that used fewer resources compared with mass production. Interest in the West was limited until performance gaps between Toyota and other car manufacturers were made evident by Womack et al., (1990). The term "*Lean Enterprise*" was launched by Womack et al., (1990) to describe the extension of Lean outside the boundaries of the organisation. After 1990 there was a gradual widening of focus away from the shop floor based on the Lean principles (Womack et al., 1996). The evolution could be summarised as a focus on quality in the early 1990s, through to quality, cost and delivery in the late 1990s and towards customer value from 2000 onwards. The term "*Lean Provision*" (Womack et al., 2005; page 8) indicating the stages necessary to deliver desired value from the producer to the customer, often running through a number of organisations, has become popular in the last few years.

1.1 Research

The thesis aims to develop new insights contributing to the understanding of Lean as a philosophy. Current empirical research has been ambiguous and vague in defining precisely the whole concept of Lean and philosophy (Womack et al., 2005; Quinn 2005; Lee 2007; Campell 2006). Repeatedly and erroneously the contemporary research dwells on treating Lean as a faith or religion (Kincaid 2004; Mehta et al., 2005) and not as an ideology (Womack et al., 2005; Ransom 2008). Lean needs to be approached from a philosophical perspective whereby the decision to adopt it should be based upon its own credentials (Lee 2008). Furthermore, Lean requires a rational harmony, not faith or obedience. It should not be viewed as a religion but an ideology strictly based on lucidity with methodical processes and procedures (Ransom, 2008). Its success depends upon inspiration, surveillance and trialling. Lean needs to be viewed as an economic reality - not a religion, not a moral crusade, and not a social cause (Womack et al., 2005; Ransom 2008).

The overall goal for Lean is the lasting improvement in company profitability underpinning high performance (Smalley, 2006). There is no clear recipe for Lean success (Henderson et al., 2003). The journey that any organisation pursues is uniquely dependent upon the organisation (Lewis 2008). Of great importance is the scrupulous evaluation of an organisation's current state and its goals and existing resources. The organisation then determines a plan that is appropriate, and on every occasion there will be one next step (Hall, 2004). Lean is a continuous process that necessitates constant evaluation and adjustment. It is not an ideology to be completed and then left to sustain itself. The integration of Lean to the business journey is an unconditional and critical requirement (Biddle, 2006). Through this integration, the company utilises Lean as a device to accomplish its goals. An organisation contemplating Lean has many considerations to take into account. Comparable to other business decisions, the choice to go Lean is not one to be taken frivolously.

Lean improves operational efficiency and effectiveness and is about waste elimination; not just in operations but all aspects of a business (Lewis, 2008). It often necessitates a situation of requiring a sacrifice in the short-term for the long-term; the short-term should be viewed as 0-10 years and the long-term as 10-50 years. Unfortunately, most organisations view long-term as 3-5 years, whereas Toyota, for instance, conceives it as a process taking in excess of 30 years (Lewis et al., 2008). All levels of management must assume the responsibility for deploying Lean and working under the continuous improvement principle (Bartels, 2005). Impersonating Toyota is not the solution unless everything about your organisation is exactly the same. There exists a requirement to integrate the principles and rules of Lean into the pragmatic operations essential to improve the current state and move it towards the desired state; Lean is a never-ending journey (Parnell, 2005). When an organisation appreciates what its primary and supporting value streams should look like across its organisation, it could be stated that a third of the Lean challenge has been successfully accomplished. When it is on its way towards creating a Lean management system to manage its process-focused enterprise, it could be stated that another third of its challenge has been successfully accomplished. The final hurdle is about reflection of the organisation's customers and thinking forward from the capabilities of its Lean processes to redesigning the business model for your industry (Pullin, 2005). The strategic implications of Lean may, in the end, become far more significant than the tactical activities to improve the operations (Hall, 2004).

Lean is a business model that delivers far superior performance for customers, employees, shareholders and society at large. Although this entails delivering to the customer exactly what is required, it also involves freeing up capacity to deliver more value from existing resources with fewer additional costs (Baggaley, 2006). In essence, it is about reconfiguring assets and relationships with supply chain partners to facilitate the step change in creating additional value for our customers (Henderson et al., 2003). Indeed we need to recognise our organisations as a collection of horizontal processes or value streams as well as the more familiar vertical organisation of functions and departments. Vertical functions correctly organise knowledge but horizontal value streams create value (Womack et al., 2005). Toyota is not dedicated to producing cars. Toyota is dedicated to finding better ways to produce cars. Lean is difficult, innovative and needs to be original (Motley, 2004). It is certainly possible to seek encouragement and stimulus through another organisation's journey but it should always be recognised that no two successful journeys will look the same (Hall, 2004).

1.2 Thesis research aims

Appropriately at the inception stage it needs to be clarified that, whilst the processes, philosophy and theory of Lean is also prevalent in the Service sector, this research focuses on the manufacturing sector alone and on its application within the UK. There are three major areas and hypotheses or conjectures that the research attempts to test.

1.2.1 Organisations embracing Lean as a philosophy performed better

It is necessary to be able to examine the contention whether the organisations embracing Lean as a philosophy operated more successfully. When examining the concept of success, the research advances beyond the financial accounts of the respective organisations. Whilst a balanced scorecard approach was used, for reasons which will be clarified, the Kaplan and Norton's (1992, 1993, 2001 and 2005) inspiration was not adopted. Instead an adapted version of a scorecard proposed by Maltz et al., (2003) was used to gauge whether organisations on the Lean journey and adopting it as a philosophy were indeed more successful. In order to evaluate this, it was necessary to judge their performance utilising key strategic, operational and some indices which attempted to investigate the future potential of the organisation.

1.2.2 When an organisation embraces Lean as a philosophy

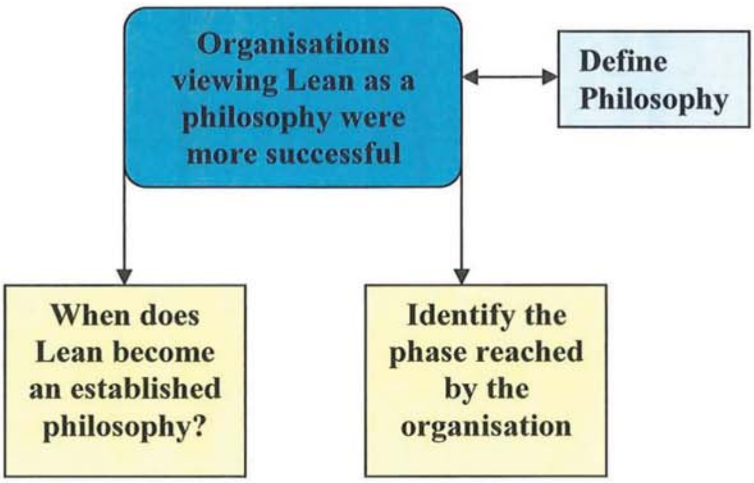
Crucially, there was another major objective; to specifically and precisely determine whether an organisation has adopted "*Lean as a philosophy*" as opposed to another process or strategy. This initially required the need to clarify accurately what is meant by philosophy within the Lean context. In testing this objective various aspects were considered; the prominent aim was to fully open this debate and to elucidate aspects required to be evaluated in determining when an organisation views Lean as an ideology; namely:

- that Lean needs to become a way of thinking
- Continuous improvement is integrated into the culture
- An appreciation that Lean is an integration of a complete system
- A recognition that Lean is not synonymous with religion
- In every circumstance, Lean has to produce profits
- Lean should never be viewed as a final destination
- The importance of developing people is fully acknowledged
- An implementation programme of the appropriate tools; a simultaneous application of five or more of the technical tools depending on the stage of implementation,
- That the tools are considered to be mechanisms to see problems and not solutions
- The organisation should not confuse local tools in the TPS with universal solutions

- That Lean should be extended to the entire value chain, including outsourcing
- That the TPS is not to be confused as the Toyota way
- The organisation needs to have a clear clarity of vision in relation to Lean
- make numerous cultural changes embracing empowerment and sponsor the Lean principles through-out the value chain
- make substantial organisational changes such as
    - remuneration systems,
    - the accounting methodologies utilised,
    - links with marketing and logistics,
    - the metrics used and
    - the training culture.

1.2.3 Identification of the Lean juncture

It was critical to be able to categorize the juncture of a Lean Journey an organisation occupies at any particular phase of its overall Lean implementation. This involved the need to develop a framework in order to markedly identify the stage an organisation occupies. Accordingly, once the stages were clarified and an organisation's position established, it would then be feasible to make recommendations in order to facilitate its progress towards a level whereby it embraces Lean as a philosophy. The subsequent analysis will demonstrate how it was possible to split the overall Lean journey into seven evident phases. Consequently an extensive audit questionnaire was developed intending to establish the juncture of the Lean journey an organisation occupies. Figure 1.1 summarises the research aims graphically:



Thesis Research aims
Figure 1.1

1.3 Overview of the Thesis

Chapter 2 reviews the extensive literature on Lean within the manufacturing sector. It scrutinizes the development of the concept particularly from the 1980s when Krafcik (1988) coined the phrase "Lean". There was also the heavy influence of Womack et al., (1990) who launched the term "*Lean Enterprise*" used to describe the extension of Lean outside the boundaries of the organisation. This appraisal proceeds to the current concept of "*Lean Provision*" (Womack et al., 2005; page 8) which describes all the stages necessary to deliver the desired value from the producer to the customer, often running through a number of organisations. Integral in this evaluation is the portrayal of the awareness suggesting Lean is not merely a collection of tools but that it requires a radical way of thinking. It looks at the Toyota way, which involves a far deeper, and more pervasive cultural transformation than what most organisations could begin to imagine. Equally Lean is about more than improving efficiency as it challenges organisations to look up and out with others to streamline the whole process from end to end, often across several organisations (Hall, 2004a; Ransom, 2008).

A principal component of Chapter 2 identifies the existing research surrounding the concept of treating Lean as a philosophy. It shows that whilst lessons have been learnt from successes such as Toyota, there exist methodological and philosophical gaps in the literature; plainly illustrating the unambiguous and explicit requirements an organisation needs to incorporate, if it is to be branded as an example of an organisation treating Lean as an ideology. The literature review imitates the main themes covered in the research; consequently it incorporates a dedicated section on the following:

- The technical inputs required for Lean success,
- By treating Lean as a philosophy it was fundamental to look at the role of culture,
- Analysing the major aspirations of organisations from Lean,
- The prominent implementation issues,
- The potential obstacles or barriers to Lean,
- That a Lean organisation portraying the ideology, principles and practices requires a concerted effort since Lean success does not materialise inadvertently,
- a discussion on performance measurement in Lean organisations,
- examining whether Lean is viewed as a panacea to every manufacturing problem, and
- a clarification of the notion of treating Lean as a philosophy.

Chapter 2 concludes with a synopsis of the identifiable research gap which is hoped that the subsequent research addresses.

Chapter Three highlights the methodology adopted for the research in order to test the aforementioned hypotheses. The justification for using both Case Studies and Survey Questionnaires is examined in detail. The strict adherence to the Case Study protocol is highlighted. There is an illustration of how a high degree of credibility in the research findings can be witnessed; equally the related research ethics practised are clarified. The "Puttick Grid" is represented as a method ensuring that the organisations chosen reflected the major types of manufacturing activity in the overall analysis. The Puttick grid characterises organisations according to:

- the amount of uncertainty faced in the organisation's market and uses indices such as sales and product mix, and
- level of complexity of the organisation's products which examines factors such as product and process complexity.

Moreover, the 2005 CIMA classification of organisations was used as a gauge in determining the size of an organisation within Britain; three supplementary indicators are used in this assessment:

- turnover,
- aggregate gross assets, and
- the number of employees.

Strenuous efforts were taken to ensure that the survey questionnaires and Case Studies represented small, medium and large enterprises as defined under the CIMA categorisation. In a further attempt to guarantee reliability, the Product-Process matrix was also utilised to categorise the sample organisations; a company can be characterised as occupying a particular region on the matrix which is determined by the firm's stage in the product life cycle and the firm's choice of production processes.

Chapter Four is the foremost technical section and appraises the overall results and analysis. In order to debate whether Lean has been a success, pertinent performance measurement is crucial and this section outlines how the DMP Model (Maltz et al., 2003) was modified to perform this role. An unrelenting theme both in literature concerning the implementation of Lean and in this research evolved around the notion of organisational cultures. The Survey questionnaire analysis was executed using the software SPSS version 13.0 for Windows and engaged both parametrical and non-parametrical tests. Subsequently extensive Lean Audits were carried out in twenty companies as a comprehensive validation mission. Correlational analysis of groups was undertaken in small, medium and large companies, using the Spearman's Rho test. Overall performance correlations between sections were also attained for a comprehensive perspective.

Furthermore, Chi-Square analysis was utilised to substantiate the correlation analysis. The total number of companies involved in the Survey Questionnaire were N=68, classified into groups, being n (small) = 12, n (medium) = 16 and n (large) = 40. Moreover, seven organisations had consented to act as Case studies in which it was feasible to explore issues at a greater depth than was practical through the survey questionnaires. Whilst the survey questionnaire was completed with key personnel within each respective organisation, the case studies however sought responses from management of varying status and the shop floor within each of the seven organisations. Questionnaires and interview schedules were used within the case study data capture and the relevant analysis is explored within this section. Relevant facets divulged in the literature review were investigated further and the results also explored in this section.

Chapter Five is categorized, as "The Lean Journey" and it was plainly an output of the overall research conducted. Whilst extensive preceding research attempted to reflect the Leanness of an organisation, there existed a void of a comprehensive Lean audit specifically examining:

- Whether Lean had been adopted by an organisation as an ideology, and to
- Specifically deduce at what phase of a Lean journey the organisation had reached.

Many contemporary models were considered including the "Shingo Prize" and the "Excellence model" and consequently, a sophisticated bespoke Lean audit was devised and undertaken in twenty organisations in order to assess how pertinent the framework was. This chapter proceeds to both clarify the audit and summarises the responses from the respective organisations regarding its aptness.

Chapter Six is the additional discussion needed and the overall conclusions accomplished. This is realised by revisiting the original research objectives; namely:

i. to establish perceptibly whether the organisations that had embraced Lean as a philosophy proceeded to perform better; this required the need to
ii. clarify exactly when an organisation is deemed to have embraced Lean as a philosophy;
iii. Consequently, if Lean is viewed as a journey, to determine the stage of the Lean journey the organisation has attained at any juncture of this mission.

An assessment was undertaken to determine whether these were indeed met. Moreover, certain inherent limitations of the research are explored in detail with explanations of how the possible negative influences were alleviated. A proposal for additional future research is also presented with a clarification of the prevailing backdrop from which this concept has developed. The chapter culminates with a section on the overall generic conclusions of the complete investigation undertaken.

1.4 Summary

The thesis continues to retain its focus on the research aims. To accomplish this, the following chapter is an extensive review of the prevailing literature interrelated to issues of Lean implementation and its potential benefits. It dissects the development of Lean from the 1980s when Krafcik (1988) coined the phrase "Lean". It proceeds to the current concept of "*Lean Provision*" (Womack et al., 2005; page 8) describing all the stages necessary to deliver the desired value from the producer to the customer, often running through a number of organisations. The technical inputs; the role of culture; the major aspirations of organisations from Lean; the prominent implementation issues; the potential obstacles or barriers to Lean, how Lean requires a concerted effort; performance measurement; whether Lean is a panacea to every manufacturing problem and the notion of treating Lean as a philosophy is scrutinised in detail. Chapter two concludes with a synopsis of the identifiable research gap which is hoped that the subsequent investigation addresses.

CHAPTER 2
LITERATURE REVIEW

2.0 Critical Analysis

This chapter provides an extensive review of the literature analysing Lean initiatives. Centrally it examines the underlying reasons for the low numbers of successful Lean initiatives within the UK. There is also a comprehensive exploration of the principle viewing Lean as a philosophy; this offers an opportunity to dovetail ones personal belief with that of the prevailing research. Mora (1999) submits that "*only some 10% or less of companies succeed at implementing TPM and other Lean manufacturing practices*" (page 2). Sohal et al., (1994), state "*that only 10% have the philosophy properly instituted*" (Page 42). Repenning et al., (2001), identify that companies use initiatives almost as a fad and submit that whilst the "*number of tools, techniques and technologies available to improve operational performance is growing rapidly. On the other hand, despite dramatic successes in a few companies, most efforts to use them fail to produce significant results*" (page 64). O' Corrbui et al., (1999), suggest in Britain during the 1990s up to 70% of business strategies failed to get fully implemented; often the output of the process was quite different from the original intent. The "*Manufacturer*" (2002) substantiates this; a hundred organisations on their respective Lean journeys were asked how close they were to becoming a Lean entity and only 3% stated they were truly Lean whilst 22% stated they were close to Lean.

2.1 Introduction

It is suggested that less than 10% of UK organisations have accomplished successful Lean implementations (Baker, 2002; O' Corrbui et al., 1999). Often Lean is viewed as a process or simply another strategy whereas they should embrace it as a philosophy (Ransom, 2008; Jones, 2009). When viewed as a philosophy it becomes a way of thinking whereas tactics or processes are mechanisms to action these thoughts. Likewise, in the United States, a study undertaken by the "Lean Enterprise Institute" (2004) states that from 900 executives questioned only 4% concluded that their Lean efforts were at an "advanced" stage; that Lean had become the standard way of operating internally and was being extended to strategic suppliers. In fact numerous definitions and descriptions of Lean exist; some interpret it as merely a collection of tools (Gordon, 1995; Drew et al., 2004; Smalley, 2009); others perceive Lean as promoted by Toyota, (Womack et al., 2005) with the focus on improving the "flow" and steadily eliminating the mura (unevenness). The difference between the two approaches is not the goal but the prime approach towards achieving it (Wheatley, 2005, Liker, 2004). Toyota does not view Lean as a collection of tools, but as a reduction of three types of waste (Lee, 2007; Koenigsaecker, 2005; Hines 2008):

- Muda (non-value adding work)
- Muri (overburden), and

- Mura (unevenness).

Lean is also seen as "working people smarter" (Chung, 1996; Fullerton et al., 2009). At the highest level, Lean rewards people at all levels in an organisation, applies the skills and a shared way of thinking to systematically drive out waste through designing and improving work of activities, connections and flows (Lee, 2008).

The generic term Lean Manufacturing was popularised by its major proponents, IMVP (International Motor Vehicle Programme) researchers of the Massachusetts Institute of Technology. Their project focused on the significant performance gap between western and Japanese automotive industries of 52 assembly plants in 14 countries over a five - year period. Sohal et al., (1994), suggest that the IMVP researchers declared that:

"*Lean production is Lean because it uses less of everything compared with mass production – half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. Also it requires keeping far less than half the needed inventory on site, results in fewer defects and produces a greater and ever-growing variety of products*" (Page 36).

However, this investigation evolved around Prof Liker's (1996) perception of Lean; "*a philosophy that when implemented reduces the time from customer order to delivery by eliminating sources of waste in the production flow*" (page 481). Nonetheless the study by NIST (2003) is awarded complete eminence; that Lean involves "*a systematic approach to identify and eliminate waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection*" (page 1). Nevertheless, for completion, the term "*Lean Provision*" (Womack et al., 2005, page 8) summarises the contemporary belief stipulating the necessary steps required to deliver the desired value from the producer to the customer and which can run through a number of organisations. This is a natural extension of the term "*Lean Enterprise*" launched by Womack et al., (1990; 2005) to describe the extension of Lean outside the boundaries of the immediate organisation.

2.2 The importance of the technical inputs for Lean

Contributors (Leitch, 2001; Burnes, 2002) have suggested that the application of Lean and the Lean tools is synonymous. Fundamentally the tools should be implemented in a structured manner and at an appropriate time whilst taking into account their interactions (Liker, 2004; Spear 2004; Lewis 2008; Conner, 2009). An elementary necessity dictates that the appropriate tools are implemented in the right circumstances within the backdrop of the organisation's value chain (Parnell, 2005; Ransom 2008). Lean is an end-to-end value stream that ultimately needs to provide an organisation with improved competitiveness (Wheatley 2005).

Consequently, an excellent cell supplying into a tangle of poorly controlled inventory is waste. Likewise, a changeover reduction programme in an organisation whereby high capacity is the norm would also be waste. A kanban system operating in a setting of unlevelled demand can also be waste (Cocolicchio, 2008). Often in implementations the basic issue remains that Lean efforts begin with a tactical approach rather than an overall strategic one (Biddle, 2006; Ransom 2008). Repeatedly, Lean practitioners have often incorrectly recommended a tactical approach since Lean has developed from operational improvements and many cannot visualise Lean as a total strategy (Halliday, 2005; Lewis et al., 2005).

Research indicates that organisations need to ensure that instead of embracing one or two isolated tools that it is necessary for companies to practice most, if not all, of the following (Lewis et al., 2006; Leitch 2001; Hines 2008; Albert, 2009):

- Continuous improvement / Kaizen: the continual pursuit of improvements in quality, cost, delivery and design. This necessitates a system of identifying improvements, executing them and feeding back the information (Campell 2006),
- Cellular manufacturing: it is vital to group closely all the facilities required to make a product, (or related group of products), in order to reduce transport, waiting and process time (Lee 2008),
- a Kanban system needs to be in place; a "signal" or "ticket" approach which facilitates the structure to only build what and when it is needed,
- Single piece flow needs to be in operation, where products proceed, one complete product at a time through various operations in design, order taking and production, without interruptions, backflows or scrap (Bartels 2005),
- process mapping; this is a detailed mapping of the order fulfilment process, utilising set symbols, to indicate the product and information flows (Jones, 2009),
- Single Minute Exchange of Dies, (SMED), in order to reduce the lead time and improve flows it is necessary to eliminate delays in change-over times on machines,
- Step change / kaikaku; this requires the need to make radical improvements of an activity to eliminate waste through a step change as opposed to the incremental approach of kaizen,
- Supplier development; a need to actively develop links with suppliers and work closely with them for mutual benefit (Bicheno et al., 2009; Henderson et al., 1999),
- Supplier base reduction by further attempting to reduce the number of suppliers an organisation engages with (Michel 2004; Hines et al., 2008),
- 5S and general visual management in order to reduce the clutter and inefficiency of any typical production and office environment (Sim et al., 2009),

- Total Productive Maintenance, (TPM), aimed at improving the reliability, consistency and capacity of machines through maintenance regimes as originally promoted by Ohno (1988),
- Value and the seven wastes: the notion of value should never be ignored; essentially the capability provided to the customer at the right time at an appropriate price, as defined in each case by the customer. This substantiates the prevailing principles of Lean addressing the wastes as suggested by Philips (2002), Maskell (2000), Nystuen (2002), Meier (2001), Standard et al., (2000), Womack et al., (2003), Parker (2003), Olexa (2002), Siekman (2000), Dimancescu et al., (1997), Liker (1996), Prizinsky (2001) Oliver et al., (1996), Johnston (2009) and Hines et al., (2008):
  - Over production,
  - Waiting,
  - Transportation,
  - Inappropriate processing,
  - Inventory,
  - Unnecessary motions,
  - Defects; and

proponents have recently added an eighth waste; under-utilised people (Ligus, 2007).

Lean is often erroneously portrayed as being in competition with other innovative ideas (Lee 2007). Recently this centres on the debate involving Lean and Six Sigma. Womack et al., (2005) suggest that the gulf between the two camps can be partly explained by the role of consultants who tend to master only one of the tools. It should never be seen as an either/or proposition. Frequently, both Lean and Six Sigma are treated too narrowly by organisations since complexity, variations and mistakes should play a part in all approaches to quality (Hall, 2004; Cocolicchio, 2008). If the focus is too narrow, Six Sigma does not lend itself to complexity or mistakes. Certain critics argue that Toyota has not placed too much emphasis on Six Sigma (Moore, 2004). Nonetheless, Toyota makes heavy use of pokayoke and heijunka in conjunction with line stops and andon boards to expose problems quickly (Campell, 2006). When the two ideologies are combined, the outcome is speed (Hines et al., 2008). Toyota has verified that by combining and narrowing processes it can help to meet milestones. Decisions are delayed as long as possible, ensuring that they are based on the maximum amount of information (Seddon 2004).

Similarly, the Lean ideology is often reported to be opposed towards the embracing of IT (Hunter, 2004). Lean proponents, by definition, are technical sceptics (Womack et al 2005).

Lean, inherently, involves a considerable time spent on the creation of processes requiring as little information as possible; whilst the rest of us try to figure out how to get more and more information (Lee 2008). The Lean community is not generally against IT but equally must not be obliged to sprint towards automated solutions, because this tends to institutionalise large amounts of waste. It is important that organisations primarily refine:

- procedures,
- motions and
- techniques.

Many ERP software firms are attempting to find ways of making their software responsive to Lean; i.e., "American Software", "SAP AG", "Oracle", "Peoplesoft Inc." (Bok 2004). Attitudes towards IT by Lean proponents are changing (Michel, 2004). IT solutions should be eradicated if they are financially focused rather than customer focused and not intended to eliminate waste and simplify and streamline operations (Waurzyniak, 2009). The problem often has been how the IT solution is used, not the IT solution itself (ERSC 2007). Ultimately, IT solutions should be viewed as enablers that sustain change; facilitate the rapid adoption of more complex Lean techniques such as line design and load-levelling production and help to capture the value delivered (XR Associates, 2004; Smalley 2009).

2.3 Cultural implications

Underlying virtually every Lean failure is the fundamental issue of corporate culture and change management (Trompenaars et al., 2004; Parks, 2002; Mann, 2005). Certain cultural requirements are regarded indispensable for Lean to thrive; as primarily outlined by Ohno, (1988). Lean seeks a collective agreement and enthusiasm for the systems and processes that lead towards the accomplishment of a Lean enterprise (Poza et al., 2001; Mann, 2005; Nelson et al., 2002). Organisational culture is the personality of an organisation (Mann, 2005); it comprises the assumptions, values, norms, and tangible artefacts of a company's employees and their behaviours (Buhler, 2005). Many theoretical, epistemological and methodological approaches to culture have revealed its intricacy. Research (http: PWC, 2006) suggests that 41% of the change projects fail; of the 59% that succeed only 20% meet the expectations of senior management. Nine out of the top ten barriers to change are quoted as people related such as poor communications and employee opposition (Ransom, 2008). Practitioners suggest that 80% of becoming a Lean enterprise is culture-related (Ligus, 2007; Buhler, 2005; Parks 2002; Ransom, 2008). The Aberdeen Group (2004) found many reasons cited as obstacles towards the adoption of Lean; the prominent one, 70%, was that a significant cultural change was needed; the third highest, 39%, surprisingly was still a lack of top management support.

2.3.1 The relevance of culture for a Lean enterprise

Irani et al., (1997), Kotter et al., (1992), Dennison (1990) and Brown (1995), concur that any strategy, regardless of its strengths, will not be accepted if it is outside the bounds of its culture. The manner in which change is introduced, embraced and tackled is defined by an organisation's culture (Poza et al. 2001; Aamodt, 1991). Overall, the evidence suggests that ignoring culture carries two major risks; namely, missing the opportunity to harness it as a positive influence on competitiveness and consequently allows it to act as a negative influence by inhibiting change (Pullin, 2005). Ignoring culture is not recommended if an organisation aims to secure competitive advantage (Womack, 2005). Managing around the culture is a real possibility given that there are often several ways to achieve the desired goals (Nelson et al. 2002). This may not result in sustained success (Womack et al. 2005; Jones 2009).

Changing the culture to fit the desired strategic variation is a lengthy process particularly if the organisation's culture is strong as the author discovered when Royal Doulton Plc embarked upon Lean in the late 1990s. A popular view (Deal et al. 1982; Denison, 1990) suggests that it is futile to bring about organisational change by attacking attitudes and values. The way to bring about organisational change is to first change behaviour. Behavioural change will bring about desired changes in attitudes and values (Cocolicchio, 2008). Changing the strategy to match the culture generally results in accepting an alteration to the final output to the one anticipated (Mora, 1999). A degree of compromise between changing the culture and adapting the strategy is more likely to be acceptable (Hatch, 1997; Mann, 2005). Critically achieving a favourable culture such as that at Toyota takes time to accomplish (Ligus, 2007; Nelson et al., 2002; Yauch et al., 2003). Kotter et al., (1992) investigated eleven large organisations such as General Electric and Xerox and concluded that achieving cultural change can take between four to six years.

Schein (1991) stressed that new values will only be incorporated once they have been proven; hopefully ultimately, for them to be taken for granted and drop to the level of unconscious assumptions (Feldman, 1991). Permanent organisational change will only be brought about by first changing people's attitudes and values which is time consuming and difficult. For a successful Lean implementation, the literature (Hatch, 1997; Daft, 2001; Lewis, 2002; Doherty et al. 2001), asserts that the employees' natural resistance to change impedes attempts to modify the culture, unless the organisation overtly recognises their concerns. Lean thinking can only exist when we install a listening and learning culture whereby process design is created by those who deliver the product or service, and not by a business analyst in an ivory tower who never sees the product (Parnell, 2005; Johnston, 2009). Daft (2001) warns that in successful organisations culture can become set and the company may fail to adapt; we should discourage rigidity and stability. Others, (Bryman, 1984; Smircich, 1983), question whether organisational change is manageable and allege that improved entrepreneurship, adoption of a market orientation and teamwork are superficial indicators of culture; view shared by Hatch (1997).

Effective implementation needs to alter the way work is done through the organisation's systems, operations and procedures which are inherently linked to the organisation's culture (Buhler, 2005; Poza et al., 2001; Liker 2004). Brown (1995) summarises the ways in which an organisation's culture could influence strategy formulation; namely, through its influence on scanning behaviour, selective perception, interpretation, impact of values, effects of assumptions and the power of various sub-cultures. Trompenaars et al., (2004) endorse that strong, appropriate, adaptable cultures which value stakeholders and leadership and have a strong sense of mission may be associated with high performance over sustained periods of time. The myth that Lean is about the Japanese culture is a total fallacy (Koenigsaecker, 2005; Allio, 2007). Nissan encountered considerable trouble regards its quality defects, rising costs and delivery problems; it had to be rescued from the brink of bankruptcy by Renault. Toyota's Georgetown Plant, (USA), is one of the most efficient plants in the world, as is their NUMMI plant in California, and NUMMI is a union plant with previous General Motors workforce.

2.3.2 Contemporary position regards organisational culture

For over two decades researchers have utilised various definitions of culture, including a shared belief system within the organisation (Sathe, 1983); widely shared core values, (Peters and Waterman, 1982); collective understandings (Barley, 1983); and the pattern of basic assumptions of an organisation (Schein, 1985). In sum these definitions evolve around shared values and much of the literature has focused on culture reflecting the organisation's founder and top managers (Peters, 1987). Earlier articles, prior to 1987 suggests Lewis (2002), concentrate on an explanation of culture; Bryman, (1984), Sathe, (1983) Barley, 1983 and Schein, (1985) are examples of authors who took a utilitarian approach. The latter period concentrated on the effects of culture on organisational performance (Brown 1995; Lewis, 2002). Fitzgerald (1988) recognized shared beliefs and common practices within organisations. Nonetheless, the following definition of culture by Daft (2001) tends to fully encapsulate the concept; that an organisation's culture "*is the set of values, guiding beliefs, understandings and ways of thinking shared by members of an organisation and taught to new members as correct*" (page 322).

The Toyota way is explicitly "*taught to new members*" (Liker 2004, page 299) and has a depth that goes to the level of basic assumptions to recognise waste (Wilson 1997). Originally scholars used it as a metaphor (Greenberg et al., 1997; Frost et al., 1991) though many have began to employ culture as a variable rather than a "*root metaphor*" (Wilson, 1997, page 88); something an "*organisation had*" versus something "*it was*" (Wilson, 1997, page 89). The prevailing literature proceeds to split culture into four types (Denison, 1990; Schein 1991; Peters and Waterman, 1982; Deal et al.,1982 and Barley 1983); adaptability/entrepreneurial culture characterised by a strategic focus on the external environment through flexibility and change to meet customer needs; mission culture dwells heavily on a clear vision (Deal et al., 1992; Martin 1992). The clan culture focuses on involvement and participation of members to meet changing external demands (Saffold, 1988). The bureaucratic culture supports a methodical approach to its daily activities (Lewis, 2002). Despite attempts to homogenise organisation cultures, sub-unit cultures are likely to remain and develop somewhat idiosyncratic cultures (Hofstede et al., 1990; Weick 1991; Feldman 1991). Undoubtedly culture evolves over time (Kotter and Heskett 1992) as a result of the turnover of group members, changes in the company's market environment and general adjustments. However, changes in the underlying values and norms determining behaviour may not alter and what companies may witness is merely behavioural compliance (Denison, 1990; Wilson, 2001). Cultural control does not seem possible in the mechanistic ways prescribed by advocates such as Peters and Waterman (1982) and Deal and Kennedy (1982). Trompenaars et al., (2004) recap that the mechanisms put forward are often distasteful, coercive and manipulative. Schein (1991) maintains that a culture will not alter unless it is brought to the surface and confronted.

2.3.3 Whether culture needs to mirror the Lean journey

Contemporary research reveals various anomalies. Deducting a profile of the current culture would enable organisations to cautiously bring the elements of the culture into alignment and move forward towards an ideal (Denison, 1990). Equally, a cultural assessment can enable organisations to analyse the gap between their current and desired cultures respectively (Qubein, 1999). The clear message from the Manufacturing Foundation's study (2004) is that one size does not fit all in the application of Lean; equally that methodologies and diagnostic tools need to be flexible enough to fit in a variety of programmes (Clemente et al., 1999; Albert, 2009; Bate 1994; Drew et al., 2003).

Hampden – Turner (1998) argue that a uniform implementation plan would probably yield varying results in different countries; the plan needs to be adapted to the ethnological culture specific to the region. Sadri (2001) and Kotter et al., (1992) maintain that culture can be manipulated to secure competitive advantage. Nelson et al., (2002) and Argis (1996) suggest that when an initiative's implementation conflicts with culture, the implementation will be resisted in one of two ways; either the system will be rejected or it will be modified so that it matches the existing culture. However, Doherty and Perry (2001) stress that many studies rely on interviewees' perceptions of cultural change, primarily evidenced through changes in user behaviour rather than explicitly measuring changes in assumptions, beliefs and values of the affected users. Nonetheless, Sathe (1983) and Wilson (1997) dispute that it is reasonable to assume that behavioural changes indicate cultural changes since the former is recognised to be the observed manifestation of a cultural change programme.

Firm evidence suggests that creating changes in organisational culture is difficult (Johnson et al., 1993; Nisbett, 2004). Smith and Peterson, (1988), promote that there exist case studies published of organisations: "*within which major changes in culture have been successfully accomplished...but these are rare*" (page 121). Lean thinking based on the Toyota way involves a far deeper and more pervasive cultural transformation than what most organisations could begin to imagine (Fitzgerald 1988; Greenberg et al., 1997). An inherent problem in Britain is that Lean reflects a slow cultural change, yet companies are under pressure to deliver benefits within the first year of implementation (Neely, 2005). Subtle attempts to modify culture by managers may reap greater benefits (Greenberg, 1997; Doherty et al., 2001; Sathe 1983; Kanter 1983). Lean enterprises, suggest Womack et al. (2005) need to accept that if an appropriate and effective culture exists, it would be desirable to take steps to support or reinforce it. Accordingly, if the culture is inappropriate, to determine what needs to be changed and to develop and implement plans for change (Jones, 2009).

The work of Spear et al., (1999) can be used as a template that states that the TPS can be summarised in four basic rules. The first surrounds the issue of standardised work methods that are fundamental to Lean; cultures recognising the importance of Heijunka (levelling out the workload), product volume mix, the demand on people, equipment and suppliers are absolutely crucial. This enables waste easier to detect. The second rule embraces the issue of supply chain management. Toyota, for instance, (Womack, 2005) created the "Supplier Consulting Group" reassuring that its suppliers can adjust to its JIT procurement. Toyota ensures that all its major suppliers are part of the Toyota's supplier association who meet to share best practices, information and concerns. Rule three focuses on the factory layout and workplace design regarded essential for Lean. Rule four incorporates the continuous pursuit for perfection by exposing problems. In Lean, the expectation is that everyone has two responsibilities. The first is to run the business on a daily basis. The second is to improve the business or contribute towards this continuously (Spear et al. 1999; Womack et al. 2005; Johnston, 2009).

2.3.4 Elements of a conducive culture for Lean

Practitioners, suggests Buhler (2005) are recognising the association between culture and organisational performance. Balmer et al., (1999) and Argyris et al., (1996) propose that consumers are attracted, not just to the products but to the entire communication environment around their purchases; equally to the idea of supporting a company whose values and styles they respect. Morgan (1997) claims that a positive culture activates learning and continuous improvement as information flows freely. Other benefits include reducing labour turnover and attracting top employees as evidenced by books such as "*The Top 100 Best Companies to work for in America*" argue Johnson et al. (1993). Furthermore, Irani et al. (1997) advise that cultural factors act as strongest motivators for employee retention. Sadri et al., (2001) reflect on Hewlett Packard where in the mid 1990s their Great Lakes division reported attrition of 20%; over 50% of the employees felt "*excessive pressure*" at work. After a program lasting two years the company, despite reduced working hours, increased its production and productivity. However, Lewis (2002) urges that "*the only newness of the learning organisation concept is that researchers and managers are beginning to realise the potential that culture has to influence the long term learning of an organisation*" (page 286). Successful Lean enterprises depict an open culture suggests Schein (1985) whereby people contribute out of a sense of commitment and solidarity. Relationships are characterised by mutuality and support. In such cultures, organisations place a high priority on mutual support, collaboration, creativity and constructive relationships (Hall, 2004).

Similarly, Lean practitioners need to recognise the distinction between organisational climate and culture. Denison (1990) correctly states that culture refers to the deep structure of organisations, which is rooted in the values, beliefs and assumptions of the respective members. In contrast climate is a perception and is descriptive since it examines the aspects of the environment that are consciously perceived by the organisational members. Ahmed et al., (1999) endorse the view that a positive culture encompasses several key elements; namely a clear corporate vision supported by the corporate values (Greenberg et al. 1997; Qubein 1999); that employees are highly valued at all levels and there exists extensive interaction between departments (Clemente et al. 1999); that the culture is adaptable and finally, the culture is perpetuated in some way perhaps through tangible symbols, slogans, stories or ceremonies that highlight corporate values (Greenberg et al. 1997). A recent development has been the link to competence-based management (Wilson 2001; Kanji et al. 1997). The suggestion is that organisations can increase productivity and create a sustainable organisation by developing a culture of competencies that span the business activities (Sanchez et al. 1996). However, Lewis (2002) refutes that by concentrating on the tangible outcomes, organisations loose sight of the intangible aspects of culture and in particular that companies comprise of people.

Evidence dictates that from a corporate perspective (Nelson, 2002; Womack et al., 2003) culture can help explain why some organisations are more successful than others. Kotter et al., (1992) help to summarise the findings into four categories; that culture can have a major impact on a firm's long term economic performance; that it will play a bigger role in the future; negative cultures can easily develop even when employees are seen to be reasonable and intelligent; that whilst difficult to change, corporate cultures can be made more performance enhancing. Furnham et al., (1993) state that: "*a good culture is consistent in its components and shared amongst organisational members, and it makes the organisation unique, thus differentiating it from other organisations*" (Page 240). However, as intimated by Morgan (1997) cultures that are regarded positive in one set of circumstances or period of time may be dysfunctional in different circumstances. In fact, it could be said that there is no such thing as an ideal culture, only an appropriate culture.

2.3.5 The noteworthy cultural considerations

A Lean culture concentrates on sustaining change through leadership, empowerment and communication. In summary a Lean culture (Greenberg et al., 1997; Buhler, 2005; Chappell, 2002; Cocolicchio 2008; Pullin, 2005; Biddle 2006; Shah et al., 2007; Conner, 2009; Nisbett et al., 2004; Mann, 2005 and Womack et al., 2005) can be defined as containing the following elements:

- making decisions at the lowest level,
- a shared vision amongst all employees,
- a participative leadership style with collaboration,
- there exists a continuous pursuit for perfection,
- teamwork through total involvement and personnel who are fully committed and participating,
- wide and extensive communications about the organisation's overall goals and performance,
- the work provides personal and professional satisfaction for the employees,
- highly skilled workers permitting them to become part of a management team,

- empowered workers,
- shared gains and
- few or no boundaries between the functions.

The Manufacturing Foundation (2004) in its study of 153 companies in the UK reiterated the core implementation themes depicted in successful Lean implementations:

- the Lean focus is carefully chosen; the boundaries are carefully selected and well defined,
- expert advisors train the trainers; that internal or external sensei with relevant experience are used,
- programmes deliver quick gains; the cautionary note to make is that Lean is necessary and would not be sustainable without investment in the future,
- staff gained accredited training qualifications; there were numerous examples cited and the initial impetus was achieved from Cardiff's LERC which promotes consistent and universal standards,
- results are captured; their research showed that the reported paybacks of 5:1 or 10:1 were not just spin. Unfortunately, many organisations used operational measures alone to quantify the success of their Lean programmes. More companies need to measure the impact of Lean on financial measures such as the return on sales, return on Capital employed and cash flow. Their study also revealed how 86% of their clients stated that they continued to spend their own money on Lean once the funding from other sources had ceased,
- people network and to share the overall learning. Networks have proven to become one of the most common sources of "non-threatening" information and knowledge on Lean.

2.3.6 The "Halo" Effect

Phil Rosenzweig (2009) unmasks the delusions that are commonly found in the corporate world. These delusions affect both the business press and academic research proposing to reveal the secrets of success or the path to excellence. The most pervasive delusion is the "Halo Effect" (page 14) suggesting that when a company's sales and profits are high, the conclusion often made is that it has a brilliant strategy, has a visionary leader, capable employees and an inspired corporate culture. When performance falters, the conclusion made is that the strategy was wrong, the leader became arrogant, the employees complacent and the culture was stagnant. In fact, little may have changed, since the company performance creates a "Halo effect" that shapes the way we perceive strategy, leadership, people and culture.

Rosenzweig's work builds on concern expressed by other researchers about misusing the term "*strong cultures*" (Lewis, 2002, page 283). Saffold (1988) and Schein (1992) had intimated that strong cultures may not lead to organisational effectiveness. Bate (1994) argues that strong cultures raise fundamental ethical questions about the managerial ideology. Daft (2001) remonstrates that it may be more appropriate to examine the level of agreement amongst members on specific value issues; this has been subsequently reinforced by Rosenzweig (2009). Liker (2004) and Mann (2005) believe Toyota is the best learning organisation; it sees standardisation and innovation as two sides of the same coin, combining them in a fashion that facilitates great continuity. Great organisations realise that the key to organisational learning is to align the objectives of its employees towards common goals (Hall, 2004).

Rosenzweig (2009) argues in his book that often business writers tend to seize on habits of companies that happened to declare good results without really considering their cause and effect. An important revelation from his book is that the impact of company performance on employee satisfaction is more powerful than is true of the reverse. He is also critical of the "best of" lists arguing that people assembling these make the critical mistake of only examining the traits of outstanding performers. In fact, the halo effect is only one amongst the business delusions that Rosenzweig (2009) discusses in his book. The others that he expounds upon are the delusions of:

- single explanations
- lasting success and
- Absolute Performance.

The "delusion of single explanation" (page 80) is about the search for the one '*explain everything*' answer to enlighten a particular result or a phenomenon. He suggests that it is a human weakness for neat stories with simple causes and effects. Equally it is a reflection of a considerable amount of our analysis processes, which research has shown, stops at the 'makes sense' threshold, whereby this actually may make no sense at all. "*Delusion of lasting success*" (page 101) is scathing on some of the popular management books and some of their authors which promise to provide a system to secure lasting success, if only we follow their formula for it. He is scathing of three of the most popular management books, 'In Search of Excellence by Tom Peters and Bob Waterman and the two best sellers by Jim Collins '*Good to Great*' and '*Built to Last*'. "Absolute performance" (page 110) refers to the need to out-perform ones competitors; a business may declare falling profits and market share despite improving key performance indicators since its competitors achieved better results.

Consequently, this research, as a direct consequence of the prevailing evidence, sought to investigate how the organisations managed to:

- make decisions at the lowest level which could be assessed by the number of organisational levels, (Shah et al., 2003),
- put forward a view that a definite clarity of vision is required (Hines et al., 1998); an indication of the organisation's status once the transformation is complete,
- ensure that there is a strategy of change whereby the organisation communicates how its goals will be achieved (Smalley, 2006),
- assign responsibilities within the pilot programme initially and ultimately within the whole organisation so that it is also evident who is championing the programme,
- develop supplier relationships based on mutual trust and commitment; this could be assessed by aspects such as:
    - number of years a relationship has existed with a supplier,
    - percentage of procurement £s purchased under long term supplier agreements,
- nurture a learning environment for which indices such as, training hours / employee, can provide an approximate barometer ("Manufacturer", 2005),
- systematically and continuously focus on the customer; this could be signalled via the percentage of projects in which the customer was involved (Koenigsaecker, 2000),
- promote Lean leadership at all levels, observed by the number of Lean metrics at all levels (Quinn, 2005),
- maintain the challenge of existing processes through, for example, number of repeat problems and customer assistance to suppliers (Hines et al., 2008),
- make a conscientious effort to maximise stability in a changing environment whereby an attempt is made to reduce:
    - Schedule changes,
    - Program restructures and
    - Procurement quantity changes,
- assess the fraction of an organisation's employees operating under Lean conditions,
- observe the proportion of an organisation's departments pursuing Lean,
- suggest Lean is a long term commitment (Emiliani, 2003; Gregory, 2002; Liker, 2004). A medium sized company needs a minimum of three to five years to pursue the Lean ideology (Koenigsaecker, 2005). According to the prevailing British classifications, (CIMA, 2005), to be regarded as small or medium it is necessary to fulfil any two of the criteria listed in Table 2.1 This classification is used throughout the analysis:

	Small	Medium
Turnover (less than or equal to)	£3.1 millions (net) £3.76 m (gross)	£12.2 m (net) £14.5 m (gross)
Aggregate gross assets (less than or equal to)	£1.9 millions (net) £2.18 m (gross)	£6.6 m (net) £7.72 m (gross)
Number of employees (less than or equal to)	50	250

Table 2.1
Classification of British Organisations

2.3.7 Relevance of an appropriate change strategy for Lean

Culture and change have contributed to every Lean failure (Hines et al., 2008; Lee, 2007; Womack et al., 2005; Koenigsaecker, 2005). Every company needs to find its own way to implement Lean. There is no universal way that will apply to all (Ransom 2008). The success of Lean depends on the willingness of the workers to collaborate (Cocolicchio, 2008). Successful Lean implementations have confirmed the need for certain core characteristics (Mann, 2005; Hall, 2004; Parks, 2002). Leadership and management need to be participating members of the total team. The leadership team has the total responsibility for the creation of this culture (Sim et al., 2009).

A consistent vision is a definite requirement to succeed as a Lean enterprise (Biddle 2006). Often this serves as a roadmap to success through the business plan. Before any organisation takes the first step of any journey, it is important to know where you want to go (the objective) and how you intend to get there (the plan). Consequently, it is necessary to cascade the top-level strategies into the division, department and finally to individual responsibilities, action plans, quantifiable goals and timeliness (Pullin, 2005). Instead of focusing on Lean techniques it is important to get the culture right first; unless, the organisation manages to anchor these new behaviours into its culture, the transition is doomed to fail (Mann 2005; Buhler 2005; Deal and Kennedy, 1982; Peters and Waterman, 1982).

There exists a need to create a sense of urgency since this reinforces the Lean competitive philosophy of speed to market (Sohal et al., 1994; Spear et al., 1999). Equally, Lean systems are much more tightly interdependent and when problems occur the processes require more attention to ensure stability. An underlying requirement for this change (Ohno, 1988; Liker 2004; Mann, 2005) is the need to produce short term results in order to secure integrity. Correspondingly, there exists a need to recognise that ultimately the best people to deliver any cultural change are the internal staff. Many proponents suggest securing the services of a change agent who is able to understand the whole system (Doherty et al. 2001; Mora 1999). Many Lean journeys are doomed for failure since there is no recognition that the services of a "sensei" are needed (Ichimura et al., 2006). If the sensei has performed his/her job, they should eventually work themselves out-of-a-job. People will change if they witness the benefits (Daft 2001). Evidence (Womack et al., 2005) suggests that it is preferential to be discrete and work on a specific project, rather than commit to a global or strategic thrust without having control. Equally, it is recommended to agree the duration of a project prior to its commencement as research demonstrates that change can be sustained over short periods. Closely aligned to this aspect are other components of Lean; standardisation and visual controls, for instance, are needed to assist the organisation in its endeavours to focus on the process. Often, for large projects, it may be necessary to breakdown large scale and long term projects (Wilson 2001; Hall 2004) into incremental goals (Henderson et al., 2003). Likewise, it is critical to assemble a strong enough team to direct the process.

Fear and anxiety should be removed to achieve the necessary trust (Henderson et al. 2003); often people are interested in their immediate environment; interest decreases the more remote the subject of the information is (Deal et al., 1982). Empowerment of employees is another imperative pre-requisite (Motley, 2004; Campell, 2006). Employee engagement is not a widely used term but it is absolutely vital for success (Helms et al. 2001). Research, ("Manufacturer" 2002), states that if employees are to make a contribution which sets them apart from the competition, work needs to be stimulating and satisfying as well as providing an opportunity to develop the skills to perform well. The "Manufacturer" 2002, states that 18% of the variations in productivity and 19% in profitability are accounted for by people management practices. Lean is not just a set of tools and techniques but at its heart are the people (Ohno 1988). It is the people whose knowledge, intelligence and desire to improve that steers organisations to new levels of continuous improvement. Equally the Manufacturing Foundation (2004) uncovered who takes responsibility for getting Lean started; interestingly 30% of the organisations were led by their top management as depicted in Table 2.2

Who takes responsibility for getting Lean started?	
Personnel	**%**
Specialists and other employees	25
Managing Director/Chief Executive	24
Other employees	18
Chairmen	6
Technical specialists	6
Supervisors	1

Table 2.2
Lean Starters

However, Ichimura et al., (2006) suggest that despite the high percentage of companies (91%) that consider Lean to be important, disappointingly, 64% of the companies felt that the workers did not have the right understanding of Lean. Equally, 55% of the organisations did not have a Lean training programme. Work related habits are just as difficult to change as are the personal habits. Psychologists use the term "extinguish" (Mann, page 16) when talking about changing habits. Extinguish implies a process taking place gradually rather than an event producing a suddenly changed state. At close examination, the Toyota Production System is about applying its principles. It proceeds to demonstrate how a strong, stable culture can be instigated whereby the company beliefs are widely shared and lived out over a period of many years (Bicheno et al., 2009). When an organisation proves to be serious regards its Lean journey it is necessary to institutionalise the improvement and sustainability (Johnston, 2009). Lean enterprises wishing to succeed in their quest cannot afford negative sub-cultures (Womack et al., 2005). Different cultures exist in most organisations; the culture of an outward-looking marketing department may be substantially different from that of an internally focussed manufacturing function. However, the aims and objectives need to be similar (Albert, 2009).

An important element to successfully implement Lean is a compensation system that links directly to the annual business plan (Baggaley, 2006). A balanced compensation plan which focuses on measures of continuous improvement, operational efficiency, teamwork and short-term results will promote the culture where Lean initiatives can survive, thrive and produce tremendous results (Kroll, 2004; Fullerton et al., 2009). Individual pay systems pay for the job, and do not differentiate skills or contribution sufficiently (Neely et al., 2005). Group and organisational-based pay plans encourage cooperation amongst workers, more than individual plans. Research (Ligus, 2007) reveals that the results are best when the following are practiced:

- workers focus on specific goals,
- the goals are achievable as perceived by the workers,
- Objective measurement is deployed and visible.

In summary the following form the best practices in managing the intricate process of Lean change in order to accomplish the desired culture; (Allio 2006; Hines et al., 2008; Ichimura et al., 2006; Biddle, 2006; Sim et al., 2009):

- create a sense of urgency and communicate it to the whole organisation,
- develop and communicate a vision and master plan that everyone can relate to,
- Create a Lean steering Committee to oversee the Lean initiative,
- assign a programme Director whose sole responsibility is to implement Lean,

- analyse the organisation's inclination for change,
- educate and train managers, staff and workers,
- develop and implement Lean performance indices,
- promote the involvement of all parties to secure authorship, ownership and buy-in,
- develop a detailed Lean implementation plan,
- provide adequate resources to accomplish the vision,
- align the culture, performance reward systems, pay systems, performance measurement systems and workforce organisation with the Lean vision,
- empower action and assist to eradicate barriers,
- develop a pilot and make it a success,
- celebrate and publicize the success,
- extend the pilots until all is accomplished,
- ensure rigour; embed the changes in formal polices, procedures, processes, work standards, job descriptions and skill classifications.

2.4 Prominent Lean enterprise objectives

The Lean Production concept was viewed as a counter-intuitive alternative to traditional manufacturing (Womack et al., 1990; Shingo, 1989; Krafcik, 1988). Katayama et al., (1996) declared that it is arguably the paradigm for operations. Despite its pre-eminence there remain a number of theoretical and methodological concerns (Oliver et al., 1998). Lavelle (2000) proposes reducing costs and shorter lead times ranked highest amongst the quoted objectives. These results are consistent with the notion proposed by consultants (Claudius-consulting, 2004; XR Associates, 2004). Standard (2000), is emphatic that the single measure most organisations strive towards is that of the total product cycle time.

Moore (2001), Convis (2001) and Hines et al., (2008) assert that Lean should not lead to redundancies. Dimancescu et al., (1997), Bateman (2001), Hanson et al., (1998) and Cocolicchio (2008) concur that growing profits through cost cutting is not likely to be sustainable and must be balanced with sales growth through innovation, new product development and process improvement. Maskell et al., (2004), dwell on the need to realign the financial goals with those Lean attempts to accomplish. Krizner (2001) clearly regards that the ultimate goal is the elimination of waste, as it can account for between 55% and 95% of the manufacturing process. The true benefit of Lean, insist Meier et al., (2001), is the overall strengthening of the system. When applied properly, Lean methods will make any shortcomings in the system appear quickly and they will have a profound impact (Ransom, 2008). In fact, a survey carried out by Sanchez et al., (2000), showed that the three most important indicators were:

- inventory rotation,
- lead time of customers orders and
- the percentage of production procedures that are documented.

More work is required to assess the correlation between the joint uses of these production indicators.

Despite some voices of discontent (Moore et al., 1997; Berggren, 1993) more companies are changing their production methods and management practices to become Leaner (Ransom 2008). Katayama et al., (1996), argued that when Womack and his colleagues conducted their research, that it was *"during conditions of a bull Stock Market and low interest rates"* (page 9). Equally, Hall, (2004), points out that the *"differences between the Toyota Production System, as practiced by Toyota and Lean manufacturing are significant. Two of those are that the TPS emphasises, worker development for problem solving and spends much more time creating standardised work, which Lean seldom incorporates"* (page 22). Bergstrom, (1994) proposes that a weakness of Lean is its inability to accommodate the variations or reductions in demand for finished products which are occurring in many Japanese companies. However, Chase (1999) warns that *"it is a long-term plan to actually implement a Lean enterprise"*, (page 36). Emiliani, (2003), suggests that the focus of Lean needs to switch to the supply chain, product development, administration and behaviour, if the full benefits are to be realised. At no stage should an organisation even assume that the Lean tools are a strategy. An absolute necessity is that the appropriate tools should be applied in the right circumstances within the context of the organisation's value chain. Despite the documented successes the majority of Lean implementations fail to achieve the ideology since there remains confusion between the Lean goals and the intended results (Hanson et al., 1998; Campell, 2006; Conner, 2009).

Jauch et al., (2001) provide a blunt synopsis by revealing that businesses performing formal strategic planning have a higher probability of success (Lee, 2008). Organisations on a Lean journey but with no strategy in place are at risk of failure at worst and at best, risk delaying / reducing the benefits to be enjoyed from Lean (Jauch et al. 2001; Lee 2007). Moreover, when a prevailing strategy is focused towards operational improvements instead of higher profits and an increased ability to compete, it will prove to be a futile strategy (Johnston, 2009). Lewis (2000) and Lin et al., (1999), exhort caution with the generic assertion that Lean aids an organisation's performance. Investigations of the relationship between profitability and

Lean adoption by Oliver et al., (1998), found no statistical significance between high level and low level users except that high level users exhibited much higher volatility in profits. Katayama et al., (1996), recommend that Lean production is incapable of responding to large oscillations in aggregate demand volumes, arguing that the Japanese economy at the time of the IMVP study was exhibiting specific conducive characteristics, creating conditions of high and stable domestic demand.

Lewis (2000) argues that the critical issue appears to be the firm's ability to appropriate the value generated by any savings the organisation makes. However, his investigation was based upon empirical data drawn from three case studies; ideally a more statistically significant sample size would have probably offered more valid conclusions (Silverman, 2000). Organisations need to consider their business as a "value system" from a customer's perspective and have a preference towards growth-oriented targets rather than cost-cutting ones (Cocolicchio, 2008). Consequently, instead of the fixation of considering Lean as a means to achieve additional margins to boost share prices it should be focused towards sales and becoming more responsive to demand (Parnell, 2005). Bicheno et al., (2009), insist that the most successful organisations need to integrate systematic changes to match the needs of the customer, strategy and people in the business; that Lean needs to look beyond manufacturing. Bicheno et al., (2009), dwell on the concept of a total Lean enterprise and suggests that it is new product development where leading Lean organisations are becoming increasingly competitive.

2.4.1 Focus on Lean having a compelling business case

A debate stems back to Sohal et al., (1994) who concluded that: "*two-thirds of the companies said that a strategic advantage had been generated... with the greatest improvements stemming from market competitive positioning, customer relationships and quality constraints.*"(page 41). Their study based in Australia, (1994), included the top 50 organisations based on the number of employees, revenue and profitability and whose names were supplied by the "Business Council of Australia" and the "Australian Chamber of Commerce." A concern about the study was that the method of data capture adopted was that of a telephone survey. A sizeable portion of literature, Billesbach, (1994), Nystuen, (2002), Standard et al., (2000), Vasilash (2001), Parker (2003), Olexa (2002)(i), Siekman (2000), Quinn (2005), Liker (1996, 2004), Prizinsky (2001) Oliver et al., (1996) Hines et al., (2008) Lathin et al., (2001) and Sheridan (2000) maintain that traditional mass producers can expect a reduction of 90% in lead time, 90% in inventories, 90% in the cost of quality and a 50% increase in labour productivity. XR Associates, (2004), ranked amongst the top 10 European manufacturing consultancy and Training providers, as asserted by Ferch (1998), alongside Claudius consulting, (2004), are insistent that Lean Manufacturing can help to reduce waste by 40%, cut costs by between 15% - 70%, decrease space and inventory requirements by 60%, push productivity up between 15% - 40% whilst cutting process changeovers by 60%.

Nystuen (2002) concluded that product lead-time was reduced by 11%, product travel time by 90% and inventory by 82%. However, he fails to reveal the level of investment initially required. Joseph Day, CEO of Freudenberg-NOK in Olexa (2002), is emphatic that $7 million a year is spent on the execution of Lean but this can result in $20 million a year cost savings. However, Bateman (2001) suggests that consultants dwell on the positives of Lean whilst being somewhat sketchy on their respective implementation records. Allen (2000) and Timco (2001) insist that a thorough evaluation of success statistics is required owing to the number of unsuccessful Lean initiatives. Needy et al., (2002), argue that the success statistics can be wrongly weighted since there are only a few true conversions to Lean; a view shared amongst others (Elliott, 2001; Convis, 2001; Liker, 2004; Rea, 2001).

Standard et al., (2000), warn that often some of the intangible benefits of Lean are difficult to quantify. Jusko (1999), as a result of the third annual *"Industry Week*" census corporate survey, claims that 55% of the corporate executives identified Lean as *"extremely critical*" (page 88), to their ability to achieve world class status; another 40% identified it as *"somewhat critical*," (page 89). Nonetheless, when it came to reporting *"wide adoption*" (page 90), 20.3% of the survey respondents stated that they had adopted predictive and preventive maintenance, though no other Lean technique reached the 20% mark in terms of wide adoption. The concept "*wide adoption*" was loosely defined, argues Phillips (2002). Hill (2001) and Moore et al., (1997) allege that many survey respondents may be at the early stages of implementation and would have not yet had the opportunity to realize their full benefits. Directly and indirectly, an estimated 26% of total economic activity in the US could be attributed to manufacturing organisations (Ransom, 2008). Likewise, productivity in the manufacturing sector had risen; a staggering 35% between 1995 -2000 alone, (Standard et al., 2000). Toyota, in the fiscal year ending 2005, reported a global record net profit of about $11billions (Halliday, 2005). "*What puts Toyota above everybody? It is their relentless drive to move forward"* (page 34). In 2004 Lexus retained its title as America's top-selling luxury brand for the fifth consecutive year and the Camry was the nation's best selling car for the third straight year. Toyota's annual profit of $8.13 billion in 2003 was larger than the combined earnings of GM, Chrysler and Ford. It was also the largest annual profit for any car manufacturer in over a decade (Liker, 2004). It has the fastest product development process in the world. New cars and trucks take 12 months or less to design, whilst competitors typically require two to three years (Womack et al., 2005). Equally, in 2003, Toyota recalled 79% fewer vehicles in the US than Ford and 92% less than Chrysler (Liker, 2004).

2.4.2 The Strategic influence of Lean

Lean has a basic goal of satisfying the customer through on time delivery and high quality products by simply eliminating waste (Motley, 2004). Eliminating variability aids to reduce the overall cycle time which is a core objective of Lean. Consequently, this aids to reap the benefits that Lean proponents (Lewis 2008; Ransom, 2008; Albert, 2009) advocate: shorter cycle time, shorter lead times, lower WIP, faster response time, lower cost, greater production flexibility, higher quality, better customer service, higher revenue, higher throughput and increased profit. Lean as a philosophy illuminates and eliminates non-value adding steps; it is also integral to successful product development processes. Time lost, mishandled information, lack of visual status controls and missing standard work are deathly to the R&D of larger corporations (Koenigsaecker, 2005; Ransom 2008; Allio 2006).

2.4.3 Impact of Lean on competition

The great organisations continue to improve their dependability perception. These organisations install strategies for ensuring that the correct goods and services are delivered consistently (Lee, 2007). World class organisations compete aggressively at the market facing end of their respective businesses. Nonetheless, efficient marketing only has an impact if it reflects the even slicker processes supplying the customers' needs. Toyota with its "*no mistakes, no delay, no waste, no failures, no inertia*" (Smith 1995, page 40) style of processing has ensured that this matches Toyota's aggressive marketing campaigns. The most efficient organisations are those that can simplify and smooth the flow from raw material input to the final product. When, companies master the various disciplines of Lean, accuracy, speed, a reduction of waste, followed by a certainty of what they are doing; consequently, they can respond quickly to market opportunities without the inertia which normally accompanies change (Johnston, 2009).

2.4.4 World class organisations

At a global level there are perhaps 50 organisations that can be truly recognised as being world class (Smith, 1995; Carnes et al., 2005). Heymans (2002) and Lee (2007) suggest the criteria attributable to organisations regarded as world class include:

- An uncompromising outlook on quality,
- Agility, flexibility and speed to market of the organisation's products or services,

- Very reliable resources (machines, people and systems),
- The engagement of every employee in change and improvement,
- A non-judgmental, non-blaming organisational culture,
- A genuine persistence and attention to detail,
- A focus on the drivers of cost and waste.

Similarly, it is proposed that world-class organisations such as Toyota, display several distinguishing leadership behaviours; most significantly, the linkage of strategy to action (Jones, 2009). Moreover, from the start, Taiichi Ohno coached his leaders to become familiar with and to observe the process. Furthermore, Toyota persistently sets goals for improvement by challenging people towards higher levels of attainment. Employee involvement seems to be insidious in world-class organisations too (Ichimura et al., 2006). Toyota enables personnel to spend time on continuous improvement besides their everyday tasks. Equally, there is an obligatory focus towards standardisation and often the importance of consistency is not fully recognised. The reduction of lead time generally within manufacturing, supply and in design is central to Lean. Stalk and Hout (1990) identified this as a competitive edge. Womack et al (2005) reiterate this point by stressing that it is never recommended to delay a customer value adding step by a non-value adding step.

2.4.4.1 Aberdeen Group

The Boston–based analyst firm Aberdeen Group in its 2004 survey, "*The Lean Strategies Benchmark report*" (Bartels, 2005) revealed important factors concerning competitiveness. The report was based on more than 275 organisations within USA; 14% have more than $1billion annual turnovers; 16% had between $250m - $1billion; and 70% had below $250m turnovers. They divided the respondents into two categories; the "*early*" (page 1) organisations were those with less than two years Lean involvement. The "*mature*" (page 1) companies had greater than two years' Lean experience. The Aberdeen Group (2004) summarised the top five business reasons for Lean:

- 85% intimated the continued pressure to improve operational performance,
- 81% maintain competitive advantage in price and service,
- 80% to improve profit,
- 75% customers demanding shorter cycle time,
- 64% customers demanding reduced prices.

The study concluded that when a manufacturing operation successfully applies a Lean strategy across the entire organisation, it is as much as three times more likely to be an industry best-in-class performer than the laggards. Equally, it is between 2.5 - 6 times less likely to be as severely affected by customer pricing and service demands and the related squeeze on profits. The Best-in-Class performers were 2.5 times more likely (25% as opposed to 10%) to indicate that customers demanding reduced prices were not important or only somewhat important to their organisation. Moreover, the same organisations were three times as likely (18% versus 6%) to indicate that customers demanding shorter cycle times were not important or only somewhat important to their organisations than other classes of performers.

The NIST report (2003) states that the benefits from implementing Lean can be split into three broad categories:

- Operational,
- Administrative and
- Strategic.

Most organisations on the Lean journey try to implement Lean primarily for operational improvements. Research (NIST Manufacturing Extension Partnership; 2003) in 40 organisations suggested that administrative and strategic benefits should not be under-rated. The typical operational improvements reported were as follows:

- Cycle time reduced by 90%,
- Productivity increased by 50%,
- Work-in-progress inventory reduced by 80%,
- Quality improved by 80% and
- Space utilization reduced by 70%.

The administrative improvements stated were as follows:

- Reduction in order processing time,
- Streamlining customer service functions so customers are no longer placed on hold,
- Reduction of paperwork in office areas,
- Reduced staffing demands, allowing the same number of office staff to handle larger numbers of orders,
- The streamlining of processing steps enabling the out-sourcing of non-critical functions. Consequently, this permits the respective organisation to focus on the customer needs,
- The implementation of job standards and pre-employment profiling ensures the hiring of above average performers only.

Strategic benefits are also accrued. However, evidence suggests that many organisations who implemented Lean do not adequately take advantage of the improvements. An organisation able to reduce its lead time began a marketing campaign that customers would receive their products earlier. Subsequently, sales increased. Not content, the organisation advertised that for a premium the shipments would be even earlier. Many of the existing customers also signed up to this agreement resulting in a huge increase in cash flow. Successful organisations learn to convert the advantages into tangible benefits. By reducing lead times, organisations can make quicker promises to customers which enabled the latter to reap these benefits by having to hold less stock. This can then increase sales of the Lean organisation facilitating earlier invoicing which improves the cash flow of the Lean organisation. Lean enables the company to become more responsive to market demands, deliver products and services faster and provide products and services less expensively than their non-Lean competitors.

2.4.4.2 PSDC Study

The McKinsey & Company's Production System Design Centre (PSDC; 2002) research showed that more than seven out of ten poorly performing companies in the UK manufacturing sector could double their return on capital and proceed to boost productivity by 20% provided all the Lean principles are adopted. Equally, 71% of businesses which delivered mediocre financial returns (less than 10% on capital) were making poor use of Lean techniques. Likewise, 60% of the strongly performing organisations (those that generated a return on capital employed, ROCE, in excess of 10% every year over a five year period) were making good use of Lean manufacturing techniques. The consensus was that Lean aids competitiveness. The results show a strong correlation between the depth of understanding, the adoption of Lean and the financial performance. Six out of ten strongly performing companies were making strong use of Lean. Three in ten of the good performers were ranked as average and one in ten was ranked poor at Lean. Of the poorly performing businesses, more than seven in ten were making poor use of Lean.

2.4.4.3 Oliver's Lean

Nick Oliver (2007) undertook a benchmark study of over 100 automotive component makers in Japan, Europe and USA. The Japanese component plants continue to be the best performers in terms of labour productivity and quality. In respect to quality, in Japan the defect rate had been improved by 58% between 1994 -2001 to an average external defect rate of 81ppm. US organisations had progressed by 35% and averaged an external defect rate of 111 ppm. Whilst, advances had been made by the British organisations and the defect rates had improved by 75%, it was a low base and performance in terms of ppm was still 5 times worse than the Japanese plants averaging an external defect rate of 416. Nonetheless, he did suggest that there was evidence that the British organisations were beginning to overcome some of the major attitude and behavioural hurdles in order to create environments where Lean could begin to prosper.

2.4.4.4 EEF Reports

The EEF final investigation (2001) was conducted in 352 EEF member companies. The productivity report showed that organisations pursuing Lean across the whole Value Chain (33%) were reaping benefits of improved performance. Nonetheless, there were over 40% of the organisations not pursuing Lean and had no plans to pursue it. Over 70% of the organisations cited overall company performance in terms of increased efficiency, productivity, profitability and lower costs as the main reason for their interest in Lean. 25% mentioned it brought them higher productivity and lower manufacturing costs. Increased competitiveness and reduced downtime were mentioned by 155 of the respondents. However, over 90% stated that the introduction of Lean had been either very or fairly successful in achieving its goals. However, a greater proportion of US-owned firms were using every Lean tool. Larger firms were deemed to be recording greater success though the intensity of its application was greater too. Equally, those firms using four or more of the key Lean tools experienced the greatest increases in productivity and profitability; the average productivity increase for the previous two years for those using four or more Lean tools was 11%; for those not engaging in Lean it was 7%. Likewise, the equivalent numbers for profitability were 8% and 6% respectively.

2.4.4.5 Shah's Bundles

Shah et al., (2003) examined in detail three organisational characteristics; namely unionisation, plant size, and plant age. Much of the empirical evidence has been constrained to one or two facets of Lean, often JIT or TQM. They selected 22 individual Lean practices and pooled them into 4 bundles; namely JIT, TPM, TQM and human resource management. All practices connected to production flow were shared to form the JIT bundle. Whilst some advocate that older plants often employing older work forces are more resistant to the changes; the evidence suggested that older plants are less likely to implement only five practices relative to newer plants. More evidence exists to support that large plants are more likely to possess the resources to implement Lean practices than smaller organisations. The findings are consistent with the literature (White et al., 1999). The larger plants are more likely to extensively implement all but five of the Lean practices. Lean advocates often propose that Lean should be considered as a system and that benefits accrue from all the practices (Womack et al., 2003). Consequently, taking this in to consideration, Shah et al., (2003) in their study of the four bundles; namely JIT, TQM, TPM and HRM found a positive correlation with operational performance. As a group they accounted for 23% of the variations in operational performance even after accounting for the effects of industry and organisational context.

2.4.4.6 AME Study

Koenigsaecker (2005) summarises the study undertaken by the AME (Association of Manufacturing Excellence) whereby senior leaders of North American companies were surveyed. Only 3% stated that they were on the Lean journey and achieving great results. However, this sample stated that in addition to productivity gains, the benefits enjoyed were:

- A reduction of 95% in lead times,
- A reduction of accident rates by 95%,
- A reduction in customer complaint / reject rates of over 90%, and
- A reduction in floor space of over 80%.

2.4.4.7 The "Manufacturer"

The Manufacturing Research Centre surveyed more than 200 UK manufacturers in January 2005 ("Manufacturer" 2005). 212 surveys were completed by senior managers and decision makers at UK manufacturing sites. Fortunately for the 92% of manufacturers for whom reduction in costs was a current key priority; this was the area that had seen the most significant improvement. More than half had seen a major improvement in reduction of costs, and a mere 4% had experienced no improvement at all. Increased efficiency and reduced waste improved significantly as a result of Lean. In fact, the only area that had not improved appreciably was the speed at which new products are launched; almost 50% had seen no improvement at all in this regard and 33% had seen minor improvements.

2.4.4.8 The Manufacturing Foundation

The Manufacturing Foundation, 2004, demonstrated how Lean works for organisations and how many achieved paybacks that covered the cost of investment several times over. Their findings were attained from 153 companies in the UK and from a range of sectors. In its detailed study of 13 British organisations huge savings were quoted. Amongst the 13 Case Study organisations, seven reported Lead time reductions, with the largest reduction of 75% and the largest absolute reduction from "six weeks to the next day" (page 39). Five organisations reported productivity improvements ranging from 6% to 40%. Two organisations achieved cost savings of over £400,000. Six organisations increased turnover; three by over 25% and one by over 100%. In summary 62% of the 153 overall organisations reported a benefit from their Lean implementation. 23 of the 55 manufacturers reported a major impact on Lead time; nine achieved lead-time improvements ranging from 10% to 30%. Three organisations reported an improvement in lead-time performance of between 30% - 70%. 29 of the 55 organisations also claimed a significant improvement in quality; 15 organisations reported an improvement of between 1% -10%. Nine felt quality had improved by between 10% - 70% and six felt it exceeded 70%. 37% of the 153 organisations stated that their primary objective in embarking upon Lean was to achieve cost reductions. However, only 14% could quantify the cost savings achieved.

2.4.4.9 Ransom Research Institute

Ransom (2008), President of the "*Ransom Research Institute*," an independent equity investment research firm serving major investment organisations suggests Lean gives organisations a competitive edge. It improves financial performance, which ultimately enhances valuations. Toyota and the Danaher business systems are regarded as the top two Lean companies globally. However, it implies that for a Lean organisation to make a real impact on the stock market, it takes between five to ten years. Danaher, for instance, was probably working on Lean for five years before Wall Street recognised this fact. Wall Street is not well informed on Lean and is driven by GAAP (General Accepted Accounting Practices) financial statements. The term "*Transactional Lean*" (page 9, Ransom 2008) whereby:

- The back office,
- Administrative service,
- Financial Lean, and
- order processing

are areas considered where quantities of muda exist. Ransom (2008) feels that organisations quoted on the stock market have been able to have a positive impact on their valuations through the following improvements:

- Inventory reduction particularly WIP,
- Physical room to grow,
- Avoidance of capital expenditures,
- Productivity acceleration,
- Cycle time acceleration,
- Quality enhancement,
- Bolstered competitive position and
- Increased liquidity.

However, Ransom (2008) proceeds to suggest the following improvements too; though the issue of not being able to easily identify metrics for them makes it difficult to quantify the benefits:

- Reduced floor space,
- Reduced WIP,
- Elimination of finished goods inventory,
- Decreased cycle times,
- Enhanced quality,
- Correspondence with takt time, and
- Improved customer satisfaction.

Overall Ransom (2008) maintains that in his experience of consulting with around 150 organisations a year which are both on the Lean journey and quoted on the stock market the following benefits have been secured as a result of Lean:

- Organic revenue growth of between 6% - 8%,
- Total revenue growth at between 10% - 12%,
- Income growth rate of between 12% - 15% and
- Cash conversion of greater than 100% of net income.

2.4.5 Lean spin-offs

2.4.5.1 Effect on the People

The impact on people is another good reason to engage with Lean. More evidence suggests that people choose jobs and employers primarily on what their opportunity and experiences will be, not just wages. Developing the culture that engages the entire workforce and drives continuous improvement will assist the organisation to recruit and retain the best individuals (Drew et al., 2003).

2.4.5.2 Partners and customers

The principle of collaboration involves working with partners and customers in a much more intimate way (Campell, 2006). This can assist to improve many aspects of a manufacturing company's operation from production, to supply chain management, to fulfilling orders and satisfying customers (Biddle, 2006). It essentially entails the need to share critical information with suppliers, partners and occasionally customers. Lean can only be implemented to an extent before an organisation needs to actively engage its total supply chain including customers and partners. Essentially, an organisation's strategic partners need to be permitted to view its activities (Lewis 2008). Likewise, standardisation is necessary; the sharing of information in a similar format and context so that organisations can automate information whenever possible. Subsequently, this leads to harmonisation; the process of agreeing the established standards with your partners (Lee, 2008). Whilst, Ohno (1988), clearly stated that the objective of the Toyota Production System was cost reduction. One needs to take this into context since in the 1950s Toyota had to overcome a 10:1 productivity handicap against the US manufacturers. In 2009, the cost pressures are still evident as US and Japanese manufacturers are faced with low-wage competitors (Johnston, 2009). However, the wage gap is so wide that there is no way cost reduction alone can bridge this gap. To be competitive, organisations need to have an edge on quality, lead time, flexibility, and product innovation. In this sense, Lean can be viewed as the pursuit of concurrent improvement in all dimensions of manufacturing performance. A study by PriceWaterhouseCoopers (2005) stated that if an organisation generates 80% of its revenues from new products, it would double its market in five years.

2.5 The implementation of Lean

Sheridan, (2000), proposes that it takes *" three years to become competent in applying such tools as set-up reduction, standard work or cell building and five years to instil a firm belief in all the tools*" (page 38). The University of Michigan and Prof Liker have been at the forefront of Lean research for over a decade; he unequivocally promotes a total approach; that Lean cannot work with isolated tools. Elliott (2001), Shingo (1989), Sanchez et al., (2000), Rea (2001) and Meier (2001) urge this policy too. Securing the full benefits of Lean requires a need to concentrate on the whole value chain (Comm et al., 2000). Convis (2001), Allen (2000) and Henderson et al., (2004), contend that for the Toyota Production System to work effectively, it needs to be adopted in its entirety, not piecemeal. Allen (2000) claims "*that Lean manufacturing is a system approach. Each approach builds on the previous one, anchoring the systems as a whole...introducing a scattering of Lean tools that are not properly used...simply bewilders the workforce.*" (page 55).

Bergstrom (1994), Allen (2000), Timco (2001) and Muffatto et al., (1999) advise Lean is an entire business philosophy, as instigated by Ohno (1988). Karlsson et al., (1996) admit that a total philosophy is needed. Chase (1999) argues Lean *"also means that the business is examined in its entirety, including how orders are processed, the way materials are purchased and the way manufacturing is done*" (page 34). Lathin et al., (2001)(i), subscribe to the total approach and stress the need to combine the "socio-technical systems"(page 324); that all work organisations combine a technical, i.e., technology, and a social system, i.e., people and organisational structures. Convis (2001) and Pullin (2002) propose that the TPS is an interlocking set of three underlying elements: the philosophical underpinnings, the managerial culture and the technical tools. George Koenigsaecker, in Sheridan (2000), who has directed Lean conversion initiatives in 18 manufacturing plants comments:

"*often people who attempt a Lean conversion start with one of the tools, or a couple, and they push them through the organisation. They then wonder why things are not flowing in the total value stream. The problem is that there are about a dozen key tools in Lean manufacturing and you have to move them all ahead somewhat simultaneously*;" he continues, "*it is a long learning curve*"(page 33).

Pullin (2002), insists that Land Rover, winners of the MX2002 "Manufacturing Excellence Award", adopted Lean but had adapted it to tackle local circumstances. Hall, (2004), reaffirms the difficulty of applying the TPS to other companies without appropriate adjustments. Whilst Womack et al., (1990), popularised Lean, the text is scant on the details of the methods for achieving it. The common theme regards improving continuously whilst focusing on the customer and eradicating waste is reiterated by Bicheno et al., (2009), Hines (1999), Lewis (2001), Rich (1999), Fullerton et al., (2009) and Repenning et al., (2001). Olexa (2002) is adamant that the philosophy needs to be in place for people to look creatively at what they do on a daily basis and do it better; a principle Ohno (1988) originally developed. Insufficient published work explicitly addresses the issue of whether Lean methods are suitable and applicable in industrial sectors which are characterised by highly differentiated, low volume production of low repeatability (Jina et al., 1996; Sawhney et al., 2005). Adler et al., (1993) and Needy et al., (2002), suggest that the pioneering work within the automobile industry is misleading as conditions differ in other industries and any correlations may be spurious. However, even in the early 1990s, Prabhu's (1992), study of three disparate industries and non-Japanese companies located in England suggested that Lean is not restricted to Japanese companies, mass production or larger organisations.

Allen (2000), Nanni et al., (1995) and Oliver (1996) assert that there is no "cookbook" to explain each step of the Lean process and exactly how to apply the tools; Lathin et al., (2001)(i), insist that quality improvements are only possible if companies implement comprehensive change management programs addressing *"both the organisational and technological aspects of quality management"*, (page 322). Bicheno et al., (2009) argue Lean should be applied to the entire value chain. Karlsson et al., (1996), insist Lean ranges from an organisation's product development to its distributional logistics as depicted in Figure 2.1:

Lean Development	+	Lean Procurement	+	Lean Manufacturing	+	Lean Distribution

Figure 2.1
Range of Lean in an Organisation

Karlsson et al., (1996) allege "*the important point to note, however, is that Lean should be seen as a direction, rather than as a state to be reached after a certain time.*" (page 34). Moreover, all the determinants might not point in the right direction all the time; "*there could be instances where they can send mixed signals.*" (page 35). Henderson et al., (1999), explain that the TPS needs to be adapted to prevailing circumstances for successful Lean implementations. Emiliani (2003), documents how the Wiremold Company achieved outstanding success by using Lean as a comprehensive management system, rather than a group of tools; a theme reiterated by Halliday (2005) and Henderson et al., (1999). Lean is successful where organisations see it as a never-ending process (Pullin 2005; Smalley, 2009). An organisation always strives to be Lean, but will never quite achieve it (Chappell 2002; Lee 2008). Essentially, there is always a gap between where the organisation is and where its ideal state is (Drickhamer, 2004). Lean is a set of rules and principles, not just tools. Tools focus on physical system changes, but that is not where the heart of Lean beats (Hall, 2004). The entire way of thinking must become embedded in every person of the organisation. It is insisted (Drickhamer, 2004) that "*it, (Lean), is a total system; if you call it a value stream, by definition you're only looking at one product, one family at a time. That's ok. It's a good way to analyse things, to understand the system, to look at one product from raw material to finished goods. But it's a slice, not the whole*" (page 27). Every organisation is unique and is likely to have distinctive problems and constraints. It is imperative that Lean is engrained in the organisation so that it can find its own answers (Hunter, 2004; Cocolicchio 2008). If the intention is to secure the full benefits, this unsettling can seem painful but is a pre-requisite since it is crucial that the business is re-organised along the "*value streams*" with the focus on the customer and product families. All the components including design, materials management and production have to be included (Spear 2004; Stamm 2004; Lewis 2008).

2.5.1 Impact of involving the supplier base

Lean has to be expanded into the supply chain (Liker 2004; Campell 2006). The need for just-in-time delivery, minimising inventories and the dependence upon the high quality products and services, embraces suppliers into the improvement efforts. Krizner (2001) proposes that for a Lean program to succeed it is vital to bring together different sections that historically erected barriers between them. Elliot (2001) and Baker (2002) corroborate that the Lean philosophy relies on three goals: flow, harmony (pace set by customers) and synchronization, (pull flow), and that this needs to exist in all sectors. Emiliani (2003) documents how the Wiremold Company achieved financial and non-financial rewards by applying Lean principles and practices throughout the value stream. Bicheno (2004) reflects on how supply chains have altered and mentions the "*partnership philosophy*" (page 189); how both parties could benefit from this arrangement. Conventionally, claim Hines et al., (2000) businesses have sought to control the supply chain through vertical integration; recently, this trend has reversed as companies now engage in a high level of outsourcing. Consequently, it makes sense to extend the order fulfilment mapping to customers and suppliers (Liker, 2004). Consequently, supply chain co-ordination should be encouraged, i.e., working to common quality standards, sharing transport and the employment of inter-company communication methods such as EDI. Furthermore, supply chain development should be supported as inefficiencies within the supply chain are examined (Conner, 2009). Usually lead-time is split between in-house processes and supplier processes, which crucially means that we should involve suppliers too (ERSC, 2007). The closer the order signal is to the actual use, the less volatility is passed upstream and smaller the buffer stock required securing availability (Lewis 2008).

2.5.2 HRM implications

Needy et al., (2002), propose companies make broad statements in relation to people being their greatest asset, though upon closer examination one often finds that the company pays lip service to this statement. A common theme is the lack of attention to the human element claim Chung (1996), Lathin et al., (2001)(i), Siekman (2000) and Bidanda et al., (2001). Human skills such as communication, problem solving, teamwork and leadership are vital for success (Philips, 2002); that people and cultural change are predominant reasons for Lean failures. Organisations need to drive out the traditional disciplinary and personnel administration and move towards strategic human resource management (Lewis, 2007; Hines et al., 2008). Competent leadership stimulates the inspiration and passion of employees, which leads to new solutions, a faster adoption of new ideas which subsequently satisfies the customers (Bodek, 2007; Johnston, 2009).

Research ("Manufacturer" 2002; Hines et al., 2008), demonstrated that when organisations want their employees to make the contribution which distinguishes them from the competition, employees require work perceived as inspiring and rewarding as well as the opportunity to develop skills to undertake these duties. Allen (2000), Sohal et al., (1994), Bicheno et al., (2009), Sanchez et al., (2000), O' Corrbui et al., (1999), Rea (2001) and Jina et al., (1996) focus on the process of change management. Vasilash (2001) insists that an aspect of the Toyota Production System, which tends to be overlooked, is the impact of morale and motivation. Smeds (1994) suggests a Lean transition involves more than a: "*pre-planned transition to a fixed future state, organisation evolution resembles an emergent process of self-organisation, where the objectives have to change flexibly along the road*" (page 74).

Ohno, (1988), maintained that whilst the Toyota Production System's objective was to increase production efficiency by constantly and thoroughly eliminating waste, there was an equally important respect for humanity. Allen (1997) supports the importance of communication; reinforced by Utley et al., (1997) who recommends a change of focus; from controlling to helping; from evaluating to empowering; from directing to coaching and from planning to listening.

Dimancescu (1997), Standard et al., (2000) and Capelli et al., (1996), remonstrate that the issue is not so much that changes must be made but rather how to implement and communicate these changes. According to Liker (1996, 2004), an area that still does not receive enough attention from researchers and companies is the role of top management during this change process. Vasilash, (2001) forwards that NOK's CEO Joseph Day states "*that Lean happens on the shop floor, not in a conference room, that Lean must be worked repeatedly*" (page 59). Seddon, (2004), challenges convention; he argues that while many commentators acknowledge that command and control is failing us, few provide an alternative. His contention is that the alternative can only be understood when one sees the failings of command and control by taking the systems view. Seddon, (2004), is scathing about leadership theorists, maintaining leadership is being able to talk about how the work works with the people who do it. In understanding an organisation as a system, Seddon, (2004), draws on the pioneering work of Ohno, though within a service perspective; arguing that the bureaucracy within public services is creating waste and he proceeds to recommend the dismantling of the specification and inspection regime. Whilst employee engagement is not a widely used term, it is vital for a successful Lean transition (Helms et al. 2001).

Research, ("Manufacturer" 2002), concluded that 18% of the variations in productivity and 19% of the variations in profitability are accounted for by people management practices. The Conference Board Report (1996) stressed that Lean is not projected to reduce jobs; they pointed to another major concern; the loss of technology from the inevitable cutbacks in research and development staff. They found that six months after layoffs, there was an increase in share price relative to market indices; though after three years, the share prices had declined relative to market indices. In a study of several hundred organisations who had gone through major cost cutting efforts (Wysocki, 1999) it was discovered that only half improved productivity; only a third improved profits and only an eighth improved morale. Equally in a major study of 3,628 companies reviewed over a 15 year period, (Morris et al., 1999), reported that employment downsizing did not improve financial performance; those with the largest layoffs exhibited the largest decreases in the rate of return on assets; the impact on profitability was negligible relative to the magnitude of the layoffs.

2.6 Prominent Obstacles to Lean

Substantial contemporary research focuses upon the main barriers preventing organisations to either adopt Lean or thwart its wider implementation (Stamm, 2004; Baker, 2002; O'Corrbui et al., 1999; Ransom. 2008; Sim et al., 2009). Whilst some of the aforementioned analysis has covered certain barriers indirectly, the following is a summary of the prevailing literature.

2.6.1 Lean witnessed as a never ending Process

Lean is a constant, long term and a never-ending process (Frigo 2003). Success is exemplified by an organisation continuing to progress at a pace from which it would be difficult to try and slow down. Transformations require a long-term commitment; a minimum time frame of five years for an average sized company (Womack et al., 2004). Similarly Lean cannot be achieved as an addition to one's everyday duties (Simpson, 2003; Stamm, 2004; Ohno, 1988; Chappell, 2002). Lean is on-going because waste continuously creeps back into organisations and their operations (Flinchbaugh, 2004; Spear, 2004; Ransom, 2008).

2.6.2 Lean is required to transcend beyond manufacturing

Lean should never be viewed as a manufacturing occurrence alone (Womack et al., 2003). It is proposed that Lean has no boundaries (Chappell, 2002; Emiliani, 2003; Liker 2004). Often Lean is viewed as a means to reduce waste, whereas it should be more about waste prevention than about waste elimination (Bicheno et al., 2009; Parnell, 2005). It needs to be viewed from the customer's perspective and has to proceed beyond just marketing or product design (Conner, 2009). Customers need to expect a relationship with the respective organisation of relative familiarity in all aspects of their dealings (Flinchbaugh, 2004). Whilst much of Lean is about getting rid of waste (muda) (Bartels, 2005); there is also the elimination of variation (mura) and overburden (muri). Variation can result in overburden, resulting in waste. In many implementations, it is safe to stay focused on the elimination of waste for the early years whilst focusing on system-level causes of waste (Quinn, 2005). Some tools used in isolation may reap good results though lasting progress would only be achieved by concentrating on the end-to-end value stream (Chappell, 2002; Jones, 2009).

2.6.3 Communication of Lean internally

Lean should not act as a licence to reduce jobs; it is imperative to send a signal that every effort will be made to re-deploy anyone displaced by the improvements (Kincaid, 2004). It is fundamental to instil confidence in people that their Lean efforts will not put them at risk (Hunter, 2004; Koltzenburg, 2004; Chappell, 2002). According to Kincaid, (2004) "*Lean isn't mean*" (page 53); that over time, attrition will reduce the headcount as the Lean transformation improves productivity. The Conference Board report (1996) illustrated how companies using a downsizing strategy; only 30% actually experienced decreased costs, 22% terminated the wrong people, 80% reported a collapse in morale, 67% showed no immediate productivity increases and 50% showed no short-term increase in profits. Nonetheless, it needs to be stressed that cost cutting may apply when an organisation is on the verge of collapse and has no choice for survival and there exists a bloated bureaucracy and cutbacks are necessary to assure longer-term success (Womack et al., 2005). This happens when employees / unions are intransigent and there is no other mechanism to improve productivity; in a major market downturn of, for instance, 10%-20% of sales volume or when there are obvious situations of waste perhaps as a result of a merger. After all, one only needs a single CEO (Womack et al., 2005)

The importance of "*Lean behaviours*" (Emiliani, 1998) (page 621) should be stressed through the various principles of value, value stream, flow, pull and perfection. Lean behaviours are simply defined as behaviours that add or create value (Emiliani, 1998). He examined the interpersonal relationships to understand the wants and expectations of the people that we interact with. Any form of inconsistent behaviour will create queues which threatens responsiveness to rapidly changing conditions. Pull applied in a behavioural context refers to the fact that people operate under many different mental models, which often requires us to adjust our style or approach (Shah et al., 2007). Similarly, perfection in a behavioural situation intimates taking advantage of the transparency brought about in order to easily identify and eliminate behaviours that do not create value. It is proposed that the types of conduct commonly found in the workplace are micromanagement, employee turnover, unclear expectations and departmental or functional focus (Liker, 1996). Nonetheless, it has been suggested, that we need to be mindful to not totally eradicate behavioural waste since, i.e., disagreements can contribute towards creativity (Hatch, 1997). Toyota refers to "*countermeasures*" rather than "solutions" (Spear et al., 1999; page 104).

2.6.4 Impact of Sub-cultures

Isolated cultures within an organisation need managing (Hatch, 1997). No one organization has a homogeneous culture and there are usually various sub-cultures which are themselves a source of conflict (Morgan, 1997). There may still be people who opt out and progressive organisations must compassionately assist these people to seek opportunities elsewhere. From the 30% - 40% of the US manufacturers claiming to have implemented Lean, only about 5% are truly operating Lean (Simpson, 2003; Liker, 2004; Koltzenburg, 2004; Hunter, 2004). In every organisation there were always a small group of managers, and a figure of 10% was often quoted, who simply would not accept new ideas (Womack et al., 2004).

2.6.5 Influence of Organisational structures

There is also a need to adapt organisational structures. Organisations will often implement the building blocs of Lean in an erroneous sequence; for example, if batch sizes are reduced prior to reducing changeover time, and the latter are lengthy, the equipment utilisation will drop and consequently reduce the ability to serve customers (Kroll, 2004). A typical reaction to this might be. "*We tried to implement Lean, and things got worse.*" Likewise, organisations can spend an inordinate time on training and an insufficient time on implementation (Chappell, 2002). There exists a need to re-organise along the "*value streams*" focusing on the customer and product families. Design, materials management and production have to be included (Smalley, 2009). Lean needs to take root in an organisation and for this to materialise executive management needs to be fully engaged (Henderson et al., 1999). Many of the concepts of Lean are complex but need to be understood if the organisation hopes to successfully implement Lean. Table 2.3 gives an overall summary of the key concepts and the different perceptions as viewed under a traditional organisation and one viewed under Lean (Hall, 2004; Kincaid, 2004; Womack et al., 2004; Waurzyniak, 2009).

There needs to be a sense of pragmatism regards materials that companies need to accept; not all inventories are waste; only inventory beyond what is needed to run the process is waste. Equally, it is vital that the value stream defines the Lean enterprise. If one section makes progress towards Lean (Bicheno et al., 2009) neither that section nor the stream, will reap the full benefits if another member falls short. Moreover, inventory often exists as a symptom of a problem in the process. Solving the problem is a rule or way to do things. Finally, achieving basic stability requires having standard methods for manufacturing; the normal definition of a standard is also a rule or way to do things; in Toyota, a standard is a rule or a basis for comparison. Many organisations (Spear et al., 1999; Hall, 2004) are discovering that a healthy dose of stability is needed before advances to other methods of Lean are contemplated. Lean is first and foremost a system, which is an integrated series of parts with a clearly defined goal (Quinn, 2005). One of the problems with Lean implementations has been the tendency to cherry-pick activities (Liker, 2004). Utilising Toyota as a benchmark (Spear et al., 1999) it is evident that the Toyota Production System is a series of nested experiments through which operations are constantly improved (Biddle, 2006).

Concept	Traditional Organisation	Lean organisation
Inventory	Asset	Waste - ties up capital and increases processing time
Ideal EOQ and Batch Size	Large to make-up for process downtime	One – to reduce downtime to zero
People utilisation	Must be busy	Based on customer demand
Process utilisation	High speed and run continuously	Designed to keep up with demand
Work scheduling	Build products to forecast	Built to demand
Labour costs	Variable	Fixed
Work Groups	Functional	Cross-functional
Accounting	Traditional financial reporting Standards	"Though-put" accounting
Quality	Inspect culture	In-built design to eliminate errors

Table 2.3
Traditional and Lean perceptions

2.6.6 Significance of IT on Lean

Lean should not discriminate against any technology that respects people and helps remove waste (Motley, 2004). A core Lean value is genchi genbutsu (actual place, actual product) which is often called "go see" in English. Software solutions make it too easy to keep smart people from going to where the theory meets reality (products meet customers). Huge LCD screens for visual management may be gee-whiz for visitors to the factory, but the team members in order to write down real problems that happened five minutes ago may use white boards (Halliday, 2005). Lean is not born from what you see; it is born from how you think (Womack et al., 2005). Lean is a set of rules and principles, not just tools (Ransom, 2008). It may be possible to fix one problem or process with a Lean tool today, but if the old thinking continues, it will recreate old problems (Bicheno et al., 2009; Chappell, 2002). The supervisors need to grasp the concept of people dynamics and emotional intelligence (Waurzyniak, 2009).

Within the context of emerging technology; companies need to look at ways of linking the shop floor to its enterprise software and then to its customers' value chain. (Sharood, 2001). Enterprise Resource Planning systems alone are typically insufficient because they do not by themselves extend from the shop floor to the enterprise level. Computer aided manufacturing and information systems, can interpret data in more than the conventional sense (Hunter, 2004). That instead of merely performing repetitive calculations on the data (Hunter, 2004) the system will understand the inherent relationships; for example, an engineering design change related to a particular product would be automatically disseminated throughout the various databases that are affected by the change. Ultimately, new processes and tools are, by design, brought into the manufacturing system (Cocolicchio, 2008).

2.6.7 Uniqueness of an organisation's Lean journey

There is no fixed recipe for Lean success as every organisation starts with a different set of ingredients (or factors and constraints). Nonetheless, there is a roadmap (Parnell, 2005). Every organisation is unique and is likely to have exclusive problems and constraints (Hall, 2004; Lee, 2008). It is imperative that Lean is engrained in the organisation so that it can find its own answers. Ransom (2008) insists that the most important tool is the hoshin kanri policy deployment (strategy deployment tool). Very few organisations use it and even fewer ones effectively. However, it remains a puzzle to ascertain what to kaizen if we are not aware what exactly our priorities are. Likewise, organisations need to recognise that supply chains are typically months or even longer (Hunter, 2004). The closer the order signal is to actual use, the less volatility is passed upstream and smaller the buffer stock required guaranteeing availability. It is also important to increase the frequency of production or delivery at every point down the supply chain. This process can only be aided by synchronizing the rate of production with the pattern of demand. Consequently it is vital that the underlying stability in our order and product flows is achieved. This includes the need to utilise Lean tools to speed up the cycle from roughly every month to exactly every week and ultimately to shipping every product required by customers daily (Hines et al., 2008).

2.6.8 Selling the Lean Benefits

It is maintained (Koltzenburg, 2004; Emiliani 2003) that there is a strong business reason to adopt Lean. Whilst the preceding analysis stresses that Lean aids competitiveness; it appears often that organisations are not convinced (Philips, 2002; Baker, 2002; Sharood, 2001). Prominent authors, (Womack et al., 2003; Liker, 1996; Henderson et al., 1999) propose that value in both manufacturing and service sectors is added in the typical product-delivery system, including design, engineering and administrative functions, and manufacturing operations, usually between 3% to 5.5% of the time. Simpson, 2003 and Sharood 2001 insist that if products from the Far East are 20% - 50% lower in cost, we need to become 30% to 60% smarter.

2.6.9 The association of Lean and accounting procedures

It is a fallacy to expect standard costing systems, or even Activity Based systems to cope with an organisation undergoing the Lean transformation (Neely et al., 2005). Ideally, value stream/ product-based costing including product development and selling along with production and supplier costs is needed so that all participants in the value stream can observe whether or not their collective efforts contribute more to value than cost (Bicheno et al., 2009; Maskell et al., 2004). It is warned (Maskell et al., 2004) that as companies move ahead with the implementation of Lean, financial functions can lag behind; when this happens, not only do they fail to support the effort, but can actually hinder it. Undoubtedly, a financial accounting system needs to meet the statutory requirements. Many organisations fall at the first obstacle as they are unable to tie the improvement metrics to the financial statements (Baggaley, 2006; Johnston, 2009).

The Lean accounting movement largely stemmed from the frustration that Lean should not be measured in the same way as traditional batch manufacturing (Baggaley, 2006). Lean takes a straightforward view between inputs and outputs of a production process (Kroll 2004). It tracks costs in less detail, expensing material as soon as it is pulled into production and eliminates work orders. Likewise, it tracks transactions and reports on the variances. Financial and accounting systems have acted as barriers to Lean systems in the past (Fullerton et al., 2009). Undoubtedly, most of the financial accounting and control systems used in manufacturing are designed for a different type of environment (Carnes et al., 2005):

- large volumes of inventory,
- high direct labour content; this situation has now altered in many organisations as a result of increased mechanisation,
- long standard runs whereby schedules were characterised by high-volume runs of the same products with few changeovers and long lead times,
- large volumes of direct suppliers whereas the assumption is that a high number of suppliers would deliver directly to the factory in large batches.

Philips, (2002) challenges conventional financial systems by stating that they are not structured to look at cost savings in the same way as a Lean enterprise would; inventory, for instance, should not be viewed as an asset. Chase, (1999) insists that some companies are examining methods of activity-based costing. This technique breaks down the company's processes into specific activities, which permits the company to measure costs relating to those activities. Maskell, (2000), widens the debate that, "*the financial community needs to contribute to the implementation instead of remaining on the sidelines, waiting for improvements to show up on the bottom line*" (Page 47). Maskell, (2000), however, fails to explore the conflict between finance and the operations personnel. Often a controller will find Lean accounting methods disturbing because of the fear that he/she will lose financial control and this often translates into conflict and animosity. Hines et al., (2000), urge companies to have a set of top level financial measures which may not be programmed towards the organisation's critical success factors.

Maskell et al., (2004), contend that Lean induces excellent examples of operational improvement; some are more associated with cost avoidance rather than cost reduction. It could be promoted that if there exists an important significant role for the accountant in a Lean enterprise perhaps it lies with this comprehension. Womack et al., (2003), insist on using the term "*creating value*" as opposed to "*adding value*" as the former is the voice of the customer whilst the latter is the voice of the accountant. Many Lean proponents correctly promote the view that since products come as a bundle of value and costly waste and often firms mix the two; customers often have no choice but to purchase the waste along with the value. Maskell et al., (2004), focus on the need to measure financial progress from a perspective of relevant business issues and with real costs instead of traditional standard costing methods. Bicheno et al., (2009) propose reforming the traditional financial accounting needed for tax and shareholder purposes; that Activity Based Costing is more likely to yield accurate costs but if not properly utilised, it can itself be wasteful (Fullerton et al., 2009). Maskell, (2004), warns that as companies move ahead with the implementation of Lean, financial functions can lag behind. There are several reasons why the accountancy profession has been slow to adopt Lean techniques:

- a lack of training or understanding of the production processes. To retain their knowledge contemporary and keep pace with a dynamic production environment, accountants need to combine the accounting skills, understanding of the business and the ability to gain in-depth knowledge of the key processes and commercial issues (Kroll, 2004),
- the departmental silos and physical proximity existent in many organisations. Often the finance section is located at a great distance from manufacturing areas. The value streams have eroded traditional barriers across the functional departments, though the companies have not often facilitated the process to interact with operations personnel,
- feelings of "*professional superiority*" (Carnes et al., 2005; page 34) whereby chartered and certified accountants feel that their education and knowledge is superior to those in operations,
- the potential fear of failure. In line with the Lean ideology it is necessary to accept the notion of potential mistakes and continuous adjustment. The culture of the organisation and the personality of the accountant has to welcome this philosophy (Maskell et al., 2004),

- unjust performance and reward structures. When an accountant's benefits are dependent on the net income, which may temporarily decrease under Lean conditions he/she may not be motivated to support or encourage new operational methods,
- the research status (Carnes et al., 2005); the contemporary research topics accepted by the prominent journals are often in the financial field. Consequently, teaching and research in operational management may not carry the same prestige,
- the lack of rigid terms and references. Whilst both standard costing and variance analysis tends to be definite and implicit whereby both the producers and accountants fully understand the system (Kroll, 2004); Lean has to be customised for each respective organisation's products and markets (Conner, 2009).

Often the non-financial measures such as lead times, scrap rates and on-time deliveries show significant improvements, yet they are not captured on the GAAP statements. Likewise, when an organisation is at the early stages of its Lean journey and begins to work through its inventory, deferred labour and overheads expand on the income statement causing concern amongst executives.

2.6.10 Maintaining the Lean initiative

The LEI Web Survey (2004) stated that backsliding to the old ways of working was the single most important factor for Lean failures. The root cause of regression in most organisations is the confusion about priorities at different levels of the organisation compounded by the failure to make anyone responsible for performance (Ransom 2008). To deter regression it is important that the organisation periodically clarifies priorities for each value stream and identifies the performance gap between what the customer needs and what the value stream is providing (Biddle, 2006). It could be stated that this process is nothing but Dr. Deming's Plan-Do-Check-Act ideally employing A3 analysis. In fact, Womack (2007) does not propose a re-organisation but for someone to periodically audit the horizontal flow of value and bring to the attention of everyone touching the stream how the organisation is performing along that stream.

Equally, there exists a need to link every step in a dramatically compressed flow that responds quickly and accurately to demand (Ichimura et al., 2006). The organisation needs to explore the gains that encourage partners to work together in collaboration (Halliday, 2005). The biggest gain is usually the smoother order signals in return for closer synchronization of production and demand (Bartels, 2005). Ensuring that this end-to-end value stream redesign is achieved is vital. Ironically, this responsiveness is achieved by focusing on stability and time compression, rather than flexibility and fire-fighting (Koenigsaecker, 2005). This results in a reduction of costs. Undeniably, converting supply chains into value streams takes considerable effort, time and an overall vision of where the organisation hopes to reach (Lee, 2007).

2.7 The momentum of Lean

For Lean success any organisation cannot leave this decision to chance (Womack et al., 2005). In its early stages it needs to be treated as a strategy until it becomes an ideology embraced by the entire value chain (Jones, 2009).

2.7.1 Business case for a concerted effort

Jauch et al (2001) argue that the evidence indicating that strategic management causes better performance is weak (Kraatz et al. 2001). The relationship is in fact quite complex, heavily influenced by factors such as the nature of change, environmental turbulence and industry structures (Frigo, 2001). However, Jauch et al. (2001) provide a candid synopsis by saying that businesses which perform formal strategic planning have a higher probability of success than those which do not. The literature is weak linking strategy and execution (Ransom, 2008). Great companies are those that have been able to sustain long term ROI and growth rates for 10 years or more. Frigo (2001) proposes that what is termed as "strategic" (page 14) is often no more than ordinary one-year to five-year capital operational budgeting. It is important to note that within the academic world, the weight of the argument appears to be shifting from seeing strategy as a rational, mathematical process, to seeing it as the outcome of the ability of an organisation to utilise its strengths and expertise in the competitive pursuit of success (Ransom, 2008). Likewise, improving operational effectiveness, whilst needed for management, should not be deemed as strategy (Porter, 1996). Strategic positioning refers to performing different activities to those of your rivals; alternatively, performing similar activities to your rivals but to do so in a different manner (Porter, 1996; Jones, 2009).

The Manufacturing Foundation (2004) in its study of 153 organisations revealed how companies discovered about Lean in the first place; Table 2.4 summarises the findings:

How Organisations discover Lean	
Sources of Lean	**%**
Conferences	15
Consultants	14
Company Visits	11
Books	11
Trade organisations	8

Business Networks	5
Support agencies	5

Table 2.4
Sources of Lean

Interestingly, 45% of the organisations became aware of Lean through non-threatening sources of best practice, including books, business networks, and company visits.

2.7.2 Lean and strategy formulation

At no stage should an organisation even assume that the Lean tools are a strategy. An essential prerequisite are the appropriate tools in the right circumstances within the context of the organisation's value chain (Hunter, 2004). Equally, by making reference to a value stream, an organisation is only examining one product, one family at a time (Quinn, 2005; Leitch, 2001; Lee 2007). Whilst this is an apt methodology to understand the system by analysing one product at a time from the raw material to the finished goods stage, it is only a slice of the total requirement. Any organisation undergoing a transformation needs to know where to be (future state) and where it is presently (Johnston, 2009). Value stream mapping is one of the tools used to define an organisation's work processes and to identify where an organisation has non value added steps. Undoubtedly, the transformation is difficult, multi faceted, risky and can be frustrating. In a Lean world, "*strategy precedes process and process precedes structure; in other words, define value first. Then define a process that provides the desired value. Then create an organisation able to operate the process;* (Womack et al., 2005, page 180).

Lean needs to be treated as a system comprising of more than the sum of its components (Allio, 2006). The Toyota Production System grew both through revolution and evolution. The revolution rejected the concepts of mass production and the evolution developed the details and the tools (Pullin, 2005; Smalley, 2009). As a cautionary note, the Aberdeen Group (2004) discovered that whilst strategically the manufacturers' vision for Lean strategies is broad; the full use of Lean techniques, commitment, knowledge and technologies is significantly behind the strategic vision of most manufacturers:

- 67% of their respondents used Lean sporadically,
- 79% did not have top management commitment and
- 87% had Lean knowledge in the hands of a few individuals only.

It is erroneous to suggest that Lean is little more than scientific management, since it predominantly focuses on people and leadership (Hall, 2004). Similarly, Lean becomes inflexible when it transforms into a program that is managed. At its core, Lean is little more than a problem solving methodology that everyone can use on a daily basis (Motley, 2004; Bartels, 2005). If Lean is successful then you will have fewer managers because people will solve problems as they arise on the shop floor (Philips 2002). Similarly, when Lean becomes a program, egos get involved with implementation projects and strategy (Sim et al., 2009).

The majority of organisations fail to achieve Lean since there exists confusion between the Lean goals and the intended result (Parnell, 2005). Many organisations struggle on the commencement of their journey which is critical to the success of Lean (Parnell, 2005). If the initial project, is not successful, there is a good chance that there will not be another opportunity since the initial project has failed to make any impact on the strategic objectives. The essential problem is that most Lean efforts begin with a tactical approach rather than a strategic one (Biddle, 2006). Ironically, many consultants recommend a tactical approach (Lee, 2008). This is because Lean has progressed from operational improvements and many cannot visualise Lean as a strategy (Conner, 2009).

Equally, many Lean consultants strive for immediate credibility by focusing on the main problems. Undoubtedly, there is a growing appreciation that Lean needs to exist at an enterprise level (Biddle, 2005). The trend for Lean organisations at the start of their journey can be grouped into several categories (Dennis, 2002); they worry about:

- how to apply some Lean principles,
- which tool to utilise first,
- who is to push the overall impetus,
- at which stage of the value chain should the journey originate from.

All of the above approaches in isolation have built-in weaknesses (Womack et al. 2005). Many organisations have started their journey with workplace re-organisation (Lewis, 2008). Undoubtedly, marginal increases in productivity are achieved, though despite being difficult to measure, the improvements may be isolated. Kanban's are often used as a compromise since ideally products should be "pulled" through the factory in quantities of one – hence the term one piece flow. Nonetheless, it is often impractical to strictly adhere to this principle (Halliday, 2005). Consequently, kanbans are used to move small, controlled batches of material in a "pull" environment. Nevertheless, kanbans without other harmonized improvements such as reducing equipment changeover times can cause poor equipment utilisation and worsen late shipments (Lee, 2008). Equally, since kanbans can be used as a compromise some organisations fail to tackle the primary issue of inventory levels as a result of changeover times (Cocolicchio, 2008).

Likewise, kaizen is a central concept which promotes empowering work teams to rapidly improve specific problems. A possible quandary that organisations encounter is that of "drive-by kaizens" (page 2, Biddle 2006). This depicts a situation whereby improvements are implemented in a haphazard manner and without any priority and without any recognition on their impact on resources, suppliers or customers. Value Stream mapping essentially attempts to highlight areas where one-piece-flow breaks down. Consequently, the "future state maps" are developed to express where the various kaizen events may assist to eradicate the root causes of stoppages (Hall, 2004). Inherent in this process has to be the recognition that individuals affected will experience this much later in the improvement cycle than those would implicated by i.e., kaizen techniques (Liker, 2004). Moreover, VSM does not always fully recognise the dynamic processes such as variability in demand and fluctuations in supply. A predominant drawback is that VSM does not fully recognise "*competing value streams*" (page 3, Biddle 2006). In most organisations there exist several value streams, numerous product lines, or in some situations one product line producing one or more products (Koenigsaecker, 2005). These value streams compete for resources and have departments such as accounts and purchasing supporting their operations. Consequently, an alteration in a value stream without consideration on how it impacts on a competing stream or support function would induce adverse consequences for the organisation (Carnes et al. 2005).

Similarly, many Lean journeys start with a major training commitment (Motley, 2004). This is often a preferred strategy for consultants since there is less pressure to deliver any result other than a trained audience (Halliday, 2005). However, unless this is carefully coordinated, there is a risk of not being able to apply the benefits to a project quickly. Accordingly, the training needs to be focused towards the provision of a solution within a specific area (Bartels, 2005). Value Stream Mapping is one of the most critical components to successful Lean yet it is often overlooked because it can sound dull and academic (Campell, 2006). The "Manufacturer" 2002 states that organisations that utilised it effectively halved lead times and doubled stock turns whilst making huge improvements in labour productivity. Likewise, Lean maintenance using various tools and techniques such as total predictive maintenance (TPM), radar controlled messages (RCM), continuous improvement, and computerised maintenance management systems (CMMS) need to be utilised in a way appropriate to the situation and to meet the organisation's needs (Neely et al., 2005). Progressive organisations, i.e., BMW Engines and Vauxhall, are using CMMS either as a stand-alone system or a maintenance module which is part of a business wide ERP system. The CMMS should provide the glue which holds the strategy together and makes fact-based decisions much easier.

The Manufacturing Foundation (2004) also highlighted the main tools that were being used; most use is being made of the tools and techniques that make problems, weaknesses and constraints visible to the team; survey is summarised in Table 2.5:

The main tools and techniques being used:	
Tools/ techniques	**%**
Workplace organisation	9
Process mapping	7
Kaizen Blitz	7
TPM	7
Value Steam Mapping	7
Visual management	7
Changeover reduction	7
Cellular manufacturing	6
Material pull systems	5
Equipment effectiveness	5
Error proofing	5
Work standardisation	5

Table 2.5
Main Lean Tools utilised

Often the barriers cited are not specific to Lean, but would have been stumbling blocks to any strategic implementation. Once the respective organisation overcomes these issues, Lean has a greater probability of success (Campell, 2006). Lean is an end-to-end value stream that delivers competitiveness. A great cell feeding into a morass of poorly controlled inventory is waste. A changeover reduction programme in a high capacity area is waste. A 5S programme without any follow through into standard attainment is largely waste. A kanban operating in a situation of unlevelled demand can also be waste. Whilst Lean is about waste, its focus should be on waste prevention. Experienced Lean practitioners, after eradicating the obvious waste, return to the first two Lean principles of customer and value stream (Liker, 2004). Rethinking the value side is as important since this leads to the seeking of new opportunities. The "Manufacturer" (2002) states that "*mechanical*" (page 23) Lean is the implementation of tools in a piecemeal fashion; "*Managerial*" (page 23) Lean is its implementation in an integrated manner. "*Innovative*" (page 23) Lean takes it beyond the shop floor and the organisation to create a new opportunity, new value and new customers.

The Manufacturing Foundation (2004) reiterated and summarised in Table 2.6 the main objectives organisations in Britain hope to achieve through Lean:

What are companies setting to achieve?	
Objectives	**%**
Reduce costs	37
Improve product quality	15
Reduce manufacturing lead time	11
Improve service quality	9
Improve on time delivery	7
Improve customer satisfaction	6
Improve manufacturing flexibility	3

Table 2.6
Aspirations from Lean

The pre-eminence of the objective to reduce costs fits with the strong emphasis of most Lean implementations; 82% of the companies set out to improve quality, cost or delivery performance. The "Manufacturer" (2002) in its survey based on 100 interviews with Production Directors and managers in UK-Based manufacturing companies revealed the following results regards what their understanding of Lean was:

- 45% stated that the aim was to reduce waste,
- 24% forwarded that the aim was to cut costs.

When asked what the expectations from Lean were; as outlined by the responses from 77 companies that felt Lean would be beneficial is summarised in the Table 2.7:

What are companies hoped to achieve from Lean?	
Objectives	**%**
Reduce costs	52
Improve on time delivery	16
Reduce manufacturing lead time	13
Increased profitability	10

Table 2.7
"Manufacturer" aspirations from Lean

2.7.3 Requirements to succeed

Organisations that have managed to succeed have generally been able to depict a genuine strategy – a radically different way of thinking and a unique strategic focus (Liker, 2004; Ransom, 2008). These companies are able to conceptualise the impact on processes, stakeholders and the business objectives (Lee, 2008). If these are not fully understood, the impacts will be discovered late and the proposed or implemented changes suffer (Baggaley, 2006). All organisations need to identify all of its process owners and participants in the value stream (Hines et al., 2008). When a company ensures that the relevant groups of people are involved at an early stage of a Lean effort, this will assist to reduce the overall resistance issue (Lewis, 2008). Likewise, this proceeds to reduce the risk of an excessively limited view of the problem areas, or be deficient in any alignment with the overall business strategy (Womack et al., 2005). There is a basic need to recognise that business transactions transcend process boundaries. Any customer service that occurs after delivery, which occurs after a sale, is only feasible once assembly/manufacture has occurred; equally, this can only progress once R&D and supplier management has taken place. Likewise, this only ensues as a result of marketing which is a direct result of leadership and planning deciding to market the product (Hines et al., 2008).

The Manufacturing Foundation 2004 found certain dominant areas of a business where Lean was applied; in their study of 153 organisations many organisations simultaneously applied several or more tools. Evidence regards the implementation of Lean outside production is still less common and less successful; Table 2.8 provides a summary of the findings:

Application of Lean to Business Areas	
Area	**% of companies used this application**
Production	68
Production planning	52
Maintenance	36
Supply chain management	34
Purchasing and procurement	28
New product introduction	22
Product design	18
Sales/customer service	12
Marketing	10
Finance control	8

Table 2.8
Areas of Lean application

Most Lean strategies are noticeably deficient and tactical in nature, rather than being truly strategic. The Aberdeen Group (2006) showed that 66% of the best in class companies believed that cost reduction was the key target for a Lean initiative. The remaining actions were operational, cultural and quality focused. This is depicted in the Table 2.9:

Best-in-Class Actions of Lean	
Action	**%**
Reduce non value-added manufacturing and supply chain costs	66%
Implement continuous improvement culture and methods	52%
Improve manufacturing and supply chain flexibility	38%
Customer demand driven manufacturing	29%
Focus on customer value-adding activities	27%
Reduce inventory and assets required to produce and deliver product	27%
Improve product quality	20%

Source: Aberdeen Group, March 2006

Table 2.9
Key Targets of Lean

Unfortunately, Lean is being considered as a cost-reduction strategy and not as a market supremacy one by the majority of the organisations (Hines et al., 2008). The above actions are more short-term and operational in nature. Regrettably, this is concrete proof that organisations are viewing Lean in a narrow manner (Lee, 2008). Indisputably, organisations should not view Lean as a cost-reduction tool and instead need to contain two crucial elements; namely customer value and business value (Albert, 2009). Table 2.10 provides a useful approach on how this should be viewed:

Customer Value	Business Value
Reduction of a cost per unit	Assists the aggressive sales strategies
Decreased cost per product customization	Perform better than the prevailing competition at comparable price points
Faster product development	To produce "on demand" as a competitive advantage
Reduction in time-to-market of new products from concept to release	Establish a market stronghold for expectations
Higher productivity and reduce the cost per unit	Higher revenues with existing resources

Table 2.10
Approaches to Lean

Every strategic action target needs to be focused to an organisation's business drivers, serve a clear purpose and needs to consider the interdependencies of all the key stakeholders. Many of the Lean failures depict certain general trends:

- lack of individuality, whereby the organisation has merely focused on Lean itself rather than the actual rationale for implementing Lean in the first place (Lee, 2007),
- very little attention is paid to the recognition of a starting point (Motley, 2004; Ransom, 2008); this is coupled with

- little or no assessment being undertaken to assess the impact on the overall organisation (Ichimura et al. 2006),
- whilst resources may be allocated to the data capture, little effort is devoted towards involving those individuals heavily impacted by the changes in the initial planning efforts (Hines et al. 2008).

Organisations that are on their Lean journey but have no strategy in place are at risk of failure at worst and at best, risking delaying/ reducing the benefits to be enjoyed from Lean. Equally, if the strategy in place is focused towards operational improvements instead of higher profits and an increased ability to compete, it will prove to be a fruitless strategy. Most companies begin their Lean journey at a tactical level whereby the results are often restricted and short-term (Campell, 2006). This can often be attributable to a cost-cutting outlook which consequently results in a long-term loss of market share (Jones, 2009). Fords, General Motors, Delphi and Lomega are examples of this mindset (Lee, 2007). Consequently, instead of the obsession of considering Lean as a means to achieve additional margins to boost share prices it should be focused towards sales and becoming more responsive to demand (Ransom, 2008). In this case, it will continue to be able to maintain lower costs, reduce prices and increase the organisation's market share. Undeniably, by working together with colleagues and suppliers to improve the end-to-end processes, the organisation can have a much greater impact on competitiveness (Cocolicchio, 2008).

2.8 Role of Performance Measurement in Lean

If Lean is seen to be an effective business decision, then there needs to be a competent method to assess this concept. The Lean benefits are not always obvious (Pullin, 2002; Arora, 2002); managing and improving processes, customer and employee relations in conjunction with the organisational perspective should enable the financial perspective to improve. During the last two decades there has been a plethora of performance measurement systems with models dwelling both on qualitative and quantitative perspectives. Organisations need to adopt a more holistic and comprehensive approach to performance assessment (Marshall et al. 2004). The Balanced Scorecard (Kaplan and Norton, 1992 and 1993) established the momentum for this viewpoint; other contributors (Bond, 1999; Wade, 1997 and Maltz et al. 2003) coupled with the work of (Dimencescu et al., 1997) provided the foundation for this work. Traditional means of measuring results through accounting methods fails to incorporate the true valuation of an organisation's intangible and intellectual assets (Kaplan et al. 1992 and 1993); these include high quality products and services, motivated and skilled employees, responsive and robust internal processes alongside satisfied and loyal customers. Research (Lawson et al. 2003; Womack et al., 2005) suggests that the latter are more critical to the long-term future of the organisation. There are many reasons why business performance measurement systems have become more topical; the literature indicates that:

- traditional accounting systems allocated overheads on the basis of direct labour (Neely, 2005). This may have been appropriate in the 1960s as direct labour often constituted in excess of 50% of the cost of goods sold. Whereas, presently, it rarely constitutes more than 5% of the cost of goods sold (Neely et al., 2005),
- the increased level of global competition faced by organisations encourages them to compete on service, flexibility, customisation and innovation (Womack et al. 2005),
- the varying external demands as customers not only expect high levels of service but also expect firms to operate in identifiable ways. Ford, for example, demand that their accredited suppliers introduce a scheme known as QOS (Quality Operating System) which essentially is a performance measurement process (Neely, 1999).

Initially this debate was intensified (Collins et al. 1994) since modern organisations need to embrace continuous improvement and consequently, measures that facilitate balancing external pressures, i.e. customer satisfaction, in conjunction with internal pressures, i.e. employee satisfaction. In isolation an internal measure may intimate that a company is performing well whereas the external measures show poor performance; shrinking the defect rates may be in line with internal strategy, yet the company could be viewed negatively by the market resulting in a deterioration of its share price. Coveney (2002) reiterates in a study of 113 companies located in US, Europe, and Asia, and where 50% had a $5 billion or more turnover, that companies with a formal strategic performance measurement system performed better in the stock market.

2.8.1 Measures beyond traditional financial analysis

Business factors such as maximisation of profits, effective business planning and better operational visibility coupled with corporate governance are key factors in driving business performance initiatives (Maxton et al., 2004). Seemingly, (Marshall et al., 2004) 70% of respondents to a survey undertaken by the "*Business Performance Management*" Forum have moved beyond financial data to incorporate marketing and customer information in performance assessment, suggesting a more holistic and comprehensive approach. A typical customer satisfaction measure that could be utilised is to discover how frequently a service job is performed right the first time on time (RFTOT). Nonetheless, it is rarely used by car companies but forms an underlying measure of satisfaction. Womack (2008) states that surveys across Europe showed that car repairs are only performed RFTOT in six cases out of ten; this equates to1.75 sigma!

By the year 2000 intangible assets became the major source for competitive advantage (Neely et al. 2005). Tangible assets accounted for a book value of less than 20% of companies' market values (Kaplan and Norton, 2001). The problem remains how to quantify intangible assets; frequently intangible assets such as knowledge affect financial outcomes through chains of cause and effect linkages involving several stages (Fullerton et al., 2009). Often they need to be bundled with other intangible and tangible assets to demonstrate any creation of value; an example would be a newly devised growth strategy which requires customer knowledge, training for sales employees, new databases, new information systems, a new organisational structure and an incentive compensation program. Concentrating on just one or, all but one, of the above could cause the new strategy to fail.

In simplest terms, manage and improve processes associated with the customer, employee, supplier and the organisational perspectives; accordingly, the financial standpoint will improve (Tangen, 2005; Gautreau et al., 2001 and Arora, 2002). Non financial measures such as quality, customer satisfaction and innovation have become increasingly important. Pan Am, IBM, Motorola, Hewlett-Packard, Intel, Steelcase and Xerox primarily focused on financial indicators initially which did not display obvious problems; they are mostly lagging indicators such as the ROCE (Schonberger, 1996; Gautreau et al., 2001). Some (Wade, 1997) advocate that the traditional emphasis on profit is short-term and any measurement of success should be congruent with company strategy. Financial measures, undoubtedly, focus on the past and survival in the longer term depends on customer service (Smith, 1998); this can be measured by factors such as:

- Quality,
- Cycle time,
- Employee skills and
- Productivity.

Experience, shows that sustained Lean success does not come from targeting opportunities in a haphazard manner using few of the Lean tools. To build a sustainable Lean foundation that consistently yields dramatic company-wide improvements on a global basis necessitates a roadmap. It is maintained (Pullin, 2002) that there are three "inhibitors", (page 28), why performance can be impaired. The first is variability, i.e., fluctuations in demand, deliveries and quality wander, people and machines perform inconsistently; secondly waste and third inflexibility whereby the company cannot react to changes in demand, or alter its working practices. In this case, a "technical solution", (page 29), is needed, i.e., value stream mapping (Pullin, 2002). Moreover, a management system is needed to ensure that the solutions are adhered to. However, coupled with this is an effective change management policy; without any of these three elements the philosophy breaks down. Frigo (2003) insists that many mediocre companies focus on performance measures relating to internal processes without a strong correlation or linkage to the customer needs in the respective targeted markets. Whilst benchmarking and best practices can yield positive results, if not careful, the company can be lead in the wrong direction by focusing on the same processes and practices of the industry, without paying sufficient emphasis on the customer (Malone et al. 2005). Companies need to understand how key performance measures can guide and focus an organisation towards superior results in their chosen area. Many (Kaplan et al. 2005) propose that organisations should consider an *Office of Strategy Management* since i.e., finance, human resources and information technology are catered for but few organisations have a department with prime responsibility for managing strategy.

2.8.2 Requirements of a performance measurement system

Often organisations continue to measure and evaluate operations based on their achievement of unit cost targets built into their standard costing systems (Conner, 2009). This recurrent problem might lead one to conclude that Lean cannot be sustained in the long run without replacing these standard costing measurements. Essentially, standard costing does not work in a Lean company since they were formulated to support mass production. Under Standard costing, individual operations receive incentives to produce as many parts as possible per unit of time. Excess production is then stored in WIP storerooms to support the future demand. However, Lean promotes the making of one product at a time, thereby eliminating the production of large WIP inventories. Nonetheless, the utilisation of machinery and labour can sometimes be reduced to cater for lower customer orders. Consequently, the intention should be to eradicate cost measures away from the shop floor and replace them with measures designed to both assess and motivate the causes of cost and performance. The traditional metrics have not worked and the major inadequacies can be easily summarised from the literature; namely:

- the traditional accounting measures are not suited for strategic decisions (Kaplan et al. 2005),
- the traditional metrics are historical and difficult to correlate, (Lawson et al. 2003),
- they provide little information on the root problems (Malone et al. 2005),
- the connection between financial and non-financial measures is fragile (Marshall et al. 2004; Fullerton et al., 2009),
- little attention is paid to cross-functional processes as opposed to functional ones (Frigo 2003),

- intangible assets are awarded modest attention, (Lawson et al., 2003; Shah 2003),
- they largely ignore value creation, (Bicheno et al., 2009; Womack et al., 2005),
- often there are too many measures, (Smith, 1998),
- they encourage managers to minimise the variances from the standard rather than actively seeking to improve continually (Womack et al. 2005),
- rarely can we aggregate from operational to strategic levels, (Yeniyurt, 2003 and Maltz et al. 2003).

The challenge remains to choose the right measures for the appropriate levels of the organisation (Booth, 1996). The literature summarises (Lawson et al. 2003) the solid evidence towards an Activity Based costing (ABC) system in concert with a scorecard system yielding significant results. ABC is known to support improvements in operational efficiencies, whereas a scorecard system supports a change strategy. Undoubtedly, the ramifications of using wrong metrics can be devastating (Silk, 1998). If not planned appropriately, the measures can run counter to the strategy and encourage the wrong type of behaviour. This theme occurs (Allio, 2006) whereby different measures at various stages are encouraged. In the early stages of a high technology business, for instance, managers focus on reliability, speed and efficiency. In the growth stages the key measure may be market share. However, in the mature industries, price, production cost and capacity utilisation may have a greater authority. Whereas in an aging industry the respective cash flow metrics can begin to take precedence.

Whilst some metrics are more relevant at certain times the system requirements of respective measures is equally critical; an impatient organisation concentrating only on the corporate level measures is doomed to fail in its attempt to formulate a performance measurement system (Sim et al., 2009). Utilising appropriate measures for different organisations is important as is using measures for different levels within any enterprise (Tangen, 2005). The following three classes are promoted; "third" (page 48) are mostly the traditional measures whereby the requirements of these measures are low. "Second" (page 48) are more balanced in their view of performance and whereby there is an introduction of non-financial measures too. "First" are the most advanced metrics which begin to look at the causal relationships between the measures. Table 2.11 adapts the proposal (Tangen, 2005) by summarising the various classes and criteria dependent on the level.

Likewise, when we look at CPM or SPM systems (Strategic Performance Measurement); there are certain characteristics which need to be in place (Coveney, 2002):

- complete integration; they need to embrace planning, budgeting, forecasting alongside reporting and analysis as one continuous process,
- they need to be enterprise wide, and meet the varied criteria as depicted in Table 2.11,
- by focusing on exceptions they permit users to discover the real problems,
- real-time automation improves decision making and evaluates information quicker,

Different classes of Measures and relevant criteria	
Categories	**Criteria of measures for this class**
Highest class	Causal relationships, focus on all stakeholders, all strategic levels are covered and utilise advanced IT
Intermediate	Look at internal and external environments, both short and long perspectives, and information directed to appropriate personnel
Foundation level	Internal focus, mainly short term, top strategic levels are covered and information is easily accessible

Table 2.11
Classes of Performance indices

Likewise, it is significant to measure what is important to the enterprise. The measures need to focus on the key strategies such as cash flow or growth. A definite requirement is the need to keep the metrics simple, from which the organisation can take action. Similarly, the metrics chosen need to be aligned to the expectations of the customers. The problem many organisations fail to conquer is translating qualitative targets into quantitative metrics which has not been fully explored. Work by the "Stockholm School of Economics" (Neely, 1999) identified a significant positive correlation between customer satisfaction and financial performance; their report states that an annual one-point increase in customer satisfaction has a net present value of $7.48 million over five years for a typical firm is Sweden. It is vital that the company can give managers targets to strive towards. Unfortunately, the evidence (Allio, 2006), suggests that many organisations find this lateral translation difficult to organize.
It is equally important to involve staff in determining the respective measures (Amaratunga et al. 2000). The challenge for many organisations remains the need to achieve a cultural shift since the focus needs to be firmly on targets. Empowerment is necessary as the metrics seen by staff as irrelevant, unrealistic or inappropriate will be counterproductive (Marshall et al. 2004). In this context the system needs to be focused towards continuous improvement in line with the Lean philosophy. It is proposed (Neely et al. 2005) that in line with continuous improvement there should be a periodic re-evaluation of the appropriateness of the established performance measurement system in response to the current competitive environment.
Measures used should not be used as a weapon by management. When management act on a metric, they can focus on someone, some (other department) or some outside factor to blame.

2.8.2.1 Evaluation of indices

A system has been designed (Tangen, 2005) to assist the evaluation process of the respective measures used by an organisation. Table 2.12 extends the original principle which permits organisations to undertake a systematic review of their performance measures. The analysis would enable the measures no longer useful to be identified. The respective measures are scored against the type of parameters outlined in Table 2.12:

Criteria used to evaluate each of the measures used		
Requirements	**Respective criteria**	**Degree of fulfilment Score 1 – 10**
Fundamental Requirements	- Accurate information - Supports objectives - Correct measurement - Concise number of measures	
Reference to Performance criteria	- Financial focus - non financial criteria - casual relationships are explored	
Reference to stakeholders	- internal concentration - external focus - all stakeholders are considered	
Strategic levels considered	- corporate level bias - most levels are considered - only lower levels are considered	
Time periods considered	- short term targets - long term emphasis - looks at evolution processes	
Information needs analysis	- easily accessible information - focused to the appropriate person - IT explored	

Table 2.12
Criteria to judge performance indices

Organisations seem content to introduce new measures of performance, but rarely do they delete obsolete ones (Lawson et al. 2003). An evaluation of the measures against different criteria is important to the organisation (Tangen, 2005). However, the evaluation of KPIs can be time consuming (Malone et al 2005). The average KPI evaluation took 11 months to complete (Tangen 2005). If we accept that a process is a sum of activities moved and directed towards the customer, then any poor performance in a link in the chain is sufficient to spoil the overall performance. Often metrics chosen show a result but the timing is too late to make corrective actions. This is a problem with output-based metrics such as on-time deliveries, total production and total transactions processed. By the time the problem is discovered it is too late to rectify the situation. Whilst output measures are not irrelevant, they are not useful for timely improvements. Equally, it is important not to measure wrong information. A classic example is "earned hours" whereby in a desire to keep people busy, "earned hours" encourages them to stay busy making something, rather than focusing on key customer needs.

Correspondingly, it is critical for Lean enterprises to deploy early warning systems. These milestones either reinforce that progress is being made or signal that problems need to be solved. Lean is a process focused initiative which makes it fundamental for the Lean journey to have these interim appraisals (Marshall et al. 2004). However, a valid and candid assessment will only be achieved, if a portfolio of measures is used (Yeniyurt, 2003). This, not only, includes the use of measures depicting the product portfolio and its life cycle but also measures the value to the organisation both internally and externally. Managers can become preoccupied with internal deadlines and dwell less on the organisation's marketplace or the behaviour of competitors.

An explicit prerequisite is the need to align the metrics with strategy. There is ample evidence (Arora, 2002; Frigo, 2003) showing that good solid metrics can facilitate the implementation of a strategy whereas poor or distorted ones actually obstruct implementation. It is reinforced (Neely et al. 2005) that often this aspect is handled badly by organisations. Whilst the measures utilised need to match the strategy, care needs to be taken regards the levels of strategy concerned; for instance, at the strategic level it is necessary to ensure that the metrics reinforce the enterprise's strategy, match the culture, and are consistent with the existing recognition and reward systems (Fullerton et al., 2009). However, at the tactical level, it would be appropriate to analyse whether all the relevant aspects have been covered such as perception and performance and that measures relate to both long and short-term objectives.

Evidence (Bond, 1999; Anthony et al., 1998 and Teach, 1998) encourages the view that often organisations collect a considerable amount of information, but do not have an effective system for translating this feedback into an effective strategy for action. Within the guidelines discussed, research (Kaplan et al. 2005; Neely et al. 2005) intimates that organisations need to start embracing Information Technology with greater enthusiasm as part of their performance measurement. An IT balanced scorecard helps to focus on the causal relationships and linkages within the organisation and helps managers to add greater value. The literature is besieged by acronyms such as CPM, BPM, or EPM for corporate, business and enterprise performance management. The benefits are visible as it can automate the collection of data and production of reports, saving considerable time and allowing managers to analyse discrepancies and particular issues. With improved IT structures, new measurement practices that aim to aggregate the operational level metrics into corporate level measures become possible to implement. However, only 28% of the organisations undertaking performance measurement had implemented BPM (Malone et al. 2005).

2.8.3 Generic scorecard precautions and considerations

It is important to recognise that no scorecard can define the best strategy for a company to adopt. It remains senior management's responsibility and vision. In an attempt to automate the system, the financial measures pose very few problems as they have been used effectively for many years; it is the non-financial measures that are difficult to establish (Allio, 2006). Managers need to dwell on the cause and effect relationships in strategy when attempting to link measurement with strategy. Whilst many acknowledge the link between customer and employee satisfaction, a scorecard may not provide guidance regarding the methodology to improve performance in order to achieve the desired strategic results (Morgan, 1998). Any scorecard requires updating and a need to realign it to altering strategies or corporate structures; however, this is both time consuming and expensive. There are also implementation problems; the total development time is one year for a typical scorecard (Sanger, 1998). It remains imperative that all companies utilise their own version of the scorecard as the measures used may contrast (Fullerton et al., 2009).

Research carried out by the Centre of Business Performance at the Cranfield School of Management (2004) of the 117 companies surveyed, 82% stated that they had a SPM system. Though, by far the most prevalent measurement system was the use of KPIs with 60% using them to a greater extent and 27% using them to some extent. In comparison only 18% used the balanced score card. 67% stated that there was a link between performance measurement and reward which is more than had been previously reported. Equally, the report showed that the main perceived benefit from linking rewards and measurement is the directional benefits that result, rather than the motivational benefits. Equally, the report showed that many companies relied more heavily on personal objectives to reward individual performance. Management by Objectives (MBO) is still the dominant factor for rewarding executives. Womack et al., (2003) reiterate the five principles:

- Value to customers; the measures need to deduce how well the upstream process satisfies the needs of the downstream processes in terms of both quality and timeliness. This is a deviation from the traditional thinking of "shareholder value" (page 37; Baggaley, 2006),
- Lean operates in the context of a value stream; Maskell (2000) summarises that a value stream represents all the processes that are performed to transform an order from a customer to a delivered product or Service. This "process" concept for an organisation examines aspects from a different context to the "departmental" view (page 37; Baggaley, 2006) generally found to be the case with performance reporting,

- Pull and flow; materials need to flow at a constant rate through the process without stopping. Embodied in the Lean ideology is that flow is determined by the rate at which the customers demand products. Consequently the performance measures selected need to ensure that these principles are accommodated,
- Perfection whereby the measurement processes need to quantify all instances of "non-value, non-flow, or non-pull" (page 38; Baggaley, 2006),
- Empowered personnel; in any Lean process, for instance, whereby low inventory levels become the norm, often problems need to be tackled as they arise.

Cascading measures is a major minefield; managers often want the measures to add-up as would be the case in a budget yet this is not always viable with performance measures. The perfect way is to cascade the business objectives through the success map; each level then takes the success map from the level of the organisation above and creates its own success for their own area (Kroll, 2004). This method takes into account the local priorities and also cascades the direction of the organisation. Whilst this may be time consuming, it is effective in cascading direction. Bourne (2007) offers the example of EDF Energy whereby it takes 2.5 people for 11,000 employees to cascade the success maps down to the team level from the UK corporate objectives and to update the success maps twice annually. Most vision and mission statements are not clear and fail to give identifiable objectives from which lower organisational levels can derive their requirements in contributing the successful completion of the vision / mission combination.

It is important to start from the customer's perspective. Even by focusing on a few metrics concentrating on the customer, it is possible to influence behavioural change and reallocation of resources. Moreover, the metrics need to be process driven. Most business indices focus on the process outputs, not the actual process itself. An example is late deliveries which act as an output metric for the delivery process. By considering the Pareto principle, twenty percent of the process performance drivers probably have the major impact at any given point in time. Moreover, an effective measurement system should be dynamic enough to rotate different drivers onto the radar screen to monitor process health when anything commences to slip out of alignment. There needs to be a realisation that trade-offs happen and that every number cannot be maximised. By looking at the example of late deliveries, whilst a process output with a related set of process drivers sitting beneath; from a customer's perspective, on time deliveries may itself be a process performance driver. Consequently, the significance to an organisation's leadership team to agree upon a priority regards what to improve.

2.8.4 A "Balanced scorecard" approach to assess Lean

More than 60% of organisations claim to be using a scorecard (Kaplan et al. 2005). Undoubtedly, the real benefits of Lean are difficult to quantify. Faster set-up, shorter cycle time and better visual management improve the operation of a factory. Lean philosophy (Standard et al. 2000) emphasises total system efficiency. Perhaps the best measure to track Lean progress is the total product cycle time that can be accommodated in a scorecard approach. Reference is made to Paul Ziplin's work (Standard et al. 2000) which concluded that manufacturing parameters that cause long cycle times also cause increased production costs; the converse is also valid, whereby factors that cause short cycle time also lead to low production costs. The related benefits include shorter lead time, greater flexibility, lower inventory, better customer service and higher revenues. It is recommended (Amaratunga et al., 2000) that the balanced scorecard can be used as a management system that focuses the efforts of people throughout the organisation towards achieving strategic objectives and converts the organisation's vision and strategy into a comprehensive set of performance and action measures that provide the basis for a strategic measurement and management system. No single performance indicator can capture the complexity of an organisation's performance (Abernathy, 1999; Brown et al., 1995; Arora 2002 and Fullerton et al., 2009). Undoubtedly, measuring organizational success is a continuous challenge for both managers and researchers.

2.9 Lean perceived as a panacea to every problem

A debate remains that culturally when applied accurately, Lean appears at odds with many of the social values in the US and Europe, where many of the needs of the individual are often regarded more highly than the needs of a group (Maxton et al., 2004). Unfortunately, many of the relationships in the West remain adversarial; in the sense that they are about one side gaining an advantage at an expense of another. In a careful analysis of Toyota's mindset it becomes obvious that its real lifeblood is the quality of its relationships. Nonetheless, we should be candid in stressing that Toyota is not perfect; critics argue that its cars are dull, and its performance in Europe has often been lacking (Maxton et al, 2004). Even Toyota in Japan has failed to produce more than two-thirds of their cars to actual customer order (Holweg, 2003).

2.9.1 Importance of market conditions

The literature criticising Lean is certainly not new. The apparent dominance of Lean in the 1980s can be largely contributed to the "*conditions of a bull market and low interest rates*" (Katayama et al., 1996, page 8). Likewise, the original process of measuring the five-year study has come under suspicion (Pilkington, 1998); that at an aggregated level, the figures for USA were not as poor as were intimated. Equally, the IMVP study highlighted the performance of the TPS, which was not representative of the remaining Japanese manufacturers. Some authors (Cooney, 2002) contend that other manufacturing strategies may be superior to Lean in certain market conditions. That market characteristics of an industrial sector should influence the type of production strategy chosen. A push system utilising batch production was found to be effective for automotive component manufacturers given unstable customer demand and short term customer relationships (Kincaid 2004). Several researchers (Cooney, 2002; Mason-Jones et al, 2000; Yusef et al., 2002) state that Lean practices do not provide a compelling competitive edge in all operational practices. That organisations focusing on volume flexibility, technology leadership, speed to market and new product development surpass companies that focus on low cost and quality. Strategies to develop and maintain supplementary capacity within the overall supply chain have also been shown to provide a significant competitive advantage.

Lewis (2000) contends that Lean can have an adverse impact on the organisation's general innovative activity. Equally, that establishing causal linkages between inputs and outputs is both intricate and multifaceted. Similarly, the economic problems encountered by Nissan (forced to merge with Renault), Honda and Mazda (brought by Ford) suggests that Lean may have reflected particular market conditions at a specific point of time (Katayama et al., 1996); that Lean finds it difficult to deal with turbulent and consistent change. This coupled with the continuous pursuit for perfection can adversely affect flexibility (Lewis, 2000). Likewise, if you apply Lean rigidly, then there is a possibility that large and powerful corporations need to be dependent on the availability of much smaller companies that supply them (Hall, 2004). Presently, Toyota relies on policy management (hoshin kanri) at the macro level and a cadre of line managers auditing their areas at the micro level (Lewis, 2008).

2.9.2 Public Reaction towards Lean

There exists some evidence concerning the public reaction towards the plethora of new products and the ever-increasing alternatives that appear at an accelerated rate (Mehta et al., 2005). Whereas, this was seen as a major attraction to consumers, the existing situation can suggest that the public can become confused by the ever increasing choice and can become irritated by the fact that their new purchases become obsolete as soon as the purchase has been made (Katayama et al., 1996; Sawhney et al., 2005). Moreover, the trend of building Japanese factories abroad has posed difficulties for Japan. This situation has led to additional competition for Japanese parent plants within Japan and its foreign markets. Consequently, many Japanese companies are increasingly importing products and components from their subsidiaries abroad; this issue needs addressing by British Lean organisations (Lewis 2008). Lean could damage sales in some sectors (Oliver et al., 2006). Whilst reliability coupled with the fulfilment of basic functional needs may secure sales in the mid to low budgets, those with higher disposable incomes tend to be impressed by different aspects. Japanese cars regularly score highly in consumer reports but at the top end of the market, German manufacturers, for instance, BMW and Mercedes still perform well despite having no particular reputation for Lean (Halliday, 2005). The most efficient plants strip out the over-engineering; "*why produce a car that can exceed 150mph*" (Oliver et al., 2006; page 19). To the Lean producer, this is viewed as waste, whereas to BMW this makes it a highly sought after brand.

The unique character of prestige cars comes from the broadening of performance capability; the additional flourish in design and options that Lean often compromises on (Lee, 2007). The likely deduction from examining the purchasing trends shows that brand still matters over environmental concerns and the predicted dependability. Undoubtedly, Japanese manufacturers perform well in the lower budget market, but they lose benefits in regards sales and profit margins that occur with attracting the strata of society with the highest disposable income (Motley, 2004). Functional waste may dominate the thoughts of the engineer and manufacturer, but their waste could well prove to be the customer's value. Organisations need to achieve an enviable mix of Lean and manufacturing excellence to market this achievement in a manner that adds value and appeal to their brands (Seddon, 2004).

Regular accusations are made that smaller deliveries just-in-time make producers more vulnerable to disruptions in supply (Bartels, 2005). We have seen the assertion that little often is worse for the environment, with half-empty smaller trucks replacing larger trucks. One flaw in this argument is the experience that focusing on asset utilisation and keeping equipment busy does not actually improve utilisation (Womack et al., 2007). When supermarkets waited for suppliers to deliver full truck loads, truck utilisation was no more than 50%. Now as supermarkets are picking up products from their suppliers more frequently, truck utilisation is also much higher. There is a common myth that congestion in Toyota City is because they send lots of little trucks to their suppliers to pick up parts more frequently. Whereas in fact, Toyota works with fewer direct suppliers, each of whom supplies five times more parts than western suppliers (Ransom 2008). Lean aims to develop a common steady rhythm across the supply chain in line with demand, guarded from supply disruptions and real fluctuations in demand by just the correct amount of standard inventories, possibly held off-line (Koenigsaecker, 2005).

2.9.3 Micro strategy

Stergiou (2006) persists that Lean can make any activity more efficient, but it can also become inflexible. He provides an example of a pharmaceutical organisation that implemented Lean in their drug discovery process. The organisation claimed vast improvements in reducing the time to market and claimed a greater percentage of "winners" (Stergiou, 2006, page 2). However, upon closer examination, it was discovered that the "winners" were purely variants and derivatives of a couple of already existing winners. In essence, their level of innovation and true discovery had fallen because the organisation was pursuing products, which were supposedly based on commercial success, rather than true innovation, which are supposed to characterise the industry. Moreover, the organisation had fiduciary responsibilities to the stakeholders coupled with stewardship obligations.

2.9.4 Variability

Some proponents of Lean remain unconvinced regards its ability to deal with variability (Campell, 2006). Some Lean approaches such as mixed model scheduling and level scheduling (heijunka) essentially seek to compress down or control the demand supply (Kincaid, 2004). The origins of Lean stem from fairly stable demand environments such as the automotive supply chains. This quite high-volume and repetitive demand is appropriate for applying kanban pull-scheduling. Many still confuse pull and kanban. Consequently, many contributors have proposed agile solutions with its increased emphasis on customer demand variability. Lean is increasingly applied in sectors outside the high-volume repetitive manufacturing environment (Hines et al., 2004). Nonetheless, from a strategic perspective it is possible to integrate other approaches without challenging the core objectives of Lean. Good examples would be overall equipment effectiveness (OEE) and overall supply chain effectiveness (OSCE). Equally, Six Sigma attacks sources of variation by applying a rigorous set of quality tools that are highly compatible with Lean.

2.9.5 Universal production system

Cooney, (2002), states that the diffusion of Lean often has been uneven and with partial rather than comprehensive adoption. This situation is often explained by the creation of hybrid models of adoption. Critics suggest that value-adding measures of physical productivity can only award partial accounts of the overall performance since these measures do not adequately account for the differences in product characteristics, (such as size, complexity or manufacturability), variations in the variety of products produced, differences to the extent of sub-contracting, standard work hours, capacity utilisation and the level of automation. The heavy reliance on labour productivity is questionable as in some manufacturing environments it may account for less than 10% of the total costs. The external business conditions, the nature of the buyer-supplier market relationships and the structure of the social and political institutions all have an influence on the realisation of value and yet the Lean proponents often dismiss these influences (Sawhney et al., 2005).

The advocates of Lean assume that the Japanese style of long-term contracts between buyers and suppliers is standard industry practice (Womack et al., 2005). Lean relies upon production levelling throughout the whole supply chain. Equally, whilst it is often advocated that Just-in-time will force the universal adoption of the Lean system; this assumed superiority is certainly questionable on two grounds (Cooney, 2002); initially, a diverse range of labour and product market factors influence its adoption; secondly, it is still unclear whether the value added by the just-in-time system can actually be realised in the marketplace in the form of profits. Lean is seen to be more successful in areas where the tasks are stable, repetitive and uncomplicated. Consequently, it suits environments that are characterised by low technical uncertainty (Mehta et al., 2005). A low degree of environmental uncertainty will often be characterised by stable markets and relatively few changes in work design. Equally, it is the nature of the competition that will influence the degree of environmental uncertainty (Cocolicchio, 2008). Sharp reductions in buffers inevitably lead to reductions in timing control for operators and increased stress levels (Parker, 2003).

2.9.6 Impact of Lean on the HRM issues

Empirical research identifies the management of human resources as a significant issue in the implementation of Lean. Bamber et al., (2000), Yauch et al., (2002) and Doolen et al., (2005) state that the "*rigid hierarchical organisational design*" (Doolen, et al; page 63) was the single biggest obstacle to the adoption of Lean practices. A sizeable portion of contemporary research focuses on the implications of large-scale changes of Lean on work design characteristics and employee outcomes. Some stress that there are negative consequences of Lean whilst others indicate that Lean can achieve world class performance with a positive effect on employees (Mehta et al., 2005). There are potentially negative effects on jobs and outcomes because of the workflow formalization inherent within Lean (Parker 2003). This is felt to be evident when jobs are designed to be coercive; methods by which management can attempt to coerce employee effort and compliance.

In contrast Womack et al., (2003) suggest that by rotating jobs and sharing responsibilities, multi-skilled workers can solve quality problems; this freedom replaces the stress of repetitive and monotonous tasks undertaken in a non-Lean environment (Biddle, 2006). Unequivocally, an increased level of autonomy, task identity and task significance will have an impact whereas skill variety may lead to increased levels of strain. The correlation between personal stress and Lean has been explored (Sawhney et al., 2005). This study reflected that the personnel requirements and system requirements were not often aligned. The results were a summary of responses from 454 members of the "*Association of Manufacturing Excellence*". Evidence also pointed out to the fact that if employees cannot support and sustain the system changes, backsliding or the lack of the ability to sustain change is a common occurrence. It could be inferred from this extensive study that Lean has not integrated human behaviour into the process. Gill (2003) indicated that Lean can result in elevated stress levels, increased worker turnover, absenteeism and time loss due to accidents and finally can have an adverse impact on health, and the performance of operators. It was suggested that practices such as standardisation could lead to high strain risks (Ichimura et al., 2006). When proponents make reference to developing the people and workers, we should not refer to their spirituality, intellectual curiosity or moral judgement (Motley, 2004). Instead we should be looking to develop their skills and attitudes in ways that will serve towards continuous improvement of the processes and ultimately to everyone's benefit within the context of success in our collective activity (Womack 2005).

2.9.7 Perception held regards Lean

Organisations that have shed employees or have exploited workers will struggle to gain cooperation from anymore in their quest to eliminate waste (Halliday, 2005). The primary objective of any business is to make money. Many organisations, pretending to implement Lean still use direct labour as their primary cost driver (Lee, 2008). Consequently, this becomes a primary target for the elimination and optimisation and they become focused too narrowly towards headcount reduction and labour efficiency. Lean involves a high degree of change which is a natural fear for many individuals. Lean is hard work, especially for managers. Equally, there exists a rich and counterintuitive technical content that they have to learn. Most Lean efforts amount to very little since they boil down to applying Toyota-like tools to the old business model (Carnes, et al., 2005). One of the most powerful messages proposed by Shingo (1989) is that it is not sufficient to understand the "*know how*" of the Toyota Production System; that you must first understand the "*know why*". Unfortunately, the term Lean is used by many to refer to dozens of different systems though most share the same fundamentals. In order to eradicate the resulting confusion, the "*Society of Automotive Engineers*" has drafted a standard that assists to define and guide the implementation of Lean initiatives for those in its industry. The document referred to as the J4000 (www.sae) assists to identify and measure best practices in the implementation of Lean in a manufacturing organisation.

2.9.8 Certain situations are regarded as more conducive towards Lean

Doolen et al., (2005) discovered that larger companies had implemented Lean practices to a greater degree. These findings were consistent with the findings of Shah et al., (2003) who concluded that larger plants across a range of industrial sectors are more liable to implement Lean. They did not discover a significant difference in the implementation likelihood of cross-functional workforce practices based on organisational size. Undeniably, for many smaller organisations involved in contract manufacturing, some Lean practices, such as cellular manufacturing, becomes much more challenging. Whereby, a small organisation with many different categories of customers and a schedule that changes all the time, may struggle to guarantee the consistency required to set up cells. Consequently, the evidence suggests that the organisational size and the type of manufacturing may be significant factors in the application of Lean (Koenigsaecker, 2005).

Shah et al., (2003) proved that contrary to popular belief unionisation did not have an extensive impact on the implementation of Lean. However, five out of eight practices had a significantly negative association between the age of the plant and its implementation. The five practices were:

- cross-functional workforce,
- cycle time reduction,
- JIT / continuous flow production,
- Maintenance optimization and
- Re-engineered production process and self directed work teams.

This implies that old plants are more likely to implement these practices relative to new plants. Moreover, of the 22 Lean practices, plant size significantly impacted on all but two of the practices. This suggests that large plants are more likely to implement the twenty practices extensively. These findings confirm many of the previous conclusions (White et al., 1999). Nonetheless, significant differences are to be found between process and discrete industries in two of the four bundles. Plants in discrete industries are more likely to implement JIT than those in process industries where kanbans are difficult to imagine. Equally, TPM practices are more likely to be implemented in process industries than in discrete industries. Paradoxically, the findings make sense when one considers the high degree of magnitude placed on capacity utilisation in process industries. Nonetheless, the findings did suggest that Lean practices are prevalent in all industries and are not restricted to industries associated with discrete part manufacturing.

Proponents (Womack et al., 2005) admit that logistically smaller organisations are more able to fully apply Lean within their own organisation. Cooney (2002) argues that the use of batch systems and craft work methods in bus and truck manufacture is based on common sense, given the low volumes and large numbers of vehicle combinations. If an analysis is undertaken of truck manufacturing, the versions of chassis, engines, transmissions, cab and coachwork can run into thousands. Consequently, producing thousands of variants lends itself to custom-building techniques whereby groups of multi-skilled workers assemble the whole product or segments of the product. The use of task specialisation on a moving line is hardly sensible. Most Lean supporters would condemn batch production as being highly uneconomical and craft work methods are ridiculed as the mere bolting together of vehicles and sub-assemblies (Hunter, 2004).

Craft work methods based upon buffered flows, such as the dock assembly method, are still widely used in bus and truck assembly (Thompson et al., 1996). Daimler-Benz, for example, whereby the adoption of Lean was limited, intended to enhance the craft skills whilst maintaining the craft production methods used in their production systems. Undoubtedly, some elements of Lean were adopted in order to improve the overall organisational effectiveness instead of eliminating craft production. Cooney (2002) provides the example of two Australian owned organisations, "Austral Wire" and "Austral Forge", who are both batch producers. Their plants are organised around autonomous manufacturing processes and consequently products have long cycle times. There exists no flow of products through the plants and instead batches of WIP are pushed through the plant and finished in time for customer delivery. Both plants make some JIT deliveries at the customer's request although there is no JIT flow within the plants.

Whilst JIT is a superior flow system, there existed two main explanations for using the batch system. These were new organisations and not all automotive companies engage in long-term supplier contracting. Equally, the two organisations' position in the marketplace and the nature of buyer-supplier relations in the component industry influence the process choices of these firms. A combination of low production volumes, extensive product and process innovation, the continual negotiation of new business contracts and the prevalence of customer switching meant that frequent and severe disruptions to production had to be managed. The batch production system with its de-coupled flow provided a solution to manage these disruptions. Besides having low volumes in total, these manufacturers also produce a wide range of products for a diverse customer base whereby each dictates their own standards and requirements. "Austral Forge" produces 50 unique forgings for 12 different customers and "Austral Wire" produces 106 unique designs for 21 different customers.

When organisations produce low volumes of diverse and changing product lines, this makes it very difficult to achieve a balanced flow of product based upon standard times (Bartels, 2005). Production levelling is made exceptionally difficult, if not unattainable, when volumes and product content are continually changing. A further complication is the persistently changing production requirements and the interruptions caused by the rapid product and process innovations occurring in these new companies (Seddon, 2004). Both component organisations depict high rates of product and process innovation, as they attempt to develop new lines and innovative processing technologies that will give them a competitive edge. The batch production system, along with its processing buffers, gives these companies the flexibility to manage the uncertainty surrounding rapid product and process innovation. A JIT system would come under considerable strain under such interruptions. The Batch system permits the interruption to be contained internally within the factory without affecting customer deliveries.

The external business environment can pose strict conditions on the internal workings of an organisation. Cooney (2002) suggests that contracts from the supply chain are generally short-term as some businesses indeed form short-term contracts as the competitors use the two organisations on a short-term basis to manage their own capacity problems. It was not uncommon to turn over products within six months of their introduction since customers switch down the supplier chain. Austral Forge, for instance, lost several Ford products for eight months to an alternative supplier as a result of a price war. Subsequently, these were returned to Austral forge once it manifested that the alternative supplier failed to meet Ford's quality and delivery requirements. Nonetheless, 28% of Austral Forge's factory volumes were affected during these eight months.

In certain circumstances, the batch system permits organisations the flexibility to try out new businesses and customers. Often vehicle organisations will award new suppliers some low volume, top-up work for existing products. Accordingly, the customer is awarded time to test out the new supplier's quality and delivery performance. Likewise, it gives the supplier a chance to check out its product costs and manufacturing requirements. In essence, both counterparts are able to try out the proposed relationship. This type of new business development is very important for the component companies. The batch system permits these organisations flexibility to try out new products without going to the expense of setting up new product cells or processing areas. Low and variable production, continual changes in products and product content and process innovations all create pressures that inhibit the adoption of JIT (Liker, 2004). Equally, production levelling and production smoothing based upon small lot production, using standard times becomes virtually impossible in an environment where there is constant and rapid change. Ironically, a buffered production system presents these organisations the flexibility to deal with the disruptions involved in developing new businesses. The batch system permits operational flexibility in order to deal with disruptions caused by product and process innovation, customer switching and new business efforts. Likewise, it facilitates the process of enhanced work designs through the use of craft work methods. In the specialised areas of the vehicle industry, there is some evidence to suggest that de-coupled flow production and the related craft work methods have enduring value. There is, in fact, little evidence that batch producers are simply "in transition" towards Lean. Instead, batch or decoupled flow production depicts enduring value despite the splicing of some Lean practices on to this system. There exists some evidence that Lean has been facing these pressures in Japan, itself, due to the altering labour conditions (Benders, 1996).

2.10 Lean as a Philosophy

The fundamental theme of the research focuses on the notion of construing Lean as a philosophy. Whilst the investigations revealed testimonials to this vision, it was discovered that frequently there was a heavy bias towards the operational elements of Lean. The organisational development, culture and supporting mechanisms were not fully acknowledged whilst sustainability along with the need to view Lean as an ideology were not confronted. An analogy is drawn with philosophy whereby philosophers are striving towards a fundamental understanding of whatever exists, including ourselves. It is advocated (Small, 2004) philosophy first appeared in the writings of Herodotus and Thucydides (fifth century BC) and could be loosely translated then as the pursuit of knowledge. Essentially, philosophy has developed examining two basic questions; the first is "*What is the nature of whatever it is that exists*" (page 7), ontology, and secondly "*How, if at all, can we know?*" (Page 8). The second branch is referred to as epistemology. Kenny, (1998) argues that philosophy aims to provide not knowledge, but understanding and proceeds to develop a complete and coherent vision. Often this is performed without making it a question of religious faith or appealing to the say-so of an authority. Whilst, individual philosophers may hold religious beliefs (Magee, 1998) the sincere ones will not attempt to support their philosophical arguments with appeals of religion. A philosophical argument is one that carries its own credentials with it, in the form of reasons. Equally, it asks for rational assent, not faith or obedience.

Moore (2001) is emphatic that Lean should be viewed more as a philosophy or condition than as a process. Comm et al., (2000) proposed "*Leanness is a relative measure*" (page 120). Ohno, (1998), demonstrated that the Toyota Production System was not just a production system, but a total management system. As a philosophy it involves complete commitment from every level within the organisation (Wheatley, 2005; Hines et al., 2008; Jones 2009). Lean goes beyond the engineering and management disciplines emphasising value and the elimination of waste in a continuous manner based on common sense (Ohno 1988, Womack et al., 2005 and Liker 2004). Likewise, organisations need to separate the Lean Philosophy from the techniques and tools used to support the philosophy (Baudin, 2006; Lee 2008). Lean is a set of techniques comprised from a system that is derived from a philosophy (Henderson et al., 2003; Cocolicchio, 2008). Lean should always be viewed as a philosophy with the tools such as Six Sigma acting as enablers (Mehta et al., 2005). The development of suppliers upstream from manufacturing is only part of the objective. It is the customer interface that the initial mura (variation not attributable to the customer) when created that causes considerable Muri (overburden); this in turn, causes all the Muda (waste) throughout the supply chain (ERSC, 2007). Mura feeds on Mura all the way upstream and unless the root causes are addressed, the supply chain will be much longer, less responsive, more expensive and less able to deliver the right product on time (Bicheno et al., 2009). Lean thinkers recognise that as soon as you begin to think that you are done, another set of issues emerge. Quinn (2005) suggests that instead of viewing it as a program we should view Lean as process-focused management. It needs to be seen as a way of thinking to make the company the best it can be at all times (Hines et al., 2008).

2.10.1 Lean extended to outsourcing

The philosophy should extend to an organisation's decision on outsourcing (Bicheno et al., 2009). It is estimated that about 70% (Liker, 2004) of Toyota's components are outsourced. Nonetheless, Toyota retains internal competency even in the components sourced out. A philosophical base of Toyota is self-reliance (Lee, 2007; Lee 2008). Whilst key capabilities are sourced out to external firms the company does not loose its internal capability. All the key suppliers are part of Toyota's supplier association (Ransom 2008). Toyota aims to create bonds amongst individuals and partners (Vasilash, 2000). The myriad of Toyota plants in many countries pursue the Toyota system (Parker et al., 2003). The work instructions are generated and controlled at the head office in Japan; nonetheless, the grass roots participation takes place with the execution of the strategic plan which is generated at the top by competent managers, engineers and specialists who have the academic and work background to tackle those big challenges to solve them (Ransom 2008; Johnston, 2009).

2.10.2 Lean forwarded as synonymous to a religion

No statements in relation to Lean should be treated as gospel. Lean is an ideology strictly based on rationality and scientific methods. Its implementation requires creativity, observation and experimentation, but not faith. Taiichi Ohno, Shigeo Shingo, Sakichi and Kiichiro Toyoda were human beings, not gods and nothing they did, said or wrote should be treated as sacred (Womack et al., 2005; Ransom 2008). Religion is based on faith, accepting as true something, which you cannot necessarily prove. Lean, however, is a logical, economically sound managerial and tactical approach to manufacturing (Mehta et al., 2005; Lewis 2008). Unfortunately, often Lean proponents pushing their organisation to pursue Lean based on similar faith cannot economically justify Lean in the face of contrary accounting data, so they urge their senior managers to support it because somehow Toyota has used Lean to great advantage (Ransom, 2008). The tools without the mindset can be regarded as analogous to a body without a soul and purpose (Lee, 2008). Similarly, we should take exception to expressions such as "*there is only one true Lean*" in reference to Toyota. Unfortunately, this brings religious thinking into the picture. One cannot propose, "*there is only one true physics*" because the way physics moves forward is through experiments whose outcomes contradict established theories. Equally, neither is the discipline open to just any absurd or discredited idea (Doolen et al., 2005). The Lean philosophy may need to be modified to be relevant in different business, social or cultural backgrounds (Spear, 2004; Ransom 2008).

The 2005 LEI Survey confirmed the low numbers of organisations on the latter stages of their Lean journeys. When asked about the level of Lean implementation within their own organisations, the following results were found:

- Planning – no implementation 14%
- Extensive – implementation underway in many areas and progress being made 28%
- Early – starting to implement in pilot areas; some progress 51%
- Advanced – Lean has become the standard way of operating and being extended to suppliers 4%

These figures are reinforced when we look at those quoted by the *Manufacturer* (2002) whereby 100 organisations on the Lean journey were asked how close they were to becoming a Lean organisation and only 3% stated they were truly Lean and 22% held they were close to Lean.

2.10.3 The longevity of Lean

Ohno, (1998), confirms that the Toyota Production System did not happen overnight but through a series of innovations spanning over three decades. Womack et al., (2005) summarize that Lean is not a destination but a journey, and a long one at that. Undoubtedly, Lean is better thought of as process-focused management; the processes under scrutiny are those that best serve the customer (Hines et al., 2008). Often engineers are trained to seek optimal solutions. The optimum, nonetheless, is a mathematical model, and once you have reached it, by definition, no further improvement is possible (Ichimura et al., 2006). On the shop floor, it could be summarised that there is no optimum and no limit. The objective should always be to modify the operation, right up until the plant closes. It is an ever-evolving way to get somewhere (Ransom, 2008). Equally, you are either on the journey or you are not; you actually never reach a destination. "*The minute you think you've reached a destination, you're actually done. You're off the journey.*" (page 52, Campbell, 2006) Consequently, Lean needs to be seen as a journey and not an end state (Lee, 2007).

Toyota is constantly under creative tension to continually improve towards what they call the "*true north*" or an ideal state of perfection (Lee 2007; Michel 2004; Pullin 2005; Ransom 2008). Liker (2004) states that a common phrase around Toyota is "*Before we build cars, we build people*". They aim to develop people so that they are strong enough to contribute towards the Toyota Way. This does not entail demonstrating extravagance towards the employees; it is about challenging and respecting employees at the same time (Campell, 2006; Lee 2007). Depending on which part of Lean literature that is referenced, proponents have advocated stages an organisation passes on its Lean journey; whereby three are selected (Lee, 2007):

- core principles which are the essential minimum requirements necessary for the system to work,
- consolidation includes the latter secondary techniques such as 5S and the beginnings of Kaizen; it includes methods and training that instil basic values aimed at sustaining the system, and
- the continuous improvement phase whereby the changes are less dramatic but certainly more important. This stage never ends, and is a core value for Toyota though many fail to accept this.

Lee (2007) states that whilst a variety of factors can influence the time frames, i.e.,

- size of the firm,
- the product-process mix,
- culture,
- leadership and other factors

if we were to assume a "*typical*" (page 17) factory with 500 employees, approximately 2,000 manufactured parts, 12 product lines, and competent leadership; in this case we could assume:

- phase one would require 12-36 months for completion,
- phase two would require an additional 1-3 years before continuous improvement sets in.

2.10.4 Lean as an economic reality

Most of the literature suggests that the purpose of Lean "*is to eliminate waste*". In fact, the first purpose of Lean should be to create a successful and robust business (Dimancescu et al,. 1997). If an organisation focuses on eliminating waste in their processes, they will differentiate themselves by being able to provide better quality and delivery at less cost (Parker et al., 2003). Despite the consistent message from Toyota, many Lean plants have felt that Lean involves pursuing the implementation of tools such as "one piece flow", "Value stream mapping", "standardised work "or" kaizen events" (Koenigsaecker, 2005). Toyota, on the other hand, has remained focused on its principles and a disciplined emphasis on process improvement to obtain the results such as profit, a reduction in the lead-time, productivity and building in quality whilst empowering its employees (Baudin, 2006; Ransom 2008).

Rarely, at a Lean conference or in a Lean article does anyone discuss in any detail the notion of profits and improvement (Lewis 2008; Halliday, 2005; Cocolicchio, 2008). It is almost as though profit is not an appropriate topic for public discussion (Womack et al., 2005). Instead, the delegates, most articles and books stress Lean is about flow, value and customer satisfaction. Undoubtedly, Lean is about these aspects but the TPS is not that simple (Lewis et al., 2006). Smalley (2006) stresses that amongst one of the first slides he was shown at Toyota during an employee orientation was the simple equation: (price – cost) "x" volume = Profit. In this highly mature competitive automotive sector (Drew et al., 2004; Cocolicchio, 2008), Toyota rightly believes that they cannot dictate the price and that the market decides how many units it will sell. Accordingly, the only lever they have is cost, so every effort is made to manufacture in such a way as to reduce cost (Koenigsaecker, 2005; Lee, 2008). Smalley (2006) stresses the Japanese proverb "*you must wring water out of a stone if necessary*" (page 2) was repeated in budget meetings and project review sessions. This aspect is constantly drilled into Toyota recruits; unfortunately, external consultants and academics cannot observe this and are unable to comment about this in their writings (Ransom 2008).

2.10.5 The Lean traditions

Toyota started with the values and ideals of the Toyoda family who were pragmatic idealists and who learnt by doing and who always believed in the mission of contributing towards society (Liker, 2004). Toyota's principles were shaped by the personalities, values and experiences of its founders in the Toyoda family. Gary Convis was named as the first American President of "The Toyota Motor Manufacturing" in Kentucky in 1999. It had taken the Toyota executives over 15 years to develop Convis into someone they could trust to carry the banner of the Toyota Way. Liker, (2004), talks about the "*Lean learning enterprise*", (page 306), in reference to how Toyota continually adapts its culture to local conditions (, Utley et al 1997; McNabb et al., 1995; Bartezzagni, 1999; Schonberger, 1996 and Henderson et al., 1999). The absolute core of the Toyota philosophy is that the culture must support the people doing the work. "*Leadership is one of the key factors that determine Lean success or failure. And when we say leadership, we mean it in the literal sense of the word*" (page 55; Campbell, 2006).

Lean requires a specific set of skills and experiences (Baudin, 2006; ESRC 2007). Whilst the literature mentions the change agents and the role of the sensei; one area that many Lean organisations pay insufficient emphasis on is the work of the team leader (Ransom, 2008). Whilst less prestigious than the TPS specialists they may be more important, because there are tens of thousands of these individuals. On the other hand, there are only about 50 TPS specialists in an organisation of over 200,000 employees. This principle stems back to Toyota's early days and the management programs were collectively referred to as "*Training within Industry*" (Smalley, 2006). The content of these courses is highly relevant in today's market; every one managing at Toyota is expected to not only have knowledge and proficiency of their job, but to teach, improve and solve work team related issues in a standard and beneficial manner (Bartels 2005). The journey for Toyota is by no means over (Hines et al., 2008). Few people at Toyota can really explain the system in a lucid manner. This is because there is a built-in DNA to the company culture.

Koenigsaecker (2005) summarises the four different areas where learning needs to take place for a true Lean transformation. The initial step is the jishukin activity in the workplace; this concentrates on some of the basic Lean tools. The second level of Lean learning is to learn leadership or management practices that support the process. Inclusive in this is the learning of how to handle new management tasks such as organising significant internal member redeployment as the organisation's productivity grows (Sim et al., 2009). The third level of learning, which can take about six years of personal experience, is to actually believe in the key principles of Lean. The fourth level whilst the most complicated but also vitally essential is the need to build a true Lean-learning experience and this involves key changes in leadership behaviour (Doolen et al., 2005; Mann 2005).

2.10.6 The Technical application

Chase (1999) states "*people say they are implementing Lean when they're just implementing one or two of the elements*" (Page 35). Lean planning helps you decide which tools to use, when and where. Equally, the principles stay the same although the tools you select may be different but the philosophy stays the same (Henderson et al., 2003; Lee 2008). Integral within this notion is the need to streamline the flow of production, reduce variability in the processing time, consequently shrinking the cycle time. In any application, some tools may not be needed, some modified and some new ones required (Smalley, 2009). By way of example, if all you have is manual assembly, you are not going to apply SMED principles to a new category of machines. Equally, if the intention is to implement mistake-proof computer controlled machines, than one needs to look beyond traditional Poka-Yoke (Bartels, 2005).

Toyota has either invented or led in the development and implementation of many tools (Henderson et al., 2003; Cocolicchio 2008). It started with jidoka, which stemmed from the invention of the automatic loom that permitted the loom to stop as soon as the thread broke. This allowed one worker to support 12 machines. This happened in 1902 and the Toyoda family and Toyota Motor Corporation have never stopped learning. Lean and TPS are not tools put into place but instead they were responses to the problems and opportunities found (Henderson et al., 2003). The manner in which the tools are used is significant. Many organisations implement value streams without a great deal of thought towards the Lean principles (Vasilash, 2000, Olexa 2002(i)). Often Kaizen teams are implemented, then inspection of processes begins once in operation and this launches waves of corrective action. Since the bad practices had been built into the value streams, the kaizen efforts give the impression of being highly effective (Koenigsaecker, 2005). Toyota, however, ensures that its product and process development are intended to create profitable operational value streams. This is achieved by ensuring that initially the production process and the product design are evaluated together in order to optimise both (Lee, 2008). The production processes are highly standardised and documented which means that the product designs only need to comply with established process requirements in order to smooth value streams (Lewis et al., 2006). It is at this stage that the equipment designs and information management systems are finalised.

A trend in many Lean efforts is the ill-advised impression given by Lean champions or change agents (Wheatley, 2005). This usually involves suggesting that value stream maps, create one piece flow; post standardised work charts create "u" shaped work cells; then implement kanban and walk the plant flow to conduct Lean audits. The inherent problem with all the above is that the practitioners in question have failed to recognise that it is important to first determine what exactly the problem is before being instructed to use a tool in question (Doolen et al., 2005, Henderson et al., 2003). The TPS never has been and nor is it intended to be viewed as a set of rigid guidelines prescribing what to do in exact detail in every situation. Systems have evolved over the years through trial and error whilst focusing on particular issues, making people challenge the conventional wisdom behind situations, identifying the root cause of issues and then proceeding to solve problems, often in a unique and spectacular fashion (Elliot, 2001). It is only when the counter measure is proven, or is seen to act as a good analytical aid, that it becomes a standard tool in the Toyota arsenal (Parker et al., 2003). Subsequently, this is taught to other members so that it could be utilised whenever applicable. Toyota uses the term counter measure specifically to send out the message that none of the "solutions" used to address the problems found are permanent; that any can be changed when something better comes along (Hines et al., 2008). Earlier proponents (Shingo, 1989) stated that the TPS is just 5% kanban, 15% production system and 80% waste elimination.

Toyota began its Lean journey in 1945 and is still progressing and changing today. Table 2.13 gives an indication of Tool development in the TPS:

Sample Problem statement	The historical root cause	The Analysis tool or countermeasures developed
Lacking work motion and flow of materials in line layouts	Insufficient detail in the layout planning or any line conversions	Value stream mapping and work motion analysis
Correctly stamped parts not available when required despite the amount of inventory	Long change over times	SMED, analyse and separate internal from external work
Correct parts are not delivered downstream as and when needed	There was no physical or accurate signal; a push style of production in evidence	Pull systems and kanban cards used to signal replenishment
High percentages of scrap and defects	Low process capability	Build in quality at the process. Not through inspection
Low labour productivity	One man and one machine	Separation of man from

where there was man/machine combination	layout and work assignment	machine. Create standardised work. To promote a multi-skilled work force with job instructions

Table 2.13
Tool Development in the TPS

SMED and work-cells became part of the TPS since they reduced inventory and waste in the Toyota context. Other techniques addressed other issues; for example, some buffers were large at Toyota because of equipment breakdowns. TPM addressed this breakdown problem. Ohno's (1988) ideology needs to be fully encapsulated; that the only way to implement Lean is to initially deduce the greatest point of need for improvement and start from there. The combination of Lean tools applied is critically important too; for example, rapid set-up (SMED) may be necessary to enable kanbans; work-cells make kanbans simpler and easier.

2.10.7 The proposed rules to follow

Spears et al., (1999) exposed a standardised way of working at Toyota that commences with four rules; whilst the language has been customized the original intent has not been altered. The four rules are:

- to structure each activity,
- clearly connect every customer/supplier,
- specify and simplify every flow,
- improve through experimentation at the lowest level possible towards an ideal state.

Whilst many organisations may feel they are undertaking the above, it is the depth of application that distinguishes organisations (Liker, 2004; Mann 2005). Every decent piece of TPS literature stresses this objective with the twin production disciplines of JIT and Jidoka, alongside the notion of continuous improvement through standardisation whilst eliminating waste in all operations to improve metrics such as quality, cost, productivity, lead time, safety and morale (Campell 2006; Doolen et al., 2005; Henderson et al., 2003). Lean is an appropriate interaction of man, tools and material (physical or intellectual), to produce an outcome efficiently (Dimancescu et al., 1997; Lewis 2008). Often the literature depicts the TPS as a house with elements such as kaizen, jidoka and JIT. These are historically relevant tools though do not necessarily represent the true heart of the TPS. The Lean principles provide the true strength and influence. Figure 2.2 represents this aptly. Each principle symbolizes a deeply embedded way of thinking of the true Lean systems thinkers (Ichimura et al., 2006). Primarily, there is a need to structure, operate and improve an organisation's activities, connections and flows. The four rules permit goods, materials and information flows through simple and specific pathways to expose opportunities (Hall 2004; Ransom 2008).

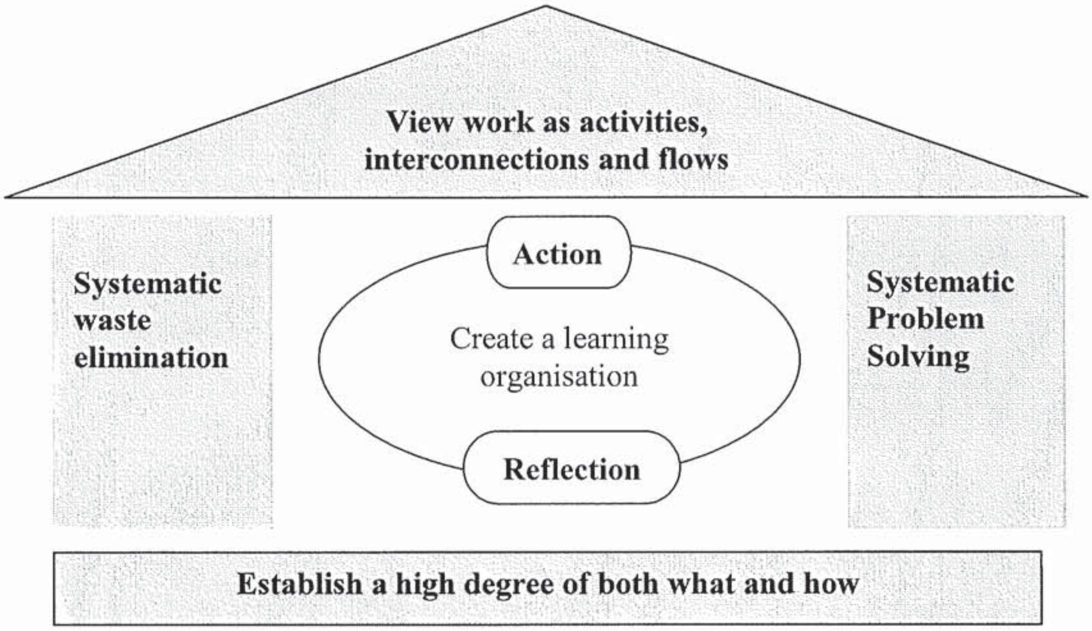


Figure 2.2
Lean principles

In essence Lean needs to be viewed as a set of principles evolving from an overarching philosophy; equally these principles are derived from very sensible production engineering experiences and requirements (Dimancescu et al., 1997; Ransom 2008). Standardization is the foundation of continuous improvement. Every improvement and process needs to be standardised (Hall, 2004). Equally, there needs to be a deeper and more detailed level of agreement (Campell, 2006). The existing system exists to solve its own problems. It is at this stage that sustainable change can be achieved (Drew et al., 2004). The organisations that excel are those that adopt the attitude that every problem is an opportunity. A problem is a variance displaying a gap between the current reality and the ideal state. The organisations adopting Lean as an ideology depict the philosophy of a learning organisation (Mann, 2005). It is important to create frequent points of reflection. The greater the points of reflection, the faster, deeper and more sustainable the organisation's transformation process is likely to be (Doolen et al., 2005). It is vital that leaders are learners and teachers. Leaders need to be open to new ideas that require them to give up some control. Equally, leaders also need to teach Lean systems; everyone from the CEO to line supervisors is a leader (Small, 2004). Leadership means understanding the current reality very deeply and clearly, and having a vision for the ideal state and understanding and ability to close the gap. These principles assist to apply the four rules effectively (Spears et al. 1999). In essence, the principles and rules fit together as the principles above enable us to apply the rules and permit the Lean transformation to come alive. This is depicted in Figure 2.3 below.

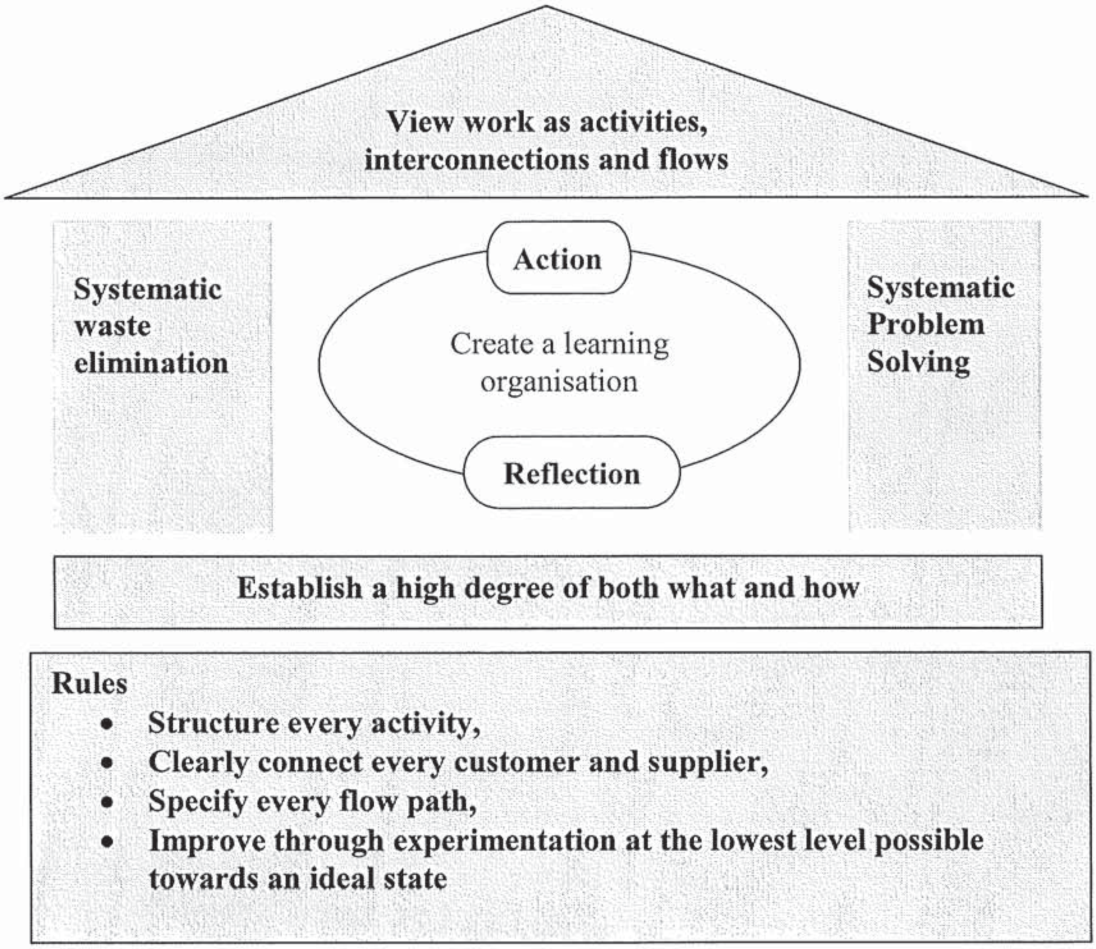


Figure 2.3
Lean principles with rules

Toyota had not even bothered to name its production system in excess of 20 years after its initial pilot. Instead they focused on making real, quantitative improvements in line with the core principles and metrics; the tools were deployed or invented along the way. Spear et al (1999) produced an excellent academic paper but one which describes the outcomes but lacks depth in giving us the insights as to how. Making improvements is strenuous, time-consuming and requires persistence (Stamm, 2004). On every occasion, it is vital that the problems are raised to the surface, challenge all the conventional notions of manufacturing wisdom, and assure that the root causes are promptly corrected (Campell, 2006).

2.10.8 Misconceptions about the TPS

The Toyota Production System as practiced by Toyota may not be easily emulated by other organisations owing to the variation by which some processes are managed and the prevailing culture (Hall, 2004; Stamm 2004). Lean thinking requires a different consciousness of the purpose of each value stream and how it works in practice. Equally, it needs a common way of thinking and working together with others up and down these value streams to manage and improve them (Drew et al., 2004). Toyota can teach us the mechanics, but it is up to each of us to evolve and improve these mechanics. It is important to outline that the TPS is not the Toyota way (Liker, 2004; Lee 2007). The Toyota Way comprises of the essential principles of the Toyota culture, permitting the TPS to function effectively (Baudin, 2006). Regrettably, many reinforce the misunderstanding that the TPS is a collection of tools that leads towards greater efficiency. Whereas, it is a total system supporting and encouraging its employees to continuously improve the processes they work on (Womack et al., 2005). The Toyota Way is a philosophy embracing a set of tools that are required to be applied appropriately in every situation (Conner, 2009). They are part of a greater system that seeks to achieve harmony and perfection to sustain success (Mann, 2005). One organisation's structural strengths and weaknesses would differ from those of others and to superimpose a recipe that works elsewhere with different constraints would be imprudent (Hall, 2004; Lee 2007).

Organisations need to recognise that there is little they can do to jump to the end state of Toyota's learning and merely implement the final result. Toyota has been moving through this journey for fifty years and some of their lessons were learnt over 100 years ago. Nonetheless, conversing and applying a set of rules and principles can dramatically reduce the time period. Value Stream mapping is probably the most widely used tool in the Lean program today (Lee, 2007). The generally held pre-supposition is that a value stream map must be drawn for each product family; then appoint a value stream manager and this should reveal all the plant's problems. It is seen as a pre-requisite for Lean. Smalley (2006) reveals how the Toyota facility in West Virginia has no value stream maps and neither does it have any Value stream managers. The reason for this is that Value stream maps were developed primarily as an analytical aid to look at material and information flow problems in certain processes. In fact, it is referred to as "*Material and information Flow analysis*" in Toyota (Smalley, 2006). Alongside this, Toyota often adds another dimension, that of human motion. It was considered that a typical layout drawing, for instance, simply fails to emphasise these aspects clearly enough to bring these problems to the surface (Liker, 2004).

In practical terms, once production has commenced, it is too late or costly to fix some of these items. As a result, a countermeasure was developed which became a requirement for engineers and others in the manufacturing processes. The emphasis was to draw detailed standardised work charts depicting operator motion and flow charts revealing material storage locations, schedule points and operator sequence before the commencement of production

(Smalley, 2006). Alternatively, the tool was used to discover ways to convert lines into more efficient ones. The TPS can be neatly summarised (Liker, 2004; Koenigsaecker, 2005; Mann, 2005; Lewis et al., 2006) since it:

- is focused on a consistent way of thinking,
- embraces a total management philosophy,
- concentrates on total customer satisfaction,
- encourages an environment of teamwork and improvement,
- essentially is a never ending search for discovering a more appropriate way,
- promotes the building of quality in the process,
- expects an organised, disciplined workplace, and
- is evolutionary.

Many organisations have been convinced that "Value Stream Mapping" is a universal tool for identifying all problems in manufacturing processes (Koenigsaecker 2005). This belief unfortunately, biases organisations with major quality, downtime, or productivity problems since these items are not surfaced when using the methodology outlined in value stream mapping (Baggaley 2006). The tool is not intended to fully consider these problems by design. Correspondingly, most Lean efforts already have an unequal bias towards the concept of "flow"; instead of learning to see what is truly not working in their processes, companies typically focus on a particular subset of operational problems and generally principally that of flow and lead time related issues (Hines, 1999; Conner, 2009).

2.11 Lean Audits

In order to build a framework which plainly and precisely depicts the juncture of a Lean journey for any organisation, it was imperative to explore the work undertaken by others in order to finally develop the audit required.

2.11.1 Goodson's basic Lean Measures

Goodson (2002) developed a tool kit that aids experts to "*Read a plant Fast*" (page 108) in as little as thirty minutes and deduce whether a factory is truly Lean. He describes his approach as *rapid plant assessment (RPA).* In order to undertake this assessment, one needs a team of experts to tour the plant. During this tour, the team observes all aspects of the plant's environment and look for evidence on how the plant adheres to best practices. Goodson (2002) created a plant assessment, which is focused more towards the effective benchmarking and assessment of the supplier plants. Nonetheless, the methodology can be used for an organisation's own operations whilst this was not the original intention. Essentially, the matrix comprises of eleven categories and each is rated from poor to best in class. There are 20 questions that proceed to assist the evaluation. The eleven categories cover the points summarised in the Table 2.14:

R E Goodman's Plant Assessment	
Categories	**Indicative type of evidence needed**
Marketing orientation	Customer Satisfaction
5S	5S, i.e., Safety, environment, cleanliness and order
Visual Management	Core Lean concept
Scheduling	Examine over-production and Heijunka
Flow and Space	Analyses movement and evidence of pull
Inventory	Looks for over-production evidence
Teamwork and motivation	Looks for policy deployment, blitz and kaizen
Maintenance and condition of tools	Evidence is sought for TPM and 5S
Management of complexity and variety	Aim remains to improve the flow and new product introductions
Supply chain integration	Looks for supplier partnerships
Commitment to Quality	Evidence of Six Sigma and continuous improvement initiatives are sought

Table 2.14
Goodman's Plant assessment

As a direct consequence of the process adopted, often the decisions taken can be very subjective and rudimentary in nature. No real evaluation exists to neither investigate organisational development nor examine the cultural implications of the organisation.

2.11.2 Schonberger's quick ratios

Schonberger (1987) originally suggested three quick ratios that remain useful reminders of the true objectives of Lean; namely:

- Lead time to work content whereby the latter is the actual work or value added time; this facilitates continuous flow,
- Process speed to sales ratio; the ideal is one whereby this proceeds to discourage WIP and encourages a balanced line,
- Number of pieces to the number of workstations. Again the ideal situation is one-piece flow with a ratio of one. Likewise, two is a decent ratio though typically we often find one of 50 or more (Bicheno, 2004). This aids to encourage focussed cells whilst discouraging stockrooms.

2.11.3 Bicheno

Debatably, it could be proposed that there are four essential measures of Lean (Bicheno, 2004). These are generic and can be implemented on various levels from cell to plant level and through the supply chain. Equally, they need to be examined together:

- Lead time which assists to reduce inventory, one-piece flow, reduction of flow length and waste reduction. There exist numerous variations including Ohno's "*Time Line*" – the time between receiving an order and receipt of the actual payment. This has the added advantage since it includes the transaction processing time, and places the emphasis on cash flow,
- Customer satisfaction; here it is important to utilise soft and hard measures,
- Schedule attainment; this examines the achievement of targets on a daily basis. However, the schedule needs to be in line with demand since otherwise this measure is of little value,
- Inventory turns; a simple alternative is days of inventory. WIP is under the control of the organisation whereas raw materials and finished goods are not fully under own control.

2.11.4 QCDMMS

An acronym for a set of measures that many Lean organisations exhibit at each line or area: (Henderson et al., 2003)

- Quality embracing aspects such as first time through,
- Cost whereby it is essentially a productivity measurement,
- Delivery performance which incorporates a need for QOTIF (Quality On Time In Full),
- Morale which is often deduced from attitudinal surveys,
- Management includes aspects such as communication and training,
- Safety examines aspects such as unsafe acts and audits of unsafe conditions.

2.11.5 Goldratt

Goldratt (1990) proposed two complementary measures for supply chain effectiveness:

- Throughput Dollar days measures the accumulation of inventory below an agreed level. Essentially sales should not be lost; if the inventory falls below the emergency level, the measure starts ticking. The measure accumulates everyday the inventory is below the target level; a shortage of 5 days is 5 times greater than the same shortage for one day. It encourages the focus on reducing delays for valuable items, and instigating the appropriate capacity. In situations whereby the item is a component the throughput is defined as the revenue of the full end item whilst deducting the direct variable costs,
- Inventory Dollar days which examines both the value of an item and the length of time that it remains in the supply chain.

2.11.6 DTI Seven Measures

The seven key measures used by the industry forum under the umbrella of Quality, Cost and Delivery (QCD) offer a clear structure for continuous improvement, raising levels of customer satisfaction and greatly improving the management of production. This is summarised in Table 2.15:

Relationships of the Seven Measures to QCD

	Quality	Cost	Delivery
Not right first time	◙	◙	◙
People productivity		◙	
Stock turns	○	◙	◙
Delivery schedule achievement	○	○	◙
Overall equipment effectiveness	○	◙	○
Value Added per person		◙	
Floor space utilisation		◙	

Table 2.15
QCD Measures

Table 2.15 demonstrates how the measures have either a

◙ Primary, or a

○ Secondary impact on the process.

These key measures of QCD have been developed by the *Industry Forum* of the *Society of Motor Manufacturers and Traders (SMMT)* and endorsed by the automotive industry within the UK. QCD is not, however, sector-specific. These key measures can be applied to improve production performance throughout the manufacturing sector.

2.11.7 Schonberger's principles

Richard Schonberger's (1996) investigation extended over 100 pioneering manufacturers in nine countries. He developed 16 principles as indicators of Lean whereby an organisation's progress was measured on a scale of 1-5 on each principle. Consequently, a maximum score of 80 points was the ultimate target with "adulthood" beginning at 53 points and "maturity" at 67 points. A summary of the 16 principles is provided in Table 2.16:

Schonberger's principles	
Customer Related	Be organised by customer families Capture customer information Rapid improvement to fulfil customer needs Production levels need to operate close to customer demand
Working practices	Whole workforce employed in change management Continually train everybody

	Expand variety of recognition, rewards and pay Front-line team to record and process own data
Logistical	Reduce suppliers and components
Operational	Cut total flow line / process time Continuously reduce variation and mishaps Control the root causes and cut internal transactions Improve the present capacity before new equipment and automation Seek simple low cost focused equipment
Lean measures	Align performance measures with universal customer needs
Marketing	Promote, market and sell every improvement

Table 2.16
Schonberger's Principles

2.11.8 Kobayashi's Keys

Iwao Kobayashi's "20 keys" (1996) gained momentum in their acceptance towards acting both as a manufacturing audit and an implementation guide for Lean at the shop-floor level. He presents a system, which combines 20 of the world's best manufacturing improvement approaches and incorporates them into a dynamic system allowing companies to adapt to a continuously changing economic and competitive environment. A five point scale is used to aid internal evaluation; the scale ranges from 1 as the "*beginner*" to 5 as the "*ideal*". There are associations between the keys demonstrated. Consequently, it is unlikely that an organisation can reach the higher levels in most keys without substantial progress in all of them. Critics have suggested that Kobayashi's ideas on operators are too regimented. Nonetheless, proponents of Lean suggest that this is a bias interpretation since the standards and disciplines are fundamental to continuing improvement, (Liker, 2004). A summary of the 20 keys is provided in Table 2.17:

Kobayashi's Keys	
General tidiness	Clean and tidy
Workplace practices	Participative management Teamwork on improvements Eradicate monitoring Worker empowerment and training Cross functional working
Production processes	Overproduction is reduced as is inventory Reduced changeover Continuous improvement in the workplace Cellular manufacturing TPM Heijunka Process control (pokayoke) Waste elimination Conserving energy and materials Scheduling New product introduction
Supplier relationships	Supplier partnership
Lean measures	Efficiency

Adopting new ideas	Technology and micro-processing when appropriate

Table 2.17
Kobayashi's Keys

Intriguingly, the views of Prof Jones are similar in the sense that the foundations of Lean are 5S, shop floor teams, quality tools and PDCA, which in turn support production and demand smoothing, JIT, and Jidoka. These, subsequently, help the elimination of waste and TPM and are capped by policy deployment. The Ford Production System also adopted the "lowest score principle" (Bicheno, 2004, page 89); whereby, if an organisation failed on one, it fails on all; this has now been abandoned as being too tough and de-motivating.

2.11.9 Mann's categories

Mann (2005) proposes eight categories of process and behaviour alongside an assessment score that defines the five levels. Table 2.18 summarises the categories and scoring levels utilised as part of the assessment.

Levels in scoring of Lean management assessments	
Levels	**Reference Stage**
One	Pre-implementation
Two	Beginning Implementation
Three	First Recognisable stages
Four	System stabilising
Five	Sustainable system

Table 2.18
Mann's Plant Assessment

Several statements seek a "less", "Yes" or "exceeds" response (page 174) that form part of the audit. The Eight categories and indicative clues whereby the various levels could be deduced are provided in Table 2.19:

Mann's proposal of a Lean Audit		
Category	**Example of type of Level one (pre-implementation) statement**	**Example of a Level 5 (sustainable system) statement**
Leader Standard Work	None in evidence	Daily and weekly review by next level
Visual controls - production	None in evidence	Visuals in regular use for out-cycle tasks throughout
Visual controls – production support	None in evidence	Tracking data regularly analysed for trends to spot problems
Daily accountability process	Daily meetings concentrate on traditional production/shortage issues	Accountability is routine; boards used effectively for long and short assignments
Process definition	Mostly in books and out of date	Expected performance for all processes defined and documented
Disciplined adherence to process	Leaders attention mostly on exceptions in results	Frequent reviews of a production and related processes
Root cause problem	When used, often by technical	Leaders expect cause analysis

solving	project teams	for all problems
Process improvement	Only made by project teams	Daily task assignments to drive small and large improvements

Table 2.19
Mann's Lean Audit

2.11.10 Henderson's categories

Henderson et al., (2003) proposed eight categories and a set of criteria under each with a scoring method of 1, 6 and 10 with one indicating that the organisation is lacking against this criteria. Table 2.20 indicates the criteria under each category and provides an example of the scoring methodology used:

Henderson and Larco's proposed audit		
Categories	**Reasons for a score of One**	**Reasons for a score of Ten**
Workplace safety, order and cleanliness	Resembling more of a pig sty	As a hospital
JIT production	Mass production	Totally Lean
Six sigma quality	Questionable quality	Six sigma producer
Empowered Teams	Very autocratic	Fully empowered teams
Visual management	Traditional information management	Fully visual company
Continuous pursuit of perfection	Hardly any	True Lean enterprise
Overall company organisation and management style	Very traditional company	Lean organisation
Company Services	Very traditional organisation	Totally Lean

Table 2.20
Henderson's Audit

Ultimately the total score secured under each category is divided by the number of the criteria and indicated on a Lean Assessment Chart. This proceeds to reflect areas the organisation needs additional concentration on.

2.11.11 Lee's Assessment tool

Quarterman Lee (2007) developed a Lean assessment tool that helps to investigate, evaluate and measure key areas of manufacturing. The tool is very user friendly and the result enables a deeper understanding of the key issues, problem areas and the potential solutions. Nine key areas of manufacturing are evaluated by the assessment. Participants answer three to six questions in each area. The model with the nine categories is depicted in Table 2.21 with an example of a question for each category:

Lean Assessment tool	
Category	**Example of question**
Inventory	What is the ratio of inventory turnover to the industry average?
The team approach	What is the annual personnel turnover?
Processes	How easy is it to shift output when product mixes changes?
Maintenance	What is the average availability of plant equipment?

Layout and handling	What proportion of total space is used for storage and material handling?
Suppliers	What is the average number of suppliers for each raw material or purchased item?
Set-ups	What proportions of the machine operators have had formal training in rapid set-up techniques?
Quality	What is proportion of the total employees that have had basic SPC training?
Scheduling/Control	What is the on-time delivery performance?

Table 2.21
Lee's Assessment

There are 40 questions and a score of between zero and four are given for each response in the assessment. Scores are then totalled for each of the nine areas. The results can then be displayed in the score worksheet and finally a Lean profile chart can be created to display the status of the plant.

2.11.12 Shah and Ward's Lean measures

Shah et al., (2007) list 48 items which they argue were selected to represent Lean. They then proceed to identify ten underlying components; three measure the level of supplier involvement, one the customer involvement and the remaining six address issues internal to the firm. They insist that together these ten factors constitute the operational complement to the philosophy of Lean and categorise ten distinct dimensions of Lean. Their argument centres on the high inter-correlations between the factors.

2.11.13 Shingo Prize Model

The model is based on the Lean management approach and model taught by Dr Shigeo Shingo (Shingo 1989). His teachings portray three levels of business improvement which can be referred to levels of "transformation" (page 3; http://wwwshingoprize.org); namely principles, systems and tools and techniques. The Shingo Prize was established in 1988 to promote an awareness of Lean and to recognise companies that achieve world class status. Whilst the progress for companies working through the model varies, the ultimate goal is clear; an integration of the Lean philosophy across the whole organisation and its value streams resulting in the achievement of consistent business results. A summary of the model is provided below; there exist four primary cultural enablers:

- Leadership focuses on the visionary management team,
- People development,
- Empowerment and
- Environmental and safety systems.

The *Continuous Process Improvement* dimension is based upon the tools and techniques understanding and deployment. The third dimension focuses upon a consistent Lean enterprise culture. The essential principle of the fourth dimension focuses upon the need for flow value, improving customer satisfaction and stakeholder value whilst maintaining a safe and healthy environment. Principally, the Shingo Prize model serves as a roadmap for organisations towards the Lean philosophies as depicted in Figure 2.4. Table 2.22 illustrates an example of the Shingo levels of transformation utilising kaizen to explain the criteria under the various levels.

Levels of Transformation			
Lean Concept	**Tools Level**	**Systems level**	**Principles Level**
Kaizen	Kaizen events designed for certain parts of the process and not tied to the strategic direction	A systematic approach towards the elimination of waste, variation and overburden; geared towards value stream mapping and strategies but still management and engineering focused	Unprompted continuous improvement; sponsored by management, engineering, or worker; Kaizen becomes part of everyday life.

Table 2.22
Example of Shingo Lean concepts

The first three dimensions primarily refer to principles, systems and tools whilst the fourth refers to Results. The score of each dimension is determined initially from the quadrant that best describes the company's current practices based upon the individual descriptors; this is based upon whether the current practice is high, mid or low within the quadrant. A percentage is selected and multiplied by the point value of the criteria to establish a current practice score. The examiners would make the following recommendations to the Board of Governors regards the award:

- Shingo Bronze medallion scoring 575-674 points,
- Shingo Silver medallion scoring 675-774 points,
- The Shingo Prize scoring 775+ points.

The factors relating to each assessment scale are as follows:

- The organisations ability to understand and deploy Lean principles,
- A commitment towards Lean throughout the organisation,
- Systems to support the Lean principles,
- The effective selection of tools, techniques and technologies throughout the organisation,
- Effective usage of Shingo's waste identification, elimination and prevention,
- Level of focus on value adding,
- Extent to which goals focus towards continuous improvement throughout the organisation,
- The cooperation and integration between employees' efforts at all levels.

Correspondingly, the assessment scale is summarised in Table 2.23

Principles, Systems, Tools – Assessment scale	
An organisations matching the descriptors would score at the top of the indicated range	
100% ↕ 80%	• Thorough understanding of Lean throughout the organisation • Total involvement and empowerment • Rigid strategic focus upon value adding • Fully implemented waste prevention application
79% ↕ 60%	• Numerous good Lean systems • A recognition of the strategic priorities • Frequent use of resources aimed at root cause problem solving
59% ↕ 40%	• Some strategic ideas but not applied systematically • Some good applications of appropriate Lean tools • Use of resources aimed at root cause problem solving but not well coordinated
20% ↕ 39%	• Little evidence of a strategic focus • Lean tools applied in an haphazard manner • No real evidence of using resources aimed at root cause problem solving

Table 2.23
Example of Shingo assessment scale

2.11.14 The Business Excellence Model

The European Foundation for Quality Management (EFGM) was formed in 1988 and the European Quality Award was established in 1991 in conjunction with the European Organisation for Quality and the European commission (Bell et al., 1998). The EFQM Excellence model has been updated in 2009 on the review of the EFQM. It provides a meaningful mechanism for self-appraisal. The model describes nine key areas or criteria Bou-Lluser (2005); this is depicted in Figure 2.5 whereby the first five criteria:

- Leadership
- People management
- Policy and strategy
- Resources and
- Processes

are referred to as "Enablers" and are concerned with how results are achieved within an organisation.

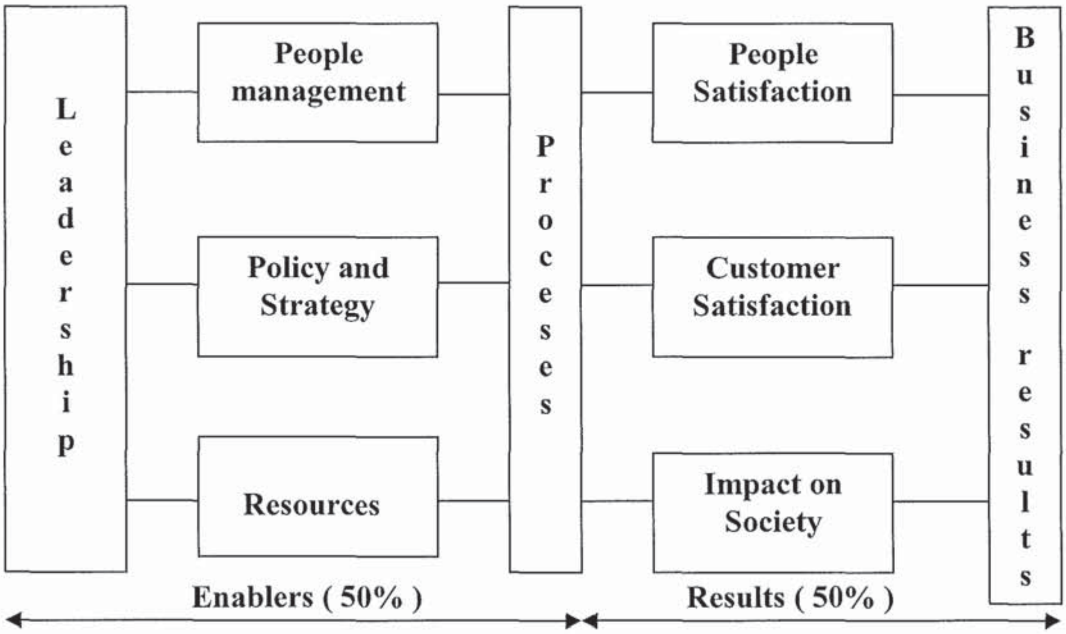


Figure 2.5
European TQM Model for self-assessment

The final four criteria:

- People satisfaction,
- Customer satisfaction,
- Impact on society and
- Business results

are referred to as "results" and are concerned with what the organisation has and is achieving. The framework indicates that customer satisfaction, people satisfaction, and impact on society are achieved through leadership driving policy and strategy, people management, resources and processes, leading ultimately to excellence in business results (British Quality Foundation, 2000). The scoring is relatively easy whereby a maximum of five is only scored if all the areas highlighted under the criteria were addressed. Having scored each criterion the total score for each element is calculated and an average is listed. Often a "Radar chart" is used and the weakest areas are reviewed whereby an action plan is then prepared.

2.12 Research Gap

Despite abundant attempts to provide a clear understanding of the Lean philosophy, the research findings are somewhat imprecise. Whilst some offer an awareness of the ideology, many simply lead to confusion and misconceptions regards positively perceiving Lean as a philosophy. The investigation will tackle the foremost gap evidently lacking within the literature:

i. to accurately measure whether the UK manufacturing organisations that have embraced Lean as an ideology have proven more successful; accordingly, the performance will be judged utilising key strategic, operational, and other indices which will capture the future potential of the organisation,

ii. illustrate a mechanism to specifically and precisely determine whether a UK manufacturing organisation has adopted "*Lean as a philosophy*" as opposed to another process or strategy. This requires a clear clarification by accurately undertaking an assessment to appraise whether the organisation had embraced specific criteria viewed as imperative in order to construe that it has adopted Lean as an ideology,

iii. to categorize the juncture of a Lean Journey the organisation occupies at any particular phase of its overall Lean implementation. As a result, a framework will be developed in order to assist organisations to markedly identify the stage an organisation occupies on its Lean journey. Once the stage is clarified it would then be practical to make recommendations in order to facilitate an organisation's progress to a level whereby it embraces Lean as a philosophy.

2.12.1 The Lean audit

To successfully implement Lean, empowerment is necessary and measures viewed by staff as irrelevant, unrealistic or inappropriate will be counterproductive (Marshall et al. 2004). In this context the system needs to be focused towards continuous improvement in line with the Lean philosophy. Likewise, a periodic re-evaluation of the appropriateness of the established performance measurement system in line with the current competitive environment is needed (Neely et al. 2005). Audits used should not be used as a weapon by management. Chapter Five critically evaluates the above audits and proceeds to develop a bespoke audit which organisations can effectively utilise to assess their respective Lean journey.

2.13 Summary

The analysis intimates that the major difficulties companies encounter in attempting to apply Lean are a lack of direction, a lack of planning and a lack of adequate project sequencing.

Knowledge of particular tools and techniques is often not a problem. Evidently, a cocktail of common ingredients are viewed indispensable for a successful implementation:

- simultaneously apply six or more relevant and appropriate technical tools depending upon the stage of implementation,
- widen application throughout the value chain,
- have a clear clarity of the vision regards Lean,
- view Lean as a never ending journey,
- install a continuous improvement viewpoint,
- make numerous cultural changes embracing empowerment and sponsor the Lean principles through-out the value chain,
- make substantial organisational changes such as
    - remunerations systems,
    - the accounting methodologies utilised,
    - links with marketing and logistics,
    - metrics used and the
    - training culture.

The underlying message has to be that specific tools and techniques should not be imitated as they are not universal; however, it is important to copy the thinking and analysis since these are universal. Evidently an uncompromising methodology was deemed necessary. The next chapter examines in depth the reasons why certain types of data capture were pursued and the rationale behind others being disregarded. In essence, owing to the nature of the inquiry:

- survey questionnaires, and
- case studies encompassing questionnaires and interview schedules were developed whereby views and perceptions of both the shop-floor and management could be reliably captured and analysed.

CHAPTER 3
METHODOLOGY

3.1 Introduction

This chapter scrutinizes in depth the justification behind the methodology pursued. To overcome potential bias and sterility, triangulation was undertaken; the pioneer, Denzin (1970), defined triangulation as "*the combination of methodologies in the study of the same phenomenon*" (page 297). In this investigation, triangulation was utilised to not only examine the same phenomenon from multiple perspectives, but to facilitate a situation whereby a deeper insight could emerge. Stake (2000) maintains that triangulation is the use of multiple perceptions or observations to clarify the meaning. He states, "*no observations or interpretations are perfectly repeatable*" (page 443). Consequently, analysing the phenomenon from different perspectives inevitably served to elucidate the meaning. It was crucial to employ various research approaches, methods and techniques. For the purpose of this research it was considered that Yin's definition of triangulation was too narrow since it is a vehicle for cross-validation when multiple methods produce comparable data (Yin, 1994).

A greater degree of validity and reliability was secured by using a varied methodological approach. Remenyi et al., (2000), identify four strains of triangulation:

- data triangulation, where data is collected at different times or from different sources in the study of phenomenon,
- investigator triangulation, whereby various researchers independently collect data on the same phenomenon and compare the results,
- methodological triangulation, where both qualitative and quantitative methods of data collection are used and the
- triangulation of theories; whereby a theory is taken from one discipline and used to explain a phenomenon in another.

3.1.1 Sample

Simple random sampling or systematic sampling whereby the sample organisations are selected at regular intervals from a sampling frame were viewed inappropriate since it was important to select organisations of varying sizes, at diverse stages of Lean and from differing industrial sectors. Equally cluster sampling was not seen to be suitable despite the fact that the population is divided into discrete groups prior to sampling. The sampling frame becomes the complete list of clusters rather than a complete list of individual cases; the idea is generally then to select a few clusters and data is collected from every case in the cluster. However, the technique normally results in a sample that represents the total population less accurately than is true of stratified random sampling. The decision faced was either a large sample from fewer discrete sub-groups (cluster sampling); alternatively, a smaller sample distributed over the whole group (stratified sampling). It was viewed as a trade-off between the amount of precision lost by using fewer subgroups and the amount gained from a larger sample size.

Consequently, a stratified sample was seen to be the most suitable. It is a modification of random sampling in which the population is split into significant strata. By dividing the population it was possible to ensure that each of the strata was represented. Equally the stratification was chosen to represent the discrete characteristics from which it could be possible to ensure a correct representation within the sample. The companies were grouped in terms of:

- geographical location (in regards the Survey questionnaire),
- size (in view of turnover, people employed and aggregate gross assets),
- differing level of Lean adoption,
- age of the organisation,
- time since Lean had been instigated,
- degree of process intricacy,
- extent of product complexity,
- levels of success and
- from a selection of varying manufacturing sectors.

The sample of companies, as suggested by Collis et al., (2003) needs to overcome possible bias and every attempt was made to ensure that the sample was representative of the total population. Equally, it was important not to jeopardise external validity with the choice of companies since otherwise the findings could not have been generalised. In this respect, the following issues were considered:

- time,
- finance,
- geographical location (in regards the Survey questionnaire),
- availability of participants,
- organisation's representatives and the
- nature of data capture.

3.1.2 The Puttick Grid

Despite restrictions encountered in respect of undertaking this level of data capture it was still important to retain a high degree of credibility in the results. Consequently, the Puttick Grid (developed by John Puttick whilst at "P.A. Consulting") was also utilised to ensure that major types of manufacturing activity were represented in the overall analysis (Table 3.1):

Uncertainty		
High U N C E R T A I N T Y	**Capital equipment** *"Made to order products"* - Ricardo - Scapa (UK) Limited - 3M (UK) Plc - Deltron Emcon Limited - Lear Corporation - Cambrian Printers - Abacus Lighting Limited - Comdev Space - Axiom Manufacturing - Dunlop Hiflex - Perkins Engines - Atkins - Nuaire Limited - Perkin Elmer - Kodak **Number = 15**	**Fashion / Jobbing** *"Made to order/fast response"* - Celestica - Fletcher Moorland - Corus Colours - Keeler Limited - Mitsui Components - EWS Manufacturing Limited - Tonge and Taylor - Cooper Standard Automotive - ASL Systems Limited - Calsonic Kansei - Trentex Engineering - Synthes Limited - Robert Bosch Limited - Cooper and Optic - Solutions Engineering Limited - Solvay **Number = 16**
Low	**Modular Products; sub-assemblies** *"Made to forecast"* - Sony manufacturing - John Crane (UK) - Vauxhall motors - Jaguar Cars - Ford Motor Company - Belle Group - BMW Petrol Engines - Leoni Wiring Systems - Royal Doulton - Avilion Limited - Eaton Electric Limited - Simrad - Britalco Engineering - TNT Logistics - Uniwire - TT EMS - ICI Manufacturing Technology - Pfizer pharmaceuticals **Number = 18**	**Commodity products / raw materials** *"made to schedule/stock"* - Timken Aerospace - Ina Bearing company - Excel (Electronic) Assemblies - Power Logistics - Unilever (UK) Foods - Borg Warner Limited - Ilford Imaging Limited - Thyssenkrupp Limited - Blanc Aero Industries - KAB Seating Limited - Patchwork Foods - Roballo Engineering - Marcus Products - Barkers Engineering - Care-Knight Limited - Podmores - PSB Group Limited - ICP Limited - Drayton Beaumont **Number = 19**
	High — Complexity	**Low**

Table 3.1
Survey Questionnaire sample

The Puttick grid characterises organisations according to the amount of uncertainty faced in the organisation's market and uses indices such as sales and product mix, and the level of complexity of the organisation's products which examines factors such as product and process complexity. The sixty-eight organisations represented in the survey questionnaire are indicated in Table 3.1 above. The intention was to ensure that each segment was well represented in reference to the organisations that took part in completing the Survey Questionnaire (Appendix One). Sixty-eight organisations were finally persuaded to partake in completing the Survey questionnaire and their distribution is summarised in the Table 3.2:

Organisations represented by the Survey Questionnaire	
Sector	**Number of organisations represented**
High complexity / High uncertainty	15
Low complexity / High uncertainty	16
High complexity / Low uncertainty	18
Low complexity / Low uncertainty	19

Table 3.2
Summary of Organisations represented in the Surveys

A similar exercise was undertaken for the seven Case Studies (Appendices 10-16). The objective was that each segment was represented in terms of the Case Study organisations chosen. Table 3.3 illustrates that the organisations chosen reflected a reputable distribution:

<table>
<tr><td rowspan="2">High

U N C E R T A I N T Y

Low</td><td>Capital equipment

"Made to order products"
- Ricardo
- Perkins Engines

Number = 2</td><td>Fashion / Jobbing

"Made to order/fast response
- Fletcher Moorland
- Trentex Engineering

Number = 2</td></tr>
<tr><td>Modular Products; sub-assemblies

"Made to forecast"
- Leoni Wiring Systems
- Royal Doulton

Number = 2</td><td>Commodity products / raw materials
"made to schedule/stock"
- Drayton Beaumont

Number = 1</td></tr>
<tr><td></td><td colspan="2">High Complexity Low</td></tr>
</table>

Table 3.3
Summary of Organisations represented in the Case Studies

3.1.3 Small, Medium or Large

In order to further ensure credibility in the results, the following (CIMA, 2005) classification was utilised as depicted in Table 3.4. According to the prevailing British classification,

	Small	Medium
Turnover (less than or equal to)	£3.1 millions (net) £3.76 m (gross)	£12.2 m (net) £14.5 m (gross)
Aggregate gross assets (less than or equal to)	£1.9 millions (net) £2.18 m (gross)	£6.6 m (net) £7.72 m (gross)
Employees (less than or equal to)	50	250

Table 3.4
CIMA Organisational classification

(CIMA, 2005), to be regarded as small or medium it is necessary to fulfil any two of the criteria listed above. Table 3.5 illustrates the sample organisations that completed the Survey questionnaire were representative of small, medium and large entities:

Classification of the Organisations that completed the Survey Questionnaire		
Small companies	**Medium sized companies**	**Large organisations**
Britalco Engineering Limited	ASL systems Limited	Abacus Lighting Limited
Copper and Optic Limited	Barkers Engineering Limited	Atkins
Fletcher Moorland	Blanc Aero Industries (UK)	Avilion limited
ICI Manufacturing technology	Cambrian Printers	Axiom Manufacturing Services
ICP Limited	Care-Knight Limited	BMW
Marcus Products	Deltron Emcon Limited	Borg Warner Limited
Patchwork Foods	Drayton Beaumont Limited	Calsonic Kansei
Podmores Limited	EWS Manufacturing Limited	Celestica
Solutions Engineering	Excel (Electronics) Limited	Comdev Space
Tonge and Taylor Limited	Keeler Limited	Cooper Standard Automotive
Trentex Engineering Limited	PSB Group Limited	Corus Colours Construction
Uniwire	Roballo Engineering	Dunlop Hiflex
	Simrad	Eaton Electric Limited
	Solvay Limited	Ford –Bridgend Engine Plant
	Synthes Limited	Ilford Imaging Limited
	Timken Aerospace Limited	Ina Bearing Limited
		Jaquar Cars Limited
		John Crane (UK) Limited
		Kab Seating Limited
		Kodak Company Limited
		Lear Corporation
		Leoni wiring Systems
		Mitsui components Ltd
		Nuaire Limited
		PerkinElmer Limited
		Perkins Engines
		Pfizer Pharmaceuticals
		Power Logistics

		Ricardo
		Robert Bosch Limited
		Royal Doulton Limited
		Scapa (UK) Limited
		Sony Manufacturing
		The Belle Group
		Thyssenkrupp Limited
		TNT Limited
		TT EMS Limited
		Unilever (UK) Foods
		Vauxhall Motors Ltd
		3M (UK) Plc

Table 3.5
Survey organisations by organisational size

Whilst there was present a heavier emphasis towards larger organisations, Table 3.6 depicts a summary, by size, of organisations that contributed to the overall Survey analysis:

Organisations represented by the Survey Questionnaire	
Size of the organisation	**Names of the Organisations**
Small organisations	12
Medium sized organisations	16
Large organisations	40

Table 3.6
Summary of Survey Questionnaires by Size

A similar exercise was undertaken for the seven Case Studies as illustrated in Table 3.7. The purpose was to ensure that the seven Case Study organisations were representative of small, medium and large entities.

Organisations represented by the Case Studies	
Size of the organisation	**Number of organisations represented**
Small organisations	Fletcher Moorland, Trentex Engineering
Medium sized organisations	Drayton Beaumont
Large organisations	Royal Doulton, Perkins Engines, Leoni and Ricardo

Table 3.7
Summary of Case Study organisations by Size

3.1.4 Product-Process matrix

The product-process matrix is a tool for analysing the relationship between the product life cycle and the technological life cycle; initially introduced by Haynes et al., (1979) whereby a company can be characterised as occupying a particular region on the matrix. The decision of where a firm locates on the matrix is determined by whether the production system is organised by grouping resources around the process or the product. Figure 3.1 depicts the choices available; Table 3.8 divides the organisations in line with the Product-Process Matrix.

Process Structure Process life cycle stage ↓	**Product structure Product Life cycle stage** ⟶	**Low volume unique**	**Low volume multiple products**	**High volume standardised product**	**Very high volume commodity product**
	(project)				
Jumbled flow (job shop)		Job shop			
Disconnected line flow (batch)			Batch		
Connected line flow (assembly line)				Assembly line	
Continuous flow (continuous)					Continuous

Figure 3.1
Product-process matrix

The characteristics of the various categories can be summarised as follows:

- Job shop is the producer of unique products whereby the outputs differ significantly in form, structure, materials and / or processing required,
- Batch processes provide similar items on a repeat basis usually in larger volumes than that associated with job shops,
- The product created by the assembly-line process is discrete; in that it can be visually counted (as opposed to continuous processes which produce a product that is not naturally divisible),
- Continuous manufacturing involves much less production whereby the product flows continuously rather than be divided. Typical examples include gas, chemicals, rubber, petroleum and wood.

<table>
<tr><th>Job Shop</th><th>Batch</th><th>Assembly Line</th><th>Continuous</th></tr>
<tr><td colspan="2">Cambrian Printers</td><td>Ricardo</td><td></td></tr>
<tr><td></td><td colspan="2">Scapa (UK)</td><td></td></tr>
<tr><td colspan="2">Abacus Lighting</td><td>3M</td><td></td></tr>
<tr><td colspan="2">Comdev Space</td><td>Dunlop Hiflex</td><td></td></tr>
<tr><td></td><td colspan="2">Deltron Emcon Limited</td><td></td></tr>
<tr><td colspan="2">Fletcher Moorland</td><td>Lear corporation</td><td></td></tr>
<tr><td></td><td colspan="2">Axion Manufacturing</td><td></td></tr>
<tr><td colspan="2">Perkins Engines</td><td>Perkin Elmer</td><td></td></tr>
<tr><td colspan="2">Atkins</td><td>Kodak</td><td></td></tr>
<tr><td>Solutions Engineering</td><td colspan="2">Nuaire Limited</td><td></td></tr>
<tr><td></td><td colspan="2">Celestica</td><td></td></tr>
<tr><td></td><td colspan="2">Corus Colours</td><td></td></tr>
</table>

<table>
<tr><td></td><td>Keeler Limited</td><td>Mitsui components</td><td></td></tr>
<tr><td colspan="2">EWS Manufacturing Limited</td><td>Solvay</td><td></td></tr>
<tr><td colspan="2">Tonge and Taylor</td><td>Sony manufacturing</td><td></td></tr>
<tr><td colspan="3">Cooper Standard Automotive</td><td></td></tr>
<tr><td colspan="2">ASL Systems Limited</td><td>Vauxall Motors</td><td></td></tr>
<tr><td></td><td>Calsonic Kansei</td><td>Jaguar Cars</td><td></td></tr>
<tr><td colspan="2">Trentex Engineering</td><td>Ford Motor Company</td><td></td></tr>
<tr><td>Care Knight Limited</td><td colspan="2">Synthes Limited</td><td></td></tr>
<tr><td></td><td>TNT Logistics</td><td>Robert Bosch Limited</td><td></td></tr>
<tr><td></td><td colspan="2">Cooper and Optics</td><td></td></tr>
<tr><td></td><td colspan="2">Leoni wiring</td><td></td></tr>
<tr><td></td><td>John Crane</td><td>Uniwire</td><td></td></tr>
<tr><td></td><td>Belle Group</td><td>Ina Bearing</td><td></td></tr>
<tr><td></td><td>BMW Petrol engines</td><td>Unilever (UK) Foods</td><td></td></tr>
<tr><td></td><td>Eaton Limited</td><td>Borg Warner</td><td></td></tr>
<tr><td></td><td>Simrad</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Royal Doulton</td><td></td></tr>
<tr><td></td><td>Avilon Limited</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Britalco Engineering</td><td></td></tr>
<tr><td></td><td>TT EMS</td><td></td><td></td></tr>
<tr><td colspan="2">ICI Manufacturing</td><td></td><td></td></tr>
<tr><td colspan="2">Pfizer pharmaceuticals</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Timken Aerospace</td><td></td></tr>
<tr><td colspan="2">Excel Electronics</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Power logistics</td><td></td></tr>
<tr><td></td><td colspan="2">Ilford Imaging Limited</td><td></td></tr>
<tr><td></td><td colspan="2">Thyssenkrupp Limited</td><td></td></tr>
<tr><td colspan="2">Blanc Aero Industries</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Kab Seating Limited</td><td></td></tr>
<tr><td colspan="2">Patchwork Foods</td><td></td><td></td></tr>
<tr><td colspan="2">Roballo Engineering</td><td></td><td></td></tr>
<tr><td colspan="2">Marcus Products</td><td></td><td></td></tr>
<tr><td colspan="2">Barkers Engineering</td><td></td><td></td></tr>
<tr><td></td><td>Podmores</td><td></td><td></td></tr>
<tr><td colspan="2">PSB Group Limited</td><td></td><td></td></tr>
<tr><td colspan="2">ICP Limited</td><td></td><td></td></tr>
<tr><td colspan="2">Drayton Beaumont</td><td></td><td></td></tr>
</table>

Table 3.8
Organisations depicted on the Product-Process matrix

The main reasons for utilising the product-process matrix were four-fold:

i. By incorporating this dimension into its strategic planning process, the firm encourages more creative thinking about its competence and competitive advantage,

ii. The matrix provides a natural way to involve manufacturing managers in the planning process so they can relate their opportunities and decisions more effectively with those of marketing and of the corporation itself,

iii. The matrix enables a firm to become more precise about its distinctive competence and can concentrate its attention on a restricted set of process decisions and alternatives,

iv. It can also assist a firm to define its product better.

This investigation utilised the product-process matrix alongside other determinants such as the size of the company and the Puttick grid since Sohel et al., (2002) found the proposed relationship between the product structure and process structure to be significant but not strong. In general terms they discovered that as the product life cycle changes the process life cycle also shifts in the consistent direction, but not necessarily along the diagonal. Some 60% of the firms studied did not fall on the diagonal. Lummus et al., (2006) suggest that further work is needed to apply these concepts across multiple companies and industries to validate the model; instead of looking at the company's products and customer requirements, it is important to examine the role of end-customer product characteristics in the processes of all firms that are partners in the supply chain. From Table 3.8 which identifies each of the sixty-eight organisations surveyed, it is evident that a good mix of organisations was represented under the:

- Job,
- Batch and
- Assembly line categorisation.

Unfortunately, no organisations were represented depicting the characteristics under the "continuous" banner. However, bearing in mind that typical examples are gas, chemicals, electricity, rubber and petroleum it is possible to recognise how this situation arose. Equally, many organisations depicted characteristics of more than one category, i.e., job and batch or batch and assembly.

3.2 The research approaches

In the following sections, a thorough appraisal is undertaken in order to justify the logic behind using both the survey questionnaire and Case Studies (Appendices 10-16) as the data capture methodologies. The Case Studies predominantly depended upon questionnaires and interview schedules focused towards both management (Appendix 5 and 6) and shop floor operatives (Appendices 7 and 8) within the seven organisations. As depicted in Figure 3.1 it was recognised that the methodologies are grouped under two paradigms; that these are extremities of a continuum since each could be placed some way along the continuum according to the assumptions.

Positivist ⟷	**Phenomenological**
Cross sectional studies,	Action Research,
Experimental studies,	Case Studies,
Longitudinal studies,	Ethnography,
Surveys.	Feminist perspective,
	Grounded Theory.

Figure 3.2
Key Methodologies

Nonetheless, a brief examination of the rationale is necessary to explain why other methodologies were considered but not pursued. Cross sectional studies take a snap-shot of an existing situation and attempt to isolate a particular phenomenon from the others but in doing so are not conducive towards an explanation of any correlation (Collis et al., 2003). Whilst they can be conducted simultaneously, for Lean it was construed that there were far too many variables for this type of investigation. Conversely, experimental studies permit causal relationships to be identified; however, for this research it was again considered that there were numerous variables. Equally, the research was based on real situations and Case Studies permitted the use of questionnaires and interview schedules whereby a greater degree of credibility was feasible. Longitudinal studies investigate the same situation or people over a period of time. It could be argued that one Case Study, Royal Doulton Plc, met the criteria for this category since it was the source of the overall investigation and where wider access opportunities existed. However, the same could not be alleged about the remaining organisations.

Action research assumes the world is constantly changing and the researcher and the research itself are part of the change (Gill et al., 1997). The close collaboration with the client company can make this into a consultancy project which was not the intention. The purpose from the inception was to remain independent and it was felt that action research might violate this objective. Similar reservations were held regards ethnography since it was felt that validity, reliability and consequently generalisability would be put at risk (Siverman 2000). Grounded theory is generated by the observations rather than being decided before the study. The purpose being to build theory that is committed to and which illuminates the area under investigation (Anderson 2007). A major concern surrounded the notion of generalisability and the practical issues related to the degree of access to the organisations which made this method an unlikely candidate (Smith et al., 2000). Similarly with the feminist perspective; at a methodological level it is concerned with challenging the traditional research paradigm from the politics and ideology of the women's movement. In an investigation of Lean within organisations and whether it was being adopted as a philosophy, this approach was deemed inappropriate (Remenyi et al., 2000). Likewise, hermeneutics is more usually associated with the interpretation of historical text, as it has been applied to law where the reasons behind judgements or statutes are sought. Owing to the number of variables concerned in any research on Lean and the importance attached to culture, hermeneutics as an option was not pursued. Participative enquiry is about "*research with people rather than research on people*" (page 75, Collis et al., 2003). Participants are involved as fully as possible. This would have launched key concerns regards validity, reliability and generalisability once again.

3.2.1 The Survey questionnaire

The survey (Appendix One) permitted large amounts of data to be collected from a sizeable population in a highly economical manner. It sanctioned greater control over the research process. Considerable time was spent on designing and piloting the questionnaire. Equally, even with the aid of SPSS and Excel the analysis took a substantial time. However, the independence was valuable since often researchers complain that their progress was delayed by their dependence on others for the information. Surveys provide an opportunity to undertake scientific tests; since in this situation experiments were not possible. By ensuring that the questions were un-ambiguous and totally comprehensible, the problem of internal validity never emerged. By building an initial rapport with the respondents, every effort was made to ensure that involvement was secured.

Equally, strenuous attempts were made to ensure that external validity never posed a problem. It was important to be able to generalise the findings. It was vital that the actual responses intimated what was truly happening. Likewise, documented proof of performance metrics substantiated the responses. Similarly, reliability was stringent; all the respondents were presented with standardised questions that were carefully worded after being piloted. There was an explicit intention to keep the survey findings transparent which assisted the overall analysis. Every effort was made to ensure that no interviewer bias was evident. Clarification on any questions was only offered when sought by the respondent. Moreover, in every case the gatekeeper of the respective organisation was a key member of the organisation's Lean team, which consequently meant that very little assistance was needed. It was important to incorporate a number of variables, which facilitated the analysis to identify patterns of correlations to determine the level of the relationships. Whilst the respondents completed every questionnaire, it was always during a meeting that had been previously arranged. Figure 3.3 illustrates the triangulation undertaken. Whilst data triangulation was not an option, it was important to ensure that the triangulation of theories, data and methodological triangulation was at the centre of the research methodology.

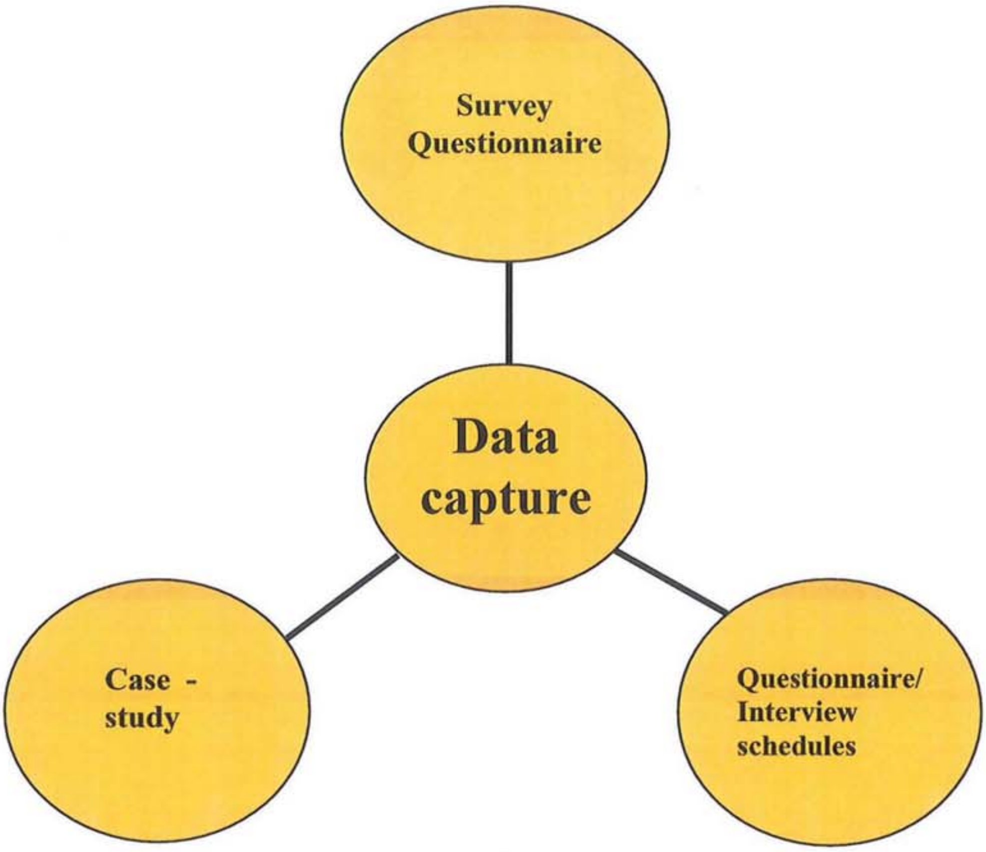


Figure 3.3
Research Triangulation taken

Irrespective of whether the Survey questionnaire or the questionnaires used in the Case-Studies were concerned, attention was devoted to the design of the questionnaire since it affects potential response rates, validity and reliability. It was considered that this could be maximised by a:

- careful design of the individual questions,
- clear layout of the pro-forma,
- lucid explanation of the purpose of the questionnaire,
- pilot test coupled with a
- carefully planned and executed administration.

It was felt that a questionnaire was not an ideal data capture method for exploratory or research that needed open-ended questions. They work best with standardised questions whereby one can be confident that they will be interpreted similarly by all respondents. There were numerous determining factors considered when making the right choice of the type of questionnaire to use; namely the characteristics of the respondents; it was important to engage with the appropriate personnel in the respective organisations and not assistants who were burdened with the task to complete the questionnaire. Furthermore, it was vital to ensure that the respondents replies were not corrupted or distorted; Saunders et al., (2003) mention "*uninformed response*" (page 283) whereby respondents deliberately guess at the right answer; "*socially desirable*" responses happen through a discussion of the answers which results in the responses being distorted. Equally, the size of the sample was considered. Moreover, the types of questions required to be asked and the quantity of questions necessary to collect the data were considered. The subsidiary factors under consideration also concerned the time available, financial implications, availability of organisations and the ease of automated data entry.

It is important to clarify the difference between the survey questionnaire, which was completed by the respective organisation representatives, and the structured interview. The crucial procedural difference is that the respondents filled in the survey questionnaire. Whilst, an obvious difference, it did have ramifications; the actual presence permitted the interaction between both parties. It is proposed (Smith et al., 2000), that personal interaction facilitates a better quality of data. The survey was used as a positivistic methodology whereby a sample of companies was selected in terms of:

- geographical vicinity (in the case of the Survey questionnaires),
- size,
- level of Lean adoption,
- age of the organisation,
- time since Lean has been instigated,
- level of complexity of the processes and products,
- degrees of success and from
- different manufacturing sectors.

This formed the selection criteria from which the organisations were chosen. Since the survey is predominately cross sectional in nature, it was vital that a representative and non-bias sample was selected. It was imperative that it would generate a high degree of confidence. Consequently, the survey questionnaire formed an ideal method to extract this information. The process adopted included an initial contact with the organisation and the appropriate "gate-keeper". Subsequently, a visit to the organisation was organised whereby the respective participant(s) completed the questionnaire during this visit. Easterby-Smith et al., (2000) suggest that there are two types of Surveys; descriptive Surveys, whereby the objective is to identify the frequency of a specific population either at one point in time or at various times for comparison; an example would be an assessment of customers attitudes towards the products or services of an organisation. Whereas in this investigation, an analytical survey was utilised to determine whether there existed a relationship between the different variables.

Much of the literature, Robson (2002), dwells on the possible shortcomings of Surveys; in order to combat them in this research it was vital to:

- ensure that interview bias was not present,
- certify that the data was not affected by interactions of interviewer / respondent,
- stress to respondents that their information was to remain anonymous,
- consider the over reliance on standardization; it could have resulted in developing questions general enough to be minimally appropriate for all respondents, possibly missing what was most appropriate to many respondents,
- deter inflexibility in that they require the initial study design (the tool and administration of the tool) to remain unchanged throughout the data collection,
- consider that it may be difficult for participants to recall information or to tell the truth about a controversial question.

Equally, whilst attention was paid to the possible limitations, it was important to explore the possible benefits of Surveys; namely, the opportunity to clarify the questions; a presence encouraged participation and involvement. This provided a basis for a judgement to be made regards the extent to which the exercise is treated seriously. Surveys are relatively inexpensive, although a visit accompanied each survey completion. Moreover they are useful in describing the characteristics of a large population. No other method of observation can provide this general capability. Many questions can be asked about an agreed topic giving considerable flexibility to the analysis; likewise, there is flexibility at the creation phase in deciding how the questions will be administered, i.e., face to face interviews. The standardized questions made measurement more precise by enforcing uniform definitions upon the participants and this ensured that similar data could be collected from groups and then interpreted comparatively (between-group study). Surveys permit a high level of reliability by presenting all subjects with a standardized stimulus; observer subjectivity is greatly eliminated. In essence, the survey was utilised as a research strategy rather than a method or technique. It was imperative to collect data in a standard format from a relatively large number of individuals and to select the samples from the known population. Bryman (1989) rightly intimates that practicalities dictate that the data is not collected simultaneously and in this case it took over two years.

3.2.2 Case Studies

Researchers have used the Case Study methodology (Appendix 9 – the protocol followed) for many years across a variety of disciplines. Social scientists, in particular, have made wide use of this qualitative research method to examine contemporary real-life situations and provide the basis for the application of ideas and extension of methods. There are several examples of the use of case methodology in the literature. Yin (1993) listed several examples along with the appropriate research design in each case. There are suggestions for a general approach to designing Case Studies, and also recommendations for exploratory, explanatory, and descriptive Case Studies. When the boundaries between phenomenon and context are not clearly evident, multiple sources of evidence are used (Yin, 1984). Since Case Studies are conducted on diverse topics, it is difficult to outline any strict or universal method or design for conducting the Case Study. However, Robert K. Yin (1993) does offer five basic components of a research design:

1. a study's questions,
2. a study's propositions (if any),
3. a study's units of analysis,
4. the logic linking of the data to the propositions, and
5. the criteria for interpreting the findings.

Many well-known Case Study researchers such as Stake (2000) and Yin (1994) have written about Case Study research and suggested techniques for organizing and conducting the research successfully. Whilst, using several Case Studies (Appendices 10 -16) may be contrary to the Case Study standpoint, it was considered necessary in order to investigate whether or not a substantial inference could be made. Extensive attention was paid to Yin's (1989) nine steps in Case Study approach and incorporated in the protocol attentively (Appendix 9):

- develop the theory,
- select cases,
- design evidence collection protocol,
- conduct the Case Studies,
- write the Case Study,
- draw cross-case conclusions,
- modify theory,
- develop policy implications and the
- writing of the cross-case report.

In this context, it was important to treat the Case Studies in a manner whereby they can contribute towards quantitative and qualitative methodology and seeing the process as complementary rather than contrasting. There is always some evidence, which cannot and should not be quantified.

Case Studies were used as extensive examinations of a single instance of a phenomenon and formed examples of phenomenological methodology. They were utilised as supplements to the Surveys. Collis et al., (2003) refers to them as "*a methodology, which focuses on understanding the dynamics present within a single setting; often used in the exploratory stages of research.*" (page 344). There is a close affiliation with the definition used by Robson (2002) that a "*Case Study is a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence*" (page 52). Whilst Scapens (1990) makes reference to the following types:

- descriptive whereby the objective is restricted to describing current practice,
- illustrative whereby the research attempts to illustrate new and possibly innovative practices adopted by respective organisations,
- experimental occur as a result of the research examining the difficulties in implementing new procedures and techniques in an organisation and evaluating the benefits,
- explanatory Case Studies attempt to utilise existing theory to understand and explain what is happening.

The distinction between Case Study types is not so contradictory and in this case it was found that the different types were combined with each other. In using Case Studies the ideas of Yin (1994), could not be neglected; he suggested that the following characteristics are inherent in Case Study research; that:

- the intention is to not only explore certain phenomena but to understand them within a particular context,
- there should not exist strict parameters as to the limits of the research,
- multiple methods for collecting data can be used in harmonisation.

It was ensured that whilst a satisfying methodology, the research did not embrace some of its limitations. Undoubtedly, access to suitable organisations was not easily achieved but certainly managed. Moreover, the boundaries were difficult to quantify but necessary as was the need to appreciate that the respective organisations do not exist in a vacuum, which meant the need to isolate certain factors. Equally, to deter any possible accusations of generalisability, multiple Case Studies were used. Moreover, as forwarded by McCutcheon et al., (1993) Case Studies can lack rigour and objectivity owing to potential subjectivity and bias; consequently, by using questionnaires and interviews it was hoped to ensure that validity and reliability were apparent.

However, the Case Studies permitted the appraisal from a more holistic perspective. The intention was to blend the positivistic and phenomenological perspective by utilising interviews to collect numerical evidence and subsequently interpret the evidence about the organisations' processes. It was considered that a full picture of the actual interaction of variables could only be obtained by looking at a practical instance. The Case Study approach certainly emphasised the total situation, as a combination of different factors need to be taken into account when dealing with the complexity of each business. Equally, the Case Study was able to go beyond a superficial evaluation of a point of view by obtaining information using interviews and questionnaires; the protocol (appendix 9) was followed rigorously.

3.2.3 Evaluation of the Case Study Approach

It was vital that restrictions regards Case Studies were clearly understood; essentially the establishment of the boundaries. Undoubtedly, the respective organisations do not exist in a vacuum, but interact with the rest of society. The organisations had a history and a future that influenced the contemporary understanding. Whilst it was important to recognise the events in a particular period of time, this needed to be placed within the context of its culture. Paradoxically, owing to this excess baggage Miles and Huberman (1984) prefer the term "site"; however, it is considered that this carries a strong geographical flavour. In recognising that some academics (Cook and Campbell; 1979) have questioned the value of Case Studies in the past, it was important to ensure that the potential pitfalls were not experienced. Case Studies have been undertaken without appropriate attention being paid to the experimental designs, which ensure that reliability and validity are embraced (Yin, 1994).

The appeal of Case Studies was that the evidence can be analysed from either a positivistic or a phenomenological perspective. Consequently, results can be synthesised in a manner that permits a proposal of a theoretical conjecture or even be used as evidence to support or contradict an established theory. Equally the inherent flexibility of Case Studies permits the establishment of a narrative description of the situation being studied. Essentially, this constituted a research tactic in its own right that added to the existing body of knowledge. It was this versatility of a Case Study that encouraged its adoption since it embraces a wide range of different sources of evidence and did not commit itself to either the positivistic or the phenomenological strand. The unit of analysis is a critical factor in the Case Study. It is typically a system of action rather than an individual or group of individuals. Case Studies tend to be selective, focusing on one or two issues that are fundamental to understanding the system being examined. Evidently, the Case Study sanctioned concentration on specific instances in an attempt to identify the complex interactive processes which may be crucial to the understanding of the organisation. Undoubtedly, it facilitated the need to look at the multi-dimensional situation. Besides the core technical data, there was a heavy emphasis placed on the cultural aspects of the respective organisations. Equally, Case Studies are not primarily designed to measure the frequency of events, but rather to support or reject theoretical propositions or conjectures related to issues about the nature of the event. Again this made it a prime candidate to examine the experiences of organisations on their respective Lean journeys.

Traditionally there have been prejudices against the Case Study method (Yin, 1989). Many of the arguments forwarded such as incomplete evidence and bias could creep into any research method. The other aspect surrounds the time issue. Yin, (1994) proceeds to explain that this need not occur provided adequate triangulation has taken place. Undoubtedly, at the onset it was appreciated that Case Study research leading to a real understanding and explanation in management would prove difficult. Nonetheless, having undertaken the role of a Lean facilitator and all its integral change management issues, it was considered that the listening and understanding facets in the evidence provided by the informants can be dealt with. The objective was not to use the Case Studies to primarily measure the frequency of the events, but rather to support or reject theoretical propositions or conjectures related to issues about the nature of the event. The intention of the research was aimed specifically to address issues surrounding the respective organisation's experiences of Lean; this would include matters such as who made the decisions regards implementation, evaluation or even termination. In this instance, it was considered that Case Studies were appropriate to this field of study.

Undeniably, bias needed to be dissuaded; Case Study research is an area of exploration that is fraught with danger primarily due to the problem of subjectivity and bias (Remenyi et al., 2000). Problems can result in capturing evidence from witnesses, and when coupled with the difficulties of analysing, it was appreciated that efforts would need to be made to minimise or at least identify the biases. Yin (1993) focuses on three possible difficulties which this investigation was determined not to encounter; namely:

- struggles encountered by the respondents in their effort to recall events accurately,
- worries that respondents could have in disclosing important information, and
- doubts individuals have about revealing information that they perceive might reflect poorly on themselves or their managers.

Nonetheless, by inquiring about multiple sources of evidence; in the case of both managers and operatives, the validity and reliability of the research was greatly improved. The Case Study was used as a primarily narrative research method whereby an accurate description was needed. It was imperative, that all relevant facts were included whereby circumstances portraying little relevance on the situation were omitted. To combat some of the possible negativity, a logical sequence along with continuity and cohesion throughout the narrative was pursued. Yin (1994) encouraged researchers to make every effort to produce an analysis of the highest quality. In order to accomplish this, he presented four principles that should attract the researcher's attention:

- show that the analysis relied on all the relevant evidence,
- include all major rival interpretations in the analysis,
- address the most significant aspect of the Case Study, and
- use the researcher's prior, expert knowledge to further the analysis.

It is important to acknowledge the appropriate procedures followed since these both aided the data capture process and provided rigour to the subsequent analysis. As outlined in the protocol (Appendix 9) eight informants were used in each case study; the split was as follows:

- two managers interviewed in a semi-structured manner using interview schedules (appendix five),
- two shop floor operatives interviewed in a semi structured manner again utilising interview schedules (appendix seven),
- two different managers were requested to complete a questionnaire (appendix six),
- two different shop floor operatives were also asked to complete a questionnaire (appendix eight); subsequently the organisation was re-visited and
- a detailed Lean audit (appendix two) was undertaken to substantiate the findings of both the Case studies and the Survey questionnaire. The Lean audit permitted the placing of the organisation on a particular juncture of its Lean journey; and
- accordingly the organisation was awarded the opportunity to complete a questionnaire (appendix four) to either refute or substantiate the results of the extensive Lean audit.

3.2.4 Advantages Case Studies offered

The quintessential characteristic of Case Studies is that they strive towards a holistic understanding of interrelated activities engaged in by the actors in a social situation. The Case Studies must always have boundaries (Stake, 1995). Case Study research is not sampling research (Yin, 1994; Stake, 1995). However, selecting cases must be done so as to maximize what can be learned, in the period of time available for the study. Although each Case Study was unique looking at specific organisations and their Lean journey, it was possible to compare the conclusions. Since Case Studies stress the holistic situation, it makes it a strong contender when dealing with the complexities of business. It was possible to extract real-time information, which was particularly relevant in looking at organisations on their Lean journey. By interviewing managers and operatives and proceeding to corroborate the evidence by making reference to the other sources of evidence there existed the opportunity for triangulation. Equally, it was possible to maintain the chain of evidence; this assists to follow the argument and the derivation of the evidence from the original research design and questions to the eventual conclusions. Equally, the Case Studies allowed the investigation to be examined in greater depth than was possible with the Survey Questionnaire. Whilst efforts were made to ascertain attitudes in the survey questionnaire, a greater understanding of the organisations in an overall context was achieved through the Case Studies. The additional information through explanatory notes proved useful in illuminating the overall findings.

3.3 The Case Study protocol (appendix nine)

A uniformity of recording was sought as this facilitates comparisons between the organisations. It was important to integrate a Case Study protocol in an effort to ensure reliability. It was considered obligatory to outline the Case study protocol (Appendix 9) that the research pursued. The protocol essentially contains not only the process for the research, but also the procedures and the general rules that were followed using the instrument; namely:

- The overview of the study project (objectives, issues, literature and research)
- Key relevant issues of the investigation,
- Field procedures (access to respective organisations, sources of information)
- Case study methodology adopted,
- The key classifications,
- Additional investigations undertaken and a
- A guide for the Case study report.

A pilot Case Study was undertaken to test out the substantive and methodological issues which assisted to develop more relevant lines of questioning. Unquestionably, this was selected on the grounds of convenience, access and geographical proximity. Stake (2000) and Yin (1994) identified at least six sources of evidence in Case Studies. The following is not an ordered list, but reflects the research undertaken within each organisation:

- Documents,
- archival records,
- interviews,
- direct observation,

- participant-observation and
- physical artefacts.

3.3.1 Case Study evidence

3.3.2 Documents

These were used to corroborate and supplement the evidence from other sources. The most useful evidence was the most recent set of published financial accounts; from this it was possible to make certain inferences. Within Lean environments there were substantial number of documents on the shop-floor which gauge various performance parameters such as cost, delivery, utilisation and labour productivity. It was possible to deduce the level of commitment the individual sections awarded to their Lean efforts from this documentation.

3.3.3 Interviews

A heavy reliance was awarded to interviews; operational and management representatives were interviewed using a structured schedule. These were organized on the lines of a focused structure that was reasonably open-ended but pursued an interview schedule. Equally, this permitted a level of intimacy with the informant, which on occasions facilitated the generation of other evidence such as documentation. In order to ascertain generalisability, different shop floor (appendix eight) and management representatives (appendix six) were also asked to complete a questionnaire.

3.3.4 Direct Observation

Undoubtedly, all evidence other than observation is essentially hearsay, and for this reason observation was necessary. Lean lends itself easily to direct observation. Often, owing to the integral components of Lean such as value streams, layouts and stock levels, it was possible to make general conclusions. It was also possible to observe locations, individual behaviour and the prevailing corporate culture. There was an opportunity to observe directly the surroundings along with the relevant interaction and behavioural and environmental conditions. Subsequently, it was possible to use the observations as yet another useful source of evidence and an important way to triangulate.

3.3.5 Participant Observation

The fourfold categorisation developed by Gill et al., (1997) regarding the participant observer's role was utilised; the roles are:

- complete participant,
- complete observer,

- observer as participant and the
- participant as an observer.

Acting in the role of a participant as an observer was considered ethically correct and that it would cause less problems. The subjects were aware that it was a fieldwork relationship. Since the researcher's identity as a researcher was evident, the subjects could be asked questions to enhance ones understanding. Undeniably, it was important to ensure reliability was not threatened. The closeness to the research can lead to significant observer bias. Consequently, efforts were made to verify information that was received from other individuals within the organisation. Figure 3.4 illustrates the options open to the researcher as an observer:

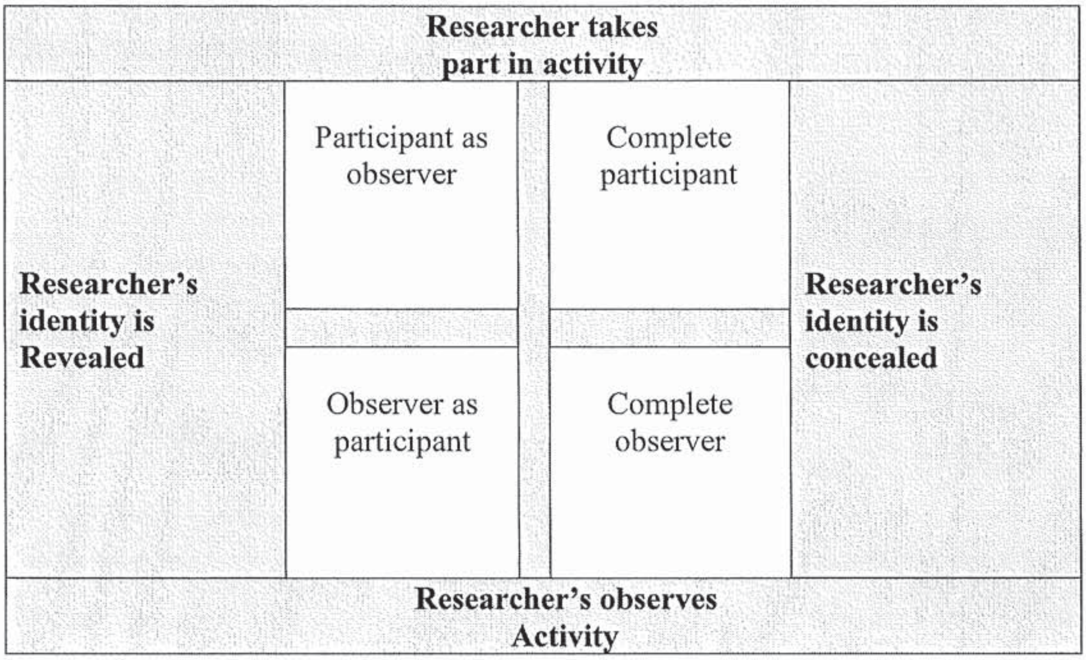


Figure 3.4
Researcher as an observer

3.3.6 Physical artefacts

A range of physical artefacts were available in each organisation; these included layouts of departments prior to Lean, savings reports attempting to exemplify the impact of Lean, job descriptions and remuneration systems both prior to and during Lean. Occasionally, it was possible to view the original communication between the sponsor of Lean and his / her senior management team, which clarified the start date of the organisation's Lean journey. Table 3.9 provides a summary of the benefits and potential shortcomings of each type of Case Study evidence utilised.

3.3.7 Archival Records

An important ingredient towards Lean success considers that the respective organisation needs to view Lean as a journey. Consequently, there should be evidence in any organisation reflecting the progress that has been made. On occasions this may merely be the documented trends of various performance indices. Equally, the layout of the shop-floor often has to be modified. Intrinsically, the hierarchical structures also have to be tailored and by undertaking a minor investigation it was possible to deduce whether this had occurred.

3.4 Analysing Case Study evidence

This aspect of the Case Study methodology is the least developed and hence the most difficult. Some researchers suggest that if the study is made conducive to statistical analysis, the process is easier and more acceptable. However not all Case Studies lend themselves to this type of analysis. Miles et al., (1984) proposed analytic techniques such as rearranging the arrays, placing the evidence in a matrix of categories, creating flowcharts, data displays, tabulating the frequency of different events, using means, variances and cross tabulations to examine the relationships between variables, and other such techniques to facilitate analysis.

There must first be an analytic strategy, which leads to conclusions. Yin (1994) presented two strategies for general use; one is to rely on theoretical propositions of the study, and then to analyze the evidence based on those propositions. The other technique is to develop a case description, which would be a framework for organizing the Case Study. Pattern-matching is another major mode of analysis. This type of logic compares an empirical pattern with a predicted one. Internal validity is enhanced when the patterns coincide. If the Case Study is an explanatory one, the patterns may be related to the dependent or independent variables. If it is a descriptive study, the predicted pattern must be defined prior to data collection. Yin (1994) recommended using rival explanations as pattern-matching when there are independent variables involved. This requires the development of rival theoretical propositions, but the overall concern remains the degree to which a pattern matches the predicted one. Stake (1995) recommended categorical aggregation as another means of analysis and also suggested developing protocols for this phase of the Case Study to enhance the quality of the research. He also presented ideas on pattern-matching along the lines that Yin (1994) had presented.

3.4.1 Interviews

Interviews were chosen since they can be associated with both positivist and phenomenological methodologies. Whilst evidently, there exists the free-range interview with a fluid agenda and open-ended questions it was decided to pursue the commonly used middle ground based on semi-structured interviews (appendices five and seven), whereby the

Analysis of the types of Case Study evidence:	Advantages	Disadvantages
Documentation	• stable – repeated review • unobtrusive - exist prior to Case Study • exact - names and dates • broad coverage - extended time span	• retrievable - difficult • bias (selectivity) • reporting bias - reflects author bias • access - may be blocked
Archival Records	• Same as above • precise and quantitative	• Same as above • privacy might inhibit access
Interviews	• targeted - focuses on Case Study topic • insightful - provides perceived causal inferences	• bias due to poor questions • response bias • incomplete recollection • reflexivity - interviewee expresses what interviewer wants to hear
Direct Observation	• reality - covers events in real time • contextual - covers event context	• time-consuming • selectivity - might miss facts • reflexivity - observer's presence might cause change • cost - observers need time
Participant Observation	• Same as above • insightful into interpersonal behaviour	• Same as above • bias due to investigator's actions
Physical Artefacts	• insightful into cultural features • insightful into technical operations	• selectivity • availability

Table 3.9
Summary of the Case Study evidence

interviewer has clearly defined purposes, whilst seeking to achieve them through some flexibility in wording and in the order of presenting the questions. In the context of this analysis, the face-to-face interview was seen as a powerful tool, though not without its potential problems; namely, theoretical, practical and analytical. The interview was seen almost as a conversation with a purpose, as proposed by Robson, (2002). However, as suggested by many, Collis et al., (2003) and Smith et al., (2000), that whilst apparently simple this can be quite deceptive. There existed considerable empathy with the view of Cohen et al., (1989) of subscribing to the opinion that interviews need to be seen as a conversation. Cohen et al., (1989), stated that an interview is "*initiated by the interviewer for the specific purpose of obtaining research-relevant information and focused by him on content specified by research objectives of systematic description, prediction or explanation*"(page 307).

The interview was seen to be a flexible and an adaptable way of finding things out. Undoubtedly, observing behaviour is clearly a useful enquiry technique, but asking people questions directly about what is going on is an obvious short cut in seeking answers to the research questions. Equally face to face interviews offer the possibility of modifying ones line of enquiry; non verbal cues may give messages which help in understanding the verbal response, possibly changing or even, in extreme cases, reversing its meaning. However, to gain the full potential of this flexibility, calls for considerable skill and experience. The lack of standardisation inevitably implies concerns about reliability. Nonetheless, the degree of professionalism adopted can assist to ensure that bias can be largely ruled out. It was important to listen and not utilise the interview as a platform for personal experiences and opinions. The questions were presented in a straightforward, clear and non-threatening way. Collis et al., (2003), propose that if people are confused or defensive, the information sought is not gained. It was vital that all cues were eliminated in the interview process thus ensuring that the interviewees were not encouraged or lead to respond in a particular fashion.

Furthermore, very long questions were avoided as the interviewee on occasions would remember only part of the question. Linked or "double-barrelled" questions were avoided too and instead split. Attention was also paid to refrain from leading questions and jargon to retain the professionalism. Moreover, interviewing can be time consuming. All interviews needed careful preparation; this manifested itself through the arrangements for the visit, securing necessary permissions, confirming arrangements and rescheduling appointments to cover for absences and crisis. Equally, the subsequent analysis adds to the time demands. Moreover, assurances were provided regarding confidentiality. Likewise, it was important to develop an element of trust since the fear otherwise was that the interviewees simply resort to stating what they feel is needed. It was vital to become knowledgeable about the organisation, which often helped to break certain barriers. In the structured component of the interviews it was imperative that the question wording remained the same and in the sequence decided previously. The answers were recorded exactly and without making cosmetic adjustments, correcting them or fabricating the process. It was vital to make sure that all interviews were conducted in the same fashion. This does not just refer to the questions asked, but also ascertaining that they should be posed in the same fashion. As far as possible, respondents understood the question in the same way and this is referred to as "*stimulus equivalence*" (page 156; Hussey et al., 1997).

3.4.2 Types and Styles of interviews

Robson, (2002) suggests that the prevailing distinction is based on the degree of structure or formality of the interview. This focuses on a dimension of differentiation, where at one extreme we have the fully-structured interview, with predetermined set questions and the responses recorded on a standardized schedule such as a questionnaire. On the other we have a semi-structured interview whereby the interviewer has worked out a set of questions in advance, but is free to modify their order based upon the perception of what may seem appropriate in the context set. The way the questions are worded was changed, explanations forwarded, and the process adopted whereby some particular questions would be omitted which seemed inappropriate, or added others.

Collis,(2003), suggested that semi-structured interviews are appropriate when:

- it is vital to understand the construct that the interviewee uses as a basis for his or her opinions about a particular aspect,
- an objective of the interview is to develop an understanding of the respondent's environment whilst permitting the researcher to influence it either independently or collaboratively,
- the step-by-step logic is not clear,
- the subject content is highly confidential,
- the interviewee may be reluctant to be truthful about an issue except in a one-to-one situation.

However, a totally unstructured (completely informal) interview whereby the interviewer has a general idea of interest and concern, but lets the conversation develop within the area was not pursued as it was considered to lack relevance for this situation. The style of interviews fell under the umbrella of "*respondent interviews*" (Robson, page 231), whereby it was important to remain in control as the interviewer and to pursue the agenda established. Similarly, the fully and semi-structured interviews are conducive to this style. The "*informant interviews*" (Robson, page 231), primarily are concerned with the interviewee's perceptions within a particular situation or context. Inevitably, the sessions are unstructured. The semi-structured interviews were used to gauge qualitative information too. The intention was to deduce the "what" and "how" whilst not neglecting the emphasis on the "why". Consequently, both the shop floor and the management respondents were bestowed the opportunity to clarify any point they wish to do so. There were various reasons for using the semi-structured interview schedule; namely they:

- permitted the opportunity to probe further when it was necessary for the interviewees to explain or build on their responses,
- often the questions might have seemed complex as organisations and consequently the interviewees varied in their knowledge of Lean,
- it was necessary on occasions to vary the order and logic of the questioning,
- owing to the complexity of the subject matter, it was felt that the interview was the ideal method of data capture.

From the literature a convention was developed which dictated how the interview schedules for both shop floor and management representatives were undertaken; the interview environment always suited the respondent who was offered the option to undertake the interview either away from work and if at their workplace where they felt most comfortable. There also existed a framework to the questions i.e., an introduction, "warm-up" questions, the main part of the interview, "cool-off" questions and the conclusion by thanking the interviewee and explaining the next steps of the research process. Care was taken to ensure that one's body language did not influence opinions; probes were used when necessary; Robson (2002) indicates four techniques which were used

- allowing a period of silence,
- offering an enquiring glance,
- using verbal signals such as: "Mmhmm",
- repeating some of what has just been said.

Summaries were used when appropriate; i.e., to keep focused and to clarify the interviewee understood the complex issues. Furthermore, accurate records were always maintained; the forms were completed in front of the interviewee.

3.4.3 The Items or Questions

Within the methodology there is evidence of using the two types:

- Closed, which forces the interviewee to choose from two or more fixed alternatives,
- open questions provide no restrictions on the interviewee on the content or manner of the reply other than on the subject area. Cohen et al., (1989), rightly advocate the

flexibility of open questions as they permit the additional probing or assist to clear misunderstandings.

Moreover, they permitted a truer assessment of the respondents' knowledge and allowed to scale items to determine the level of agreement or disagreement. In order to facilitate the process, the interview schedules were split since some parts were merely acting as an "aide-memoir" from those components that were to be directed to the interviewees.

3.5 Confronting the interview bias

It was necessary to recognise some of the potential pitfalls associated with interviews; the following considerations were taken into account to deter interviewer and interviewee bias in all interviews; namely in preparing for the interview, it was vital that background information about the organisation was evident. This coupled with the relevant technical experience meant that credibility as judged by the interviewee was present. The level of information supplied to the interviewee remained consistent and structured. The opening comments were used as an opportunity to secure both the credibility of the process and the interviewee's confidence. The overall approach to questioning attempted to increase the reliability of the data by phrasing the questions clearly, using more open questions, and leaving the sensitive questions towards the end of the interview once trust had been established. Equally, the nature and impact of the behaviour during the interviews was carefully observed. A neutral, but not an uninterested, response was projected in relation to the interviewees responses in order not to provide any lead that may result in bias. Robson, (2002) advocates sitting slightly inclined towards the interviewee and adopting an open posture which signals attentiveness to the interviewee.

Attention was devoted to listening skills; during the interviewing, it was necessary to explore and probe explanations and meanings; however, this was done by providing the interviewee with reasonable time to develop their own responses and not to project views upon them. The approach taken to record data was also scrutinised; this was compiled during the interview to deter subsequent bias (Collis et al., 2003). The generalisability issue was paid particular attention; it was important to demonstrate that the findings would have a broader significance than the case(s) that formed the basis of the research. This also permits the theoretical propositions to be advanced that can be tested in other contexts. A problem that can be experienced is that of distinguishing between "*objective*" and "*subjective*" reporting. It is important that another person reading the outcome of a survey can distinguish easily between factual or numerical results, and the interpretation of the results. It is perfectly acceptable to conjecture about the reasons for a particular finding, but it is never helpful to mix facts and conjecture in a report. It was always considered that the reader is also capable of interpreting the results, perhaps in another way. Consequently, it is possible to separate the objective results from the subjective interpretation.

3.6 Questionnaires (appendices six and eight)

Questionnaires were used since they too can be associated with both positivistic and phenomenological methodologies. Besides closed questions, some open-ended questions were used for both the operatives and management to gauge their views of their organisation's Lean journey. Whilst response rates can be low (Hussey et al., 1997; Robson 2002) they were undertaken whilst visiting the respective organisation; consequently the respondents were aware that they only had a certain time frame to complete the questionnaires. Whilst reliability and validity in reference to the questionnaires utilised are discussed later; the following generic protocol was used in designing the questions: (Remenyi et al., 2000; Robson 2002; Collis et al., 2003; Anderson, 2007)

- all participants were informed of the purpose of the questionnaire,
- questions were easily readable and free of jargon,
- vague descriptions were avoided and questions were easily construed,
- one question was asked at a time,
- focus remained on the overall objective,
- insensitive questions were avoided which may cause embarrassment,
- questions which are essentially a memory test were evaded, and
- Participants were provided with clarification if required.

3.6.1 Advantages Questionnaires offered

Questionnaires are easy to analyze. It was felt that the data entry and tabulation for nearly all surveys can be easily done with many computer software packages. Moreover, questionnaires are familiar to most people. Nearly everyone has had some experience of completing questionnaires and they generally do not make people apprehensive. Questionnaires could lead to a reduction in bias. There was a uniform question presentation and no middle-man bias. It was considered that even the researcher's own opinions should not influence the respondent to answer questions in a certain manner. No verbal or visual clues influenced the respondent. Equally, questionnaires are less intrusive than telephone or face-to-face Surveys. Furthermore, the respondent was free to complete the questionnaire in his / her own time. Unlike other research methods, this research instrument does not interrupt the respondent.

3.6.2 Disadvantages of Written Questionnaires

A major disadvantage of written questionnaires is the possibility of low response rates. It can dramatically lower our confidence in the results. Nonetheless, by being on site, this acted as a constant reminder to the individual. Another disadvantage of questionnaires is the inability to probe responses. Questionnaires are structured instruments. They allow little flexibility to the respondent with respect to response format. In essence, they often lose the "flavour of the response" (i.e., respondents often want to qualify their answers). By allowing frequent space for comments, an attempt was made to partially overcome this weakness. Comments are amongst the most helpful of all the information on the questionnaire, and they usually provide insightful information that would have otherwise been lost. Nearly ninety percent of all communication is visual. Gestures and other visual cues are not available with written questionnaires. The lack of personal contact will have different effects depending on the type of information being requested. A questionnaire requesting factual information will probably not be affected by the lack of personal contact. A questionnaire probing sensitive issues or attitudes may be severely affected. Finally, questionnaires are simply not suited for some people; a written survey to a group of poorly educated people might not work because of reading skill problems. More frequently, people are turned off by written questionnaires because of misuse. Nonetheless, since the questionnaires were generally completed whilst visiting the organisation, the severity of the limitations was largely addressed.

3.7 Sample size

The decision regarding the appropriate number of questionnaires is complex. Essentially, it is a case of deciding the degree of accuracy needed and confidence in the ultimate answer. There are several major considerations to deliberate:

- the kind of statistical analysis that was planned,
- the anticipated variability in the samples coupled with the results based on the experience; as a general rule the greater the expected variation, the larger the sample size,
- the general traditions within the respective research area regarding appropriate sample size,
- the smaller the population, the bigger the ratio of sample size to population size; small populations (under 1,000) a ratio of about 30% is advisable. Populations between 1,000 to 10,000 a ratio of about 10% is acceptable and for populations over 15,000 a ratio of 1% may suffice, (Smith et al, 2000),
- a higher level of accuracy requires a higher sampling ratio and
- the higher the number of different variables to be examined in the analysis of the data, the higher the sampling ratio should be.

3.8 Credibility of the research findings

It was necessary to reduce or eradicate the possibility of making mistakes in the subsequent analysis owing to the data captured. A key issue for any investigative enquiry is its credibility; the extent to which the data obtained is both relevant and valuable. Anderson (2007) summarises that whilst the concepts of validity and reliability are difficult to understand; both can be better comprehended by a set of questions. Questions relating to reliability, which the research considered, were:

- whether the methods used would generate the same results on other similar occasions?
- would similar observations be reached by different observers?
- is it easy to understand how raw data has been collated and analysed?

The questions relevant to validity were:

- the difference ,if any, that the context of the investigation would have made to the data generated?
- to what extent has the enquiry process itself influenced the possible responses?
- how easy was it to separate cause and effect in the data?
- the certainty that other factors (intervening variables) had not affected the data and
- to what extent would the research results be generalisable?

Equally, the ethical issues emerged as the planning of the research, access to the organisations and individuals, the collection, analysing and reporting of the data developed. Ethics were seen to be a reference for the appropriateness of ones behaviour in relation to the rights of those who become the subject of the research, or are affected by it. Ethics has been defined as a "*code of behaviour in relation to the rights of those who become the subject of your work or are affected by it*" (Anderson 2007; page 59). All research enquires, irrespective of the discipline in which they are based in should operate within general principles of acceptable behaviour and practice. The research undertaken adhered to the following general Code of Professional Conduct (CIPD, 2005):

- efforts were made to check the accuracy of the information,
- confidentiality of personal information,
- equal opportunities and non-discriminatory practices were followed,
- a fair dealing in the treatment of individuals.

Equally, five ethical principles focused on the CIPD Code (2005) were followed and they underpinned the whole process from the beginning to the conclusion:

- privacy and confidentiality,
- data was collected in an appropriate manner,

- there existed informed consent by those being researched,
- there was no deception and
- the research was carefully interpreted.

The conduct of the research was guided by a code of ethics, which provided a statement of principles and procedures for the research (Aston University, 2004)

It was fully recognised that all stages of the research process have ethical implications (Saunders et al., 2003). There are certain ethical issues directly applied to the design and initial access stages. The consent to participate needs to be viewed as a continuum since the scope can vary. In the process of the Survey Questionnaire, it was always identified to the gatekeeper that a tour of the site would be greatly appreciated. However, this was identified to them at the onset of the communication. During the data collection stage, issues relating to bias and reliability were always considered. This can become an issue with qualitative methodologies such as interviewing, which were vigilantly dealt with as outlined earlier. Business and management research inevitably raises a number of additional ethical issues. Privacy is a key issue and it was important that the participants:

- had the right not to participate and to not extend the scope beyond that information which is freely given,
- were not contacted at times unsuitable to them,
- were not subjected to longer periods of contact than had been arranged,
- anonymity and confidentiality were observed in relation to the discussions and to the reporting stages.

Further ethical issues were considered when undertaking the data collection:

- objectivity; essentially bias was minimised as far as possible,
- confidentiality and anonymity was assured to both the organisations and their respective participants,
- fair treatment was undertaken by ensuring that no participant was put under undue pressure, and
- privacy was respected on every occasion.

There were also key issues regards the interpretation of data and the formulation of conclusions; namely, accuracy, objectivity, confidentiality and anonymity; this applied to both organisations and participants. In summary the following values were always adhered to:

- all relevant permissions were gained at the beginning,

- where possible the participants were encouraged to shape the form of the enquiry; a good example was the audit questionnaire whereby the candidates chose the sequence of the questionnaire,
- access was always negotiated with individuals,
- no observation was undertaken without the explicit permission of those observed,
- permission was secured before any organisational documents were copied,
- participants were notified of the opportunity to suggest amendments once completed with view towards enhancing fairness, accuracy and relevance and
- generally responsibility was taken to maintain confidentiality.

3.8.1 Reliability of Case Studies

Reliability refers to the issue of whether the evidence and the measures are both consistent and stable. Consequently, by using multiple Case Studies it was considered that the evidence would be more compelling and the results additionally robust. Easterby-Smith, (2000) and Remenyi et al., (2000), suggest that an exemplary Case Study should fulfil five characteristics and these were adopted as an analytical inspection of the research; namely these propose that they:

- should be significant,
- must be complete,
- have to consider alternative perspectives,
- need to display sufficient evidence and
- should be composed in an engaging manner

In regards to reliability, it was felt that posing three questions could assess this:

- would the measures yield similar results on other occasions?
- would similar observations be reached by other observers?
- Is there transparency in how sense was made from the raw data?

However, in line with the proposals of Robson (2002), efforts were made to deter four potential threats to reliability:

- subject or participant error; care was taken to select the most appropriate people in the organisations involved in the Lean journey,
- subject or participant bias; consultants were not used to capture the data as some bias may have been encountered,
- observer error; consequently, a high degree of structure was applied to the questionnaires which was hoped would reduce the threat to reliability, and
- observer bias; every effort was taken to ensure this did not materialise.

3.8.2 Validity of Case Studies

The literature dictated that construct validity is especially problematic in Case Study research. It has been a source of criticism because of potential investigator subjectivity. Yin(1994) proposed three remedies to counteract this: using multiple sources of evidence, establishing a chain of evidence and having a draft Case Study report reviewed by key informants. Internal validity is a concern only in causal (explanatory) cases. There is usually a problem of "inferences" in Case Studies, and can be dealt by using pattern matching, which has been described above. External validity deals with knowing whether the results are generalizable beyond the immediate case. Some of the criticism against Case Studies in this area relates to single Case Studies. However, that criticism is directed at the statistical and not the analytical generalization which forms the basis of Case Studies. Reliability is achieved in many ways in a Case Study; an important method involves the development of the Case Study protocol.

It was imperative that the research passed any judgement on its Case Study design; Remenyi et al., (2000) suggest that this could be judged on

- construct validity; refers to the establishing the correct operational measures for the concepts, ideas and relationships being studied. In order to achieve this, it was important to carefully identify the ideas, concepts and relationships and issues that were studied. Moreover, it was necessary to demonstrate that the selected measures actually addressed the ideas, concepts and issues under scrutiny,
- internal validity; according to Rosenthal et al., (1991), this may be defined as the degree of validity of statements made to assess the causal relationship of two variables. In this case, it was attempted to examine the possible alternative explanations of the phenomenon,
- external validity; sometimes referred to as generalizability. This is concerned with whether the findings are generalizable to a wider audience beyond the immediate research environment. Whilst, the phenomenologist is less concerned with this, positivists pay considerable attention to this concept. The nature of the investigation lends itself to making generalisations.

With regard to significance, it needs stressing that they are of general interest to business and management professionals; in reference to completion, the boundaries were specifically communicated. As a direct consequence of triangulation the alternative perspectives and the displaying of sufficient evidence were certainly achieved. Equally, the findings have been substantiated and the information used to compose several articles ensuring that the need to embrace an engaging manner has been achieved.

3.8.3 Reliability and Validity of questionnaires

Attempts were made to measure the reliability of the responses to questions in both questionnaires and interviews (Collis et al., 2003). "*Test re-test method*" (page 186) suggests asking the same people, the same questions on two separate occasions. The responses on the two occasions were then correlated and the correlation coefficient of the two sets of data calculated. This provided an index of reliability. However, the problem was convincing individuals to partake in this exercise. Consequently this was only undertaken on a few respondents in the cases concerning the survey questionnaire, the interview schedules and the questionnaires. Moreover, the "*split-halves method*" whereby the responses were split by compiling a separate pile for responses to the first half of the questionnaires and to the latter half. Equally, the two piles are then correlated and the correlation coefficient of both sets of the data construed. Again, this was undertaken for several survey questionnaires, interview schedules and questionnaires. Nonetheless, it was evident that whilst the questions reflected a satisfactorily high reliability rating, there is little indication of their respective validity. In order to combat this, every effort was made to ensure that the questions closely corresponded to the purpose of the study. Often this could be gauged by surmising the level of interest the respondents displayed in answering the questions.

3.9 Summary

The fundamental differences between Surveys and Case Studies made them ideal choices. Broadly, the survey studied the organisations not in their own right, but as a means of understanding the population from which they are drawn. In contrast Case Studies were embarked upon with the primary concern being the understanding of the particular case in isolation. Equally, it should be reiterated that it would be naive to suggest that any form of research, or even human activity generally is totally without bias. Even in the physical sciences, the researchers bias is reflected in the subject studied, the experiments chosen coupled with the way in which the experiment was conducted. It was recognised that if bias cannot be totally eliminated, that it should be recognised and its implications acknowledged and accepted. Likewise, every effort was made to ensure that the evidence was carefully weighted, tested and sifted to eliminate fictitious and false statements; where possible, personal rationalisations and bias were eradicated too. Survey and Case Study research have quite different objectives and cannot be viewed as interchangeable; nonetheless that makes them excellent complementary tools. Survey research was undertaken in order to accumulate numerical evidence and interpreted using statistical generalisations; whereby, Case Studies relied upon in-depth evidence that was evaluated on the basis of analytical generalisations;

here the intention was to deduce a particular set of results to the broader ideology of Lean as proposed by Yin (1989).

The methodology used played a major role in the next chapter that predominantly scrutinizes the results from the Survey questionnaire and Case Studies consisting of both questionnaires and interview schedules. The Survey questionnaire analysis was performed with the aid of the software SPSS version 13.0 for Windows. The data was collected through meticulous Survey questionnaires undertaken in sixty-eight organisations. Subsequently extensive Lean Audits were carried out in twenty companies as a comprehensive validating exercise. Overall performance correlations between sections were also attained for a general perspective. Chi-Square analysis was also utilised to substantiate the correlation analysis.

CHAPTER FOUR

RESULTS and ANALYSIS

4.0 Analysis Background

The Survey questionnaire analysis was performed using the software SPSS version 13.0 for Windows and engaged both parametric and non-parametrical tests. The data was collected through meticulous Survey Questionnaires undertaken in sixty-eight organisations. Furthermore, seven extensive Case studies were also undertaken and the information is analysed in this section. Subsequently extensive Lean Audits were carried out in twenty companies as a substantial validating exercise. The Data from survey questionnaires was captured between November 2003 and October 2007; the Case Studies were undertaken between January 2004 and July 2007; the Lean audits were undertaken between June 2007 and July 2008. Correlational analysis of groups was successfully performed in small, medium and large companies, using the Spearman's Rho test. Overall performance correlations between sections were also attained for a comprehensive perspective. Chi-Square analysis was also utilised to substantiate the correlation analysis; it measures the variance between measures. The total number of companies involved in the Survey Questionnaire were N=68, classified into groups, being n (small) =12, n (medium) =16 and n (large) = 40. The prevailing British classifications, (CIMA, 2005), states that to be regarded as small or medium it is necessary to fulfil any two of the criteria listed in Table 4.1:

	Small	Medium
Turnover (less than or equal to)	£3.1 millions (net) £3.76 m (gross)	£12.2 m (net) £14.5 m (gross)
Aggregate gross assets (less than or equal to)	£1.9 millions (net) £2.18 m (gross)	£6.6 m (net) £7.72 m (gross)
Number of employees (less than or equal to)	50	250

Table 4.1
Classification of British Organisation

4.1 Performance of Larger Companies

An important complementary factor which emerged from the analysis suggested that larger companies were more successful as a consequence of adopting Lean. As a result of the scorecard, devised and discussed at length later in this chapter, it was feasible to identify the impact of Lean on the performance of the organisations. The scorecard formed part of the survey questionnaire (Appendix One, page 8). The scorecard comprised of five categories with various indices under each; the respondent organisations provided feedback on the impact of Lean on all the indices. The five major success dimensions were initially advocated by Maltz et al., (2003):

- Financial,

- Market,
- Process,
- People and the
- Future.

Each company needs to use the components of the framework in differing ways and with dissimilar degrees of importance. The appropriate set of measures depends on the firm's size, technology, strategy, coupled with the characteristics of the relevant industry and environment in which the firm operates. It was considered important to evaluate the possible future provision the organisation has in place to ensure that it reaps the full benefits of Lean; consequently the Balanced Score Card (Kaplan et al., 1992; 1993; 2001 and 2005) was not considered suitable and the "Multi-Dimensional Model" (Maltz et al., 2003) was customized for the purpose of the investigation.

The best fifteen performing organisations comprised of the top 22% of all the 68 companies; large companies accounted for 47% of this figure. Whilst an initial judgement could easily be forwarded that the larger companies are more successful; however, since a greater number of large companies were surveyed, further analysis was imperative. Table 4.2 provides a summary of all the sixty-eight organisations. The Performance Factor (the sum of the five category averages as depicted in Table 4.5) was considered to provide an accurate indication of each organisation's performance. The column headed "SML" utilises a code of S = small, M = medium and L = a large organisation.

THE BEST PERFORMING 15 ORGANISATIONS		
Name of Organisation	**SML**	**Performance Factor**
Robert Bosch Ltd.	L	336.1
Comdev Space	L	160.5
Excel (electronic) Assemblies Ltd.	M	156
Borg Warner Limited.	L	125.8
EWS (manufacturing) Ltd.	M	107.9
Cooper Standard Automotive	L	96.8
Podmores Ltd. Engineers	S	96.4
Mitsui Components Europe Ltd.	L	95.1
Jaguar Cars Ltd.	L	94.4
Copper & Optic Terminations Ltd.	S	91.6
PSB Group Ltd.	M	90.7
Fletcher Moorland (electrical)	S	90.5

ASL Systems Ltd.	M	89.1
Celestica Ltd.	L	82.7
ICP Ltd	S	81.2
The remaining organisations		
Name of Organisation	**SML**	**Performance Factor**
Perkin Elmer	L	78.4
Simrad	M	78.4
Solutions Engineering Ltd.	S	74.9
Perkins	L	73.1
Trentex Engineering Ltd.	S	71.9
Nuaire Ltd.	L	71.7
Barkers Engineering Ltd.	M	69.3
Eaton Electric Ltd.	L	69.1
Drayton Beaumont Ltd.	M	63.1
Marcus products.	S	62.7
Uniwire	S	62.4
Cambrian Printers	M	62.3
Synthes.	M	61.5
Avilion Ltd.	L	58.8
Care-Knight	M	57
Kodak Company Ltd.	L	56.7
John Crane UK Ltd	L	56.6
Solvay Chemicals	M	54.6
3M (UK) Plc.	L	54.6
Sony manufacturing Co.	L	54.4
Ilford Imaging Ltd.	L	53
TTems	L	52.6
Timkin Aerospace.	M	52.6
Ricardo.	L	50.6
KAB Seating Ltd.	L	49.2
Patch work foods	S	47.9
Britalco Engineering Ltd.	S	46.9
Ford Motor Co. (Bridgend plant)	L	46
Vauxhall Motors Ltd. (Ellesmere Port.)	L	45

The Belle Group	L	44.5
Tonge & Taylor Ltd	S	44.2
Roballo Engineering	M	43.1
Pfizer Ireland Pharmaceuticals	L	41.4
INA Bearing Company Ltd.	L	40.7
Abacus lighting Ltd.	L	40.5
Dunlop Hiflex	L	40.3
Atkins	L	38.1
Thysenkrupp Automotive Thallent chassis Ltd.	L	36.5
Royal Doulton (UK) Ltd.	L	35
Clasonic Kansei Corp	L	34.2
Uniliver UK Foods	L	34
Deltron Emcon Ltd.	M	33.9
Leoni Wiring Systems (UK)	L	33.4
Axiom manufacturing services	L	33
TNT Logistics	L	31.8
ICI Manufacturing Technology	S	29.1
Corus Colors	L	27.5
Scapa UK Ltd	L	27.4
Lear Corp	L	26.5
Power Logistics	L	24.1
Blanc Aero (UK) Ltd.	M	21.5
Keeler Ltd	M	13.5
BMW Petrol engine	L	10.6

Table 4.2
Performance factor for every organisation surveyed

Chi-square analysis was performed on the information gathered for the small / medium / large companies based on the performance Factor; the largest companies proved to be significantly different to the small and medium companies.

Chi-Square Tests			
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.305[a]	9	.890
Likelihood Ratio	6.601	9	.679
Linear-by-Linear Association	1.417	1	.234
N of Valid Cases	68		

a. 17 cells (85.0%) have expected count less than 5. The minimum expected count is .22.

Table 4.3
Chi-Square test to check variable independency

To ensure credibility in the results it was first and foremost necessary to establish that the company size did not essentially influence the results. By way of example two hypotheses were tested:

- H0: That the variables were independent of each other,
- H1: the size of a company is not relevant to the factors. In order to test the H0, H1, the Chi squire test was adopted at a 95% confidence interval,
- If sig values >0.05, we can judge that the variables are independent. In Table 4.3 the assymp sig (The significance level based on the asymptotic Distribution of a test statistic)(p) =0.890>0.05; the likelihood ratio>0.05; and the linear-linear association >0.05. The Chi-square test, in Table 4.4, upholds the analysis discovered in Table 4.3:

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8104.453(a)	128	.000
Likelihood Ratio	7960.906	128	.000
Linear-by-Linear Association	130.829	1	.000
N of Valid Cases	4321		

a 7 cells (3.6%) have expected count less than 5. The minimum expected count is 2.04.

Table 4.4
Chi Square of Larger organisations' Performance

Table 4.5 depicts the scorecard which was used in the research to determine the impact of Lean on the respective organisations. It was crucial to broaden the determination beyond the financial analysis alone. The performance model adopted and subsequently adapted was the *Dynamic Multi-dimensional Performance* (DMP) framework (Maltz et al., 2003). It depicts success as a dynamic, on-going concept that is judged on various timeframes, and represents multiple stakeholders. The "customer" dimension addresses the aspirations of many prominent academics and practitioners; the "process" dimension concentrates on the internal dynamic management; "people development" recognises the critical role of the firm's employees and the "future" dimension is focused on preparing for change whilst sustaining an organisation's vitality for years to come. Moreover, the DMP framework provides an opportunity to examine an organisation's performance in multiple time horizons, i.e., the "financial" represents the very short term whereas the "future" looks at the very long term. The "People" dimension explicitly acknowledges the critical roles of multiple stakeholders and addresses a major limitation of the Balanced Scorecard.

The effect of Lean on the customers, internal processes and people was also sought through the various indices listed in the second column. In total 36 indices were used to make an informed judgement on the actual impact of Lean on the organisation. The Performance Factor was considered to provide an accurate indication of each organisation's performance.

Categories	Individual indices
Financial	Profit after interest and tax
	Rate of return on Capital employed
	Current ratio
	Earnings per share
Customer / Market measures	Market share by product group
	Customer satisfaction index
	Customer retention rate
	Service quality
	Responsiveness [customer defined]
	On-time delivery [customer defined]
Process	NPD lead time
	Cycle time
	Time to market for new products
	Quality of New product development and project management processes
	Quality costs
	Quality ratings
	Defects of critical products / components
	Material costs
	Manufacturing costs
	Labour productivity
	Space productivity
	Capital efficiency
	Raw material inventory
	WIP inventory
	Finished goods inventory
	Stock turnover
People	Employee perception Surveys
	Health and Safety per employee: - accidents - absenteeism - labour turnover
	Retention of top employees
	Quality of professional /technical development
	Quality of leadership development

Future	Depth and quality of strategic planning
	Anticipating future changes
	New market development
	New technology development
	% sales from new products

Table 4.5
Indices represented in each average

To further preserve integrity in the results, Spearman's Rho, the non-parametric option to the Pearson's correlation and a measure of association between rank orders was used. Only correlations exceeding ¦0.600¦ (absolute value) were considered relevant. Further tests on correlation between the Small / Medium / Large organizations and performance were carried out. Table 4.6 undertakes the initial mean and standard deviation; since the standard deviation is 0.777, it suggests that there are no extreme outliners, i.e., extremely high or low values affecting the mean.

	Mean	Std. Deviation	N
	2.41	.777	68
Performance Total	63.450	44.6688	68

Table 4.6
Mean and Standard deviation

Table 4.7 provides a summary of the correlation tests:

		Small/Medium/Large organisation	Performance Total
Small/Medium/Large organisation	Pearson Correlation	1	-.050
	Sig. (2-tailed)		.687
	Sum of Squares and Cross-products	40.471	-115.549
	Covariance	.604	-1.725
	N	68	68

Table 4.7
Correlation Tests

To further test the credibility of the findings a Kendall's tau test was undertaken; Table 4.8 provides a summary. This suggested a significant relationship between small / medium / large organisations and performance (tau = -0.19, N = 68, p= 0.046). The Spearmans rho confirmed a significant difference between the groups (rho=0.243, p=<0.05) The Kendall's tau_b, the Spearman's rho and the correlation coefficients =1, and the sig (2-tailed) = 0.046<0.05, therefore, the Correlation is significant at the 0.05 level (2-tailed). In another words, proving the larger companies are more successful.

Nonparametric Correlations				
			Small / Medium / Large	**Gtotal**
Kendall's tau_b	Small/Medium/Large organisation	Correlation Coefficient	1.000	-.192*
		Sig. (2-tailed)	.	.046
		N	68	68
	Gtotal	Correlation Coefficient	-.192*	1.000
		Sig. (2-tailed)	.046	.
		N	68	68
Spearman's rho	Small/Medium/Large organisation	Correlation Coefficient	1.000	-.243*
		Sig. (2-tailed)	.	.046
		N	68	68
	Gtotal	Correlation Coefficient	-.243*	1.000
		Sig. (2-tailed)	.046	.
		N	68	68

Table 4.8
Non Parametric Correlation Tests

4.1.1 Factors influencing the performance of larger companies

It was necessary to identify the reasons why larger organisations performed much better. Exhaustive analysis of small, medium and large organisations guided towards certain important factors. Undeniably, an important consideration was the application of Lean across not just the internal organisation, but the entire value chain. As previously outlined the literature (Allio, 2006; Parnell, 2005 and Baggaley, 2006) state the need to embrace Lean across the whole value chain in order to reap the full benefits. The seven case studies investigated the extent of Lean within each organisation. Both the interview schedules and questionnaires posed this question to different managers and the results are summarised in Table 4.9. Equally the 68 organisations that engaged with the survey questionnaire were posed the same question and the results are reflected in Table 4.10. The results were more buoyant than those from the Case Studies; undoubtedly there was room for some embellishment of the results which was not feasible within the Case Studies; again, there was an element of bias since either management or Lean champions who introduced Lean to the organisation acted as respondents to the survey questionnaire.

Managers opinion regards the spread of Lean within the organisation		
	Interview	**Questionnaire**
Lean occurs across the whole value chain	**0.0%**	**0.0%**
Lean is in our company only	**0.0%**	**0.0%**
Lean is in Manufacturing and Supply only	**0.0%**	**0.0%**
Only a few isolated tools are used	**0.0%**	**0.0%**
Lean is in Manufacturing or supply sections	**42.9%**	**28.6%**
Lean is in some units of manufacturing or supply	**57.1%**	**71.4%**

Table 4.9
Case Study responses related to the spread of Lean

In comparison the results of the survey questionnaire are summarised in Table 4.10:

Surveys' response regards the spread of Lean within the organisation	
Across the manufacturing or the supply function only	**20%**
Across manufacturing and supply functions only	**20%**
Across the whole value chain including an attempt to involve suppliers	**30%**
Across some, but not all, units of manufacturing or supply	**30%**
Have embraced only a few isolated tools i.e., Kanban or 5s in parts of some departments	**30%**
Across the whole internal organisation	**40%**

Table 4.10
Survey responses regards the spread of Lean

However, an important discovery was made when the results regarding the application of Lean within the small, medium and large organisations was further analysed. Table 4.11 confirms that despite larger organisations occupying a higher proportion of the sample, two out of five applied Lean across the whole value chain. This contrasts with small and medium organisations whereby only one in five organisations applied Lean across the whole value chain. This issue is reinforced by the responses given regards the expectations from Lean; when asked about the possibility of improving the supply chain as an on-going aspiration, the responses received were:

- 74% of the large organisations,
- 53% of the medium sized organisations, and only
- 47% of the small organisations stated it as an aspiration.

Extent to which Lean is administered within the organisation			
	Small organisations	**Medium sized organisations**	**Large organisations**

Lean applied to whole value chain including an attempt to involve suppliers	20%	25%	40%
Lean is administered within the whole internal organisation	80%	25%	43%

Table 4.11
Extent of Lean Adoption

Despite smaller organisations, as depicted in Table 4.12, revealing a higher percentage of employees and departments operating under Lean, it should be documented that after considering the size of some of the larger organisations, that the results are still remarkable.

Departments and employees operating under the Lean umbrella			
	Small organisations	**Medium sized organisations**	**Large organisations**
Proportion of an organisation's departments operating under the Lean umbrella	77.9%	49.7%	56.5%
Proportion of an organisations employees operating under Lean	78%	48.4%	58.5%

Table 4.12
Lean Adoption by Company Size

4.1.2 Cultural factors impacting upon the larger organisations

Furthermore, some of the cultural analysis could have contributed towards the superiority of larger organisations. When confronted with whether "*The organisation promotes a culture which maintains the challenges of existing processes by proactive systems such as Standard Operating Procedures*" (Appendix One; Question E8) a response of 1-10 was sought with "10" suggesting total agreement; the following results were achieved:

- 77% of large organisations scored a 7-10,
- 57% of medium sized organisations scored a 7-10, and only
- 42% of small organisations scored a 7-10.

Likewise, when respondents were asked whether "*The organisation offers customer assistance to suppliers and maintains Supplier Development Teams*" (Appendix One; Question E9) the following results were recorded:

- 23% of larger organisations scored a 9 or 10,
- only 6% of medium sized organisations scored a 9 or 10, and
- 0% of the small organisations managed to score a 9 or 10.

Chi-square analysis performed on Aspirations revealed an interesting conclusion regards the "*Aspirations of improving the supply chain management*". Large companies appeared to show more aspirations of improving the supply chain management, followed by the medium companies (Tables C and D in Appendix 17).

Similar analysis undertaken on Cultural implications illustrated a significant result relating to the "*Length in years the Lean tool has been in operation within the organisation*". The Large companies excelled at this factor too followed by the medium companies (Tables "E" and "F" in Appendix 17). Nonetheless, Chi-square analysis performed on remaining Cultural considerations revealed no significant results. The size of the company was not proven to be significantly differently based on these cultural considerations. Likewise Chi-square performed on Sustainability also did not reveal any significant results; the size of the company did not prove to be significantly different based on these sustainability factors. Equally, in the case of "*Barriers due to insufficient internal funding*" the Larger companies performed slightly worse. Tables "A" and "B" in Appendix 17 further clarify this point.

4.1.3 Lean tools in application

It is absolutely indispensable that if Lean is to succeed in an organisation that besides the aforementioned factors, that six or more appropriate and timely Lean tools are simultaneously applied within the organisation (Henderson et al., 2003; Lee 2008; Ransom, 2008). As a preamble, the entire sixty eight organisations were investigated to discover the length of time the various Lean tools had been implemented within their organisations and the results are summarised in Table 4.13:

Survey responses regards the length of time tools have been embraced within the organisations	
	Years
Step Change / Kaikaku	**1.5**
Single piece flow operations	**2.1**
Single Minute Exchange of Dies [SMED]	**2.4**
Supplier base reduction	**2.7**
Supplier Development – activating links with suppliers	**3.2**
Total Preventative Maintenance	**3.4**
Kanban systems	**3.6**
Attacking value and the seven wastes	**3.7**
Cellular manufacturing	**3.8**
Process mapping	**3.9**
5's and general visual management	**4.0**
Continuous improvement / Kaizen	**5.4**

Table 4.13
Time Lean tools had been in operation

Information was also gathered from the seven case-study organisations regards the deployment of tools; managers views were sought both in the questionnaires (Table 4.14) and the interview schedules (Table 4.15) as is summarised below:

Questionnaire responses from managers regards tools embraced within their organisations	
	%
Step change/Kaikaku	**10.0**
Supplier Development –activating links with suppliers	**11.4**
Single Minute Exchange of Dies (SMED)	**.15.0**
Supplier base reduction	**30.7**
Single piece flow operations	**37.1**
Cellular manufacturing	**40.7**
Kanban systems	**50.7**
Attacking value and the seven wastes	**52.1**
Total Productive Maintenance	**53.6**
Process mapping	**64.3**
5's and general visual management	**68.6**
Kiazen/continuous improvement	**72.9**

Table 4.14
Tools embraced through questionnaires

Pleasantly, there was considerable agreement; in fact whilst the ranking slightly differed, there was total concurrence regards the top five tools engaged within the seven organisations:

- TPM,
- Attacking value and the seven wastes,
- Process mapping,
- 5's and general visual management and
- kaizen/continuous improvement

Nonetheless, of considerable concern were the results on the following:

- supplier development and
- supplier base reductions

which appeared very low on the list.

Interview schedule responses from managers regards the Lean Tools embraced within their organisation	
	%
Step change/Kaikaku	**21.4**
Single Minute Exchange of Dies (SMED)	**25.7**
Supplier Development - activating links with suppliers	**26.4**
Cellular manufacturing	**35.7**
Single piece flow operations	**39.3**
Kanban systems	**43.6**
Supplier base reduction	**47.9**
Total Productive Maintenance	**57.9**
Attacking value and the seven wastes	**58.6**
Process mapping	**59.3**

5's and general visual management	**65.7**
Kiazen/continuous improvement	**69.3**

Table 4.15
Tools embraced through interviews

To consolidate this evidence, responses from the survey questionnaires undertaken in the sixty eight organisations also revealed the following information regards the tools deployed within the organisations; this is depicted in Table 4.16:

Survey responses regards the Lean Tools embraced within their organisation	
Step Change / Kaikaku	**33%**
Single Minute Exchange of Dies [SMED]	**41%**
Supplier Development - activating links with suppliers	**42%**
Supplier base reduction	**43%**
Single piece flow operations	**48%**
Cellular manufacturing	**61%**
Kanban systems	**64%**
Total Productive Maintenance	**65%**
Process mapping	**65%**
Attacking value and the seven wastes	**75%**
5's and general visual management	**81%**
Continuous improvement / Kaizen	**83%**

Table 4.16
Survey –Tools embraced

Whilst the Case Studies were in agreement regards the top five tools engaged within the seven organisations and pleasantly only one ranking order diverged, the top five tools were identical to those indicated in the survey questionnaires:

- TPM,
- Attacking value and the seven wastes,
- Process mapping,
- 5's and general visual management and
- kaizen/continuous improvement.

The case studies attempted to attain further credibility of the results; there was a consensus view with over 70% of the respondents agreeing that their respective organisation had been on the Lean journey for between three to six years as depicted in Table 4.17; equally only 14.3% considered their organisation to have been on the Lean journey for in excess of seven years. The seven case-studies also investigated the time span the organisations had been on the Lean journey; again differing managers were posed this question.

Managers opinion of the Time span their organisation has embraced Lean			
Interview Schedule		**Questionnaire**	
1-2 years	**7.1%**	7 months-1 year	**0.0%**
0-6 months	**14.3%**	1-2 years	**14.3%**
7+ years	**14.3%**	7+ years	**14.3%**

5-6 years	**28.6%**	5-6 years	**28.6%**
3-4 years	**35.7%**	3-4 years	**42.9%**

Table 4.17
Time on the Lean journey

In an effort to further split the analysis, Tables 4.18, A, B and C depict the prevailing situation in small, medium and large organisations respectively. It is apparent that whilst the breadth of tool application may not be higher, but the length of time the tools have been implemented is certainly longer in larger organisations (Table 4.18C):

Lean Tools	Years
Single piece flow operations	**1**
Supplier base reduction	**1.2**
Single Minute Exchange of Dies [SMED]	**1.3**
Step Change / Kaikaku	**2.1**
Supplier Development - activating links with suppliers	**2.2**
Cellular manufacturing	**2.5**
Kanban systems	**2.7**
5's and general visual management	**3.3**
Total Preventative Maintenance	**3.3**
Attacking value and the seven wastes	**3.4**
Continuous improvement / Kaizen	**3.5**
Process mapping	**3.8**

Table 4.18 A
Tools in Smaller organisations

Step Change / Kaikaku	**0.8**
Supplier base reduction	**0.9**
Single Minute Exchange of Dies [SMED]	**1.3**
Single piece flow operations	**1.6**
Kanban systems	**1.9**
Supplier Development - activating links with suppliers	**2.1**
Cellular manufacturing	**2.2**
Total Preventative Maintenance	**2.4**
Process mapping	**2.5**
5's and general visual management	**3.1**
Attacking value and the seven wastes	**3.3**
Continuous improvement / Kaizen	**5.1**

Table 4.18 B
Tools in medium organisations

Step Change / Kaikaku	**1.6**
Single piece flow operations	**2.7**
Single Minute Exchange of Dies [SMED]	**3.2**
Supplier base reduction	**3.8**
Total Preventative Maintenance	**3.9**
Attacking value and the seven wastes	**4.0**
Supplier Development - activating links with suppliers	**4.0**

Process mapping	**4.5**
5's and general visual management	**4.5**
Kanban systems	**4.6**
Cellular manufacturing	**4.8**
Continuous improvement / Kaizen	**6.0**

Table 4.18 C
Tools in Large organisations

In order to reinforce the point the listed top six tools in small, medium and large organisations were taken to achieve an average application. It was discovered that larger organisations performed much better; the average length that the top six quoted Lean tools had been in operation was:

- 4.7 years for large organisations,
- 3.3 years for the small sized organisations, and
- 3.1 years for the medium sized organisations.

Likewise, a similar exercise was undertaken within the Survey questionnaires to deduce any differences between the organisations of different sizes surveyed regards the tools in application. A considerable degree of conformity existed. All three sizes of organisations had identical top seven tools. Whilst the rank varied slightly, the top seven tools were the same as depicted in Table 4.19a, b and c:

Tools Large organisations adopted	
Step Change / Kaikaku	**36%**
Single Minute Exchange of Dies [SMED]	**50%**
Supplier Development – activating links with suppliers	**53%**
Single piece flow operations	**55%**
Supplier base reduction	**55%**
Kanban systems	**63%**
Cellular manufacturing	**67%**
Total Productive Maintenance	**67%**
Process mapping	**72%**
Attacking value and the seven wastes	**74%**
5's and general visual management	**83%**
Continuous improvement / Kaizen	**84%**

Table 4.19a

Tools medium sized organisations adopted	
Supplier base reduction	**29%**
Step Change / Kaikaku	**30%**
Supplier Development - activating links with suppliers	**30%**
Single Minute Exchange of Dies [SMED]	**34%**
Single piece flow operations	**46%**
Cellular manufacturing	**51%**
Process mapping	**51%**
Total Productive Maintenance	**52%**
Kanban systems	**60%**

Attacking value and the seven wastes	**69%**
5's and general visual management	**75%**
Continuous improvement / Kaizen	**79%**

Table 4.19b

Tools Small sized organisations adopted	
Single Minute Exchange of Dies [SMED]	**22%**
Supplier Development - activating links with suppliers	**22%**
Supplier base reduction	**23%**
Step Change / Kaikaku	**25%**
Single piece flow operations	**28%**
Cellular manufacturing	**57%**
Process mapping	**61%**
Kanban systems	**69%**
Total Productive Maintenance	**74%**
5's and general visual management	**83%**
Continuous improvement / Kaizen	**84%**
Attacking value and the seven wastes	**85%**

Table 4.19c
Survey responses to Lean Tools adopted

The top seven tools were as follows:

- Attacking value and the seven wastes
- Kaizen,
- General visual management,
- Total productive maintenance,
- Kanban systems,
- Process mapping and
- Cellular manufacturing.

4.1.4 Tracking of the Lean results

Equally significant, was the nature in which the Lean results were traced in the respective organisations. The sixty eight organisations surveyed revealed interesting information regards how the companies tracked the results of Lean; Table 4.20A is a summary for all surveyed organisations; 4.20B, C and D further breaks this down for small, medium and large organisations respectively:

Survey responses regards how Lean is tracked within the organisation	
Reviewed at board meetings only	**10%**
Ad-hoc process reviews	**30%**
half yearly process reviews	**40%**
weekly process reviews	**50%**

quarterly process reviews	**60%**
monthly process reviews	**70%**

Table 4.20A

Survey responses regards how Lean is tracked in small organisations	
	0%
Other (please specify below)	**0%**
half yearly process reviews	**30%**
Ad-hoc process reviews	**30%**
weekly process reviews	**50%**
monthly process reviews	**50%**
quarterly process reviews	**70%**

Table 4.20B

Survey responses regards how Lean is tracked in medium organisations	
	0%
Other (please specify below)	**13%**
half yearly process reviews	**19%**
quarterly process reviews	**31%**
weekly process reviews	**38%**
Ad-hoc process reviews	**44%**
monthly process reviews	**63%**

Table 4.20C

Survey responses regards how Lean is tracked in Large organisations	
Other (please specify below)	**10%**
Reviewed at board meetings only	**18%**
Ad-hoc process reviews	**33%**
half yearly process reviews	**50%**
weekly process reviews	**60%**
quarterly process reviews	**65%**
monthly process reviews	**83%**

Table 4.20D
Tracking of Lean

Again various proponents have stressed the importance of instigating a process of systematically tracking the results, hence ensuring remedial and timely action can be taken when required (Neely et al., 2005; Hunter 2004; Hines et al., 2008). When the respondents in the respective organisations were asked how often the Lean results are tracked, the following information became apparent regards the weekly and monthly tracking:

- large organisations: 60% weekly and 83% monthly too,
- medium sized organisations: 38% weekly and 63% monthly, and
- the smaller organisations, 50% weekly and 50% monthly.

4.1.5 Summary performance of larger organisations

Consequently, whilst this was not the original intent of the research, the findings have revealed a noteworthy complementary consensus that larger organisations performed better. Various factors have been exposed which have contributed to the enhanced performance. Larger organisations seem to operate under Lean to a greater extent across the value chain. This was reinforced by highlighting it as an aspiration to involve suppliers at an early stage of their implementation journey. Equally some of the supporting cultural considerations were in place to support the appropriate environment ensuring Lean is successful. Furthermore, the Lean tools were found to be in operation for a longer period in larger organisations. If we are to accept Lean as a business ideology, once again it was discovered that the larger organisations seem to trace the results of their Lean implementations more fervently than was the case with smaller and medium sized organisations.

4.2 The Highest performing organisations

Having rationalized that the analysis was able to demonstrate the impact of Lean on the respective organisations, it was important to extract the underlying reasons for the best performing organisations. Consequently, it was vital that the factors contributing to the superior performance of the fifteen organisations was acknowledged. Primarily, although each factor was considered individually, some characteristics between the relations of the factors can be generalised by using the Spearman's Rho correlations. Table 4.21 summarises the main differences between the fifteen best performing organisations and the remaining:

Topic	Fifteen best performing companies
Barriers to Lean	Higher negative correlations
Expectations/ Aspirations	Higher correlations
Cultural implications-technical	Higher correlations
Cultural considerations-related issues	Higher correlations (negative values)
Sustainability	-
Performance indicators	Higher correlations,

Table 4.21
Overall comparison of the Best performing organisations

4.2.1 Contemporary information regards the barriers to Lean

In an attempt to distinguish the reasons for the better performers, the potential barriers towards the adoption or spread of Lean in the respective organisations were investigated.

In Line with the contemporary research, (Hatch, 1997; Kenny 1998; Ligus 2007) which states that the more personal any potential consequences of change are perceived, a greater number of barriers will be erected. The 2005 Lean Enterprise Institute Survey substantiated the results found in 2004; they had stated that the biggest obstacles to Lean implementation were as follows:

- lack of implementation knowledge - 49%
- backsliding to the old ways of working - 49%
- middle management resistance - 40%
- financial value of Lean not recognised - 39%
- lack of crisis to create a sense of urgency - 36%
- Lean is viewed as a fad - 32%
- Supervisor resistance - 29%
- Not overcoming those opposed to change - 27%
- Employee resistance - 22%
- Other budget constraints - 15%
- Failures of past Lean projects - 11%

The final Engineers Employers' Federation's report (2001), insisted that to enjoy the full benefits of Lean, organisations needed to utilise a package of 4 to 5 tools and this was not apparent in most British companies. Moreover, it showed that a greater proportion of US-owned firms were using more Lean tools than the UK owned companies; equally, on average, productivity growth between 1998-2000 of organisations using 4 or more Lean tools was found to be 11%, whilst for those not on the Lean path it was deduced to be 7%. The analysis was proposed within the context of much of the empirical evidence suggesting why Lean success rates are evidently low; the "Manufacturer" 2002 in its survey of 100 organisations when asked what were the barriers or delays in operating Lean revealed the following:

- company culture - 48%
- investment/cost - 47%
- staff attitude - 38%
- change issues - 33%
- lack of understanding of process - 29%
- lack of understanding of benefits - 29%
- nature of manufacturing facility - 27%

The Lean Enterprise Institute Survey (2004) of over 900 executives identified the following hurdles to Lean transformation:

- Backsliding to the old ways of working - 36%
- Lack of implementation knowledge - 25%
- No obvious project, and urgency - 24%
- Traditional cost accounting system - 22%
- Resistance by middle management - 21%
- Lean is viewed as a fad - 19%
- "Anchor draggers" resisting change - 18%
- Resistance by hourly employees - 11%
- Resistance by supervisors - 10%
- Failure of past Lean efforts - 6%.

4.2.1.1 Case Study information on Barriers

The Case Studies revealed interesting results regards the barriers to Lean; it was important to secure responses from both the management team and the shop floor. Consequently, the data capture needed to reflect the views of these groups of people;

- Shop-floor questionnaire, Appendix 8,
- Management questionnaire, Appendix 6,
- Shop-floor interview schedule, Appendix 7, and a
- Management interview schedule, Appendix 5.

The Managers' questionnaire responses are summarised in Table 4.22:

Managers list of Lean Barriers – Questionnaire	**%**
The need to convince shareholders/owners	**42.1**
Insufficient external funding	**52.1**
Insufficient understanding of the potential benefits	**54.3**
Insufficient senior management skills to implement Lean	**67.1**
Insufficient management time	**67.1**
Employee attitudes/resistance to change	**75.0**
Insufficient supervisory skills to implement Lean	**79.3**
Insufficient workforce skills to implement Lean	**80.7**
Insufficient internal funding	**82.1**
Cultural issues	**82.1**
Cost of the investment	**90.0**

Table 4.22
Managers List of barriers

In order to reinforce this issue, different managers were posed the same question in the form of an interview schedule in each organisation; the results from these sets of managers are illustrated in Table 4.23:

Managers list of Lean Barriers – Interview schedule	%
The need to convince shareholders/owners	**40.0**
Insufficient understanding of the potential benefits	**51.4**
Insufficient external funding	**52.1**
Insufficient management time	**61.4**
Insufficient senior management skills to implement Lean	**65.7**
Insufficient internal funding	**74.3**
Employee attitudes/resistance to change	**74.3**
Insufficient workforce skills to implement Lean	**75.0**
Insufficient supervisory skills to implement Lean	**75.7**
Cultural issues	**77.9**
Cost of the investment	**81.4**

Table 4.23
Interview List of barriers

Interestingly there was agreement amongst the different sets of managers in the seven case studies. The top two barriers were cost and culture; however whilst the ranking varied in just one instance, insufficient supervisory and work force skills coupled with the lack of internal funding were quoted to be the three highest barriers besides culture and cost. Nevertheless, it is important to make a cautionary observation of partiality; having undertaken a virtual longitudinal study at Royal Doulton Plc, it was discovered that often both the shop-floor and management would readily blame each other in reference to the erection of barriers. Accordingly, this aspect required further investigation.

4.2.1.2 Survey questionnaire

A similar analysis was undertaken on the sixty eight organisations that had consented to complete the survey questionnaire. It was decided to investigate the situation overall within the whole sample initially. The main barriers quoted are depicted in Table 4.24:

Main Barriers towards Lean adoption or expansion	%
Need to convince shareholders / owners	**22**
Insufficient external funding	**39**
Insufficient internal funding	**46**
Insufficient understanding of the potential benefits	**47**
Cost of the investment	**50**
Cultural issues	**51**
Insufficient management time	**54**
Insufficient senior management skills to implement Lean	**58**
Insufficient workforce skills to implement Lean	**59**
Employee attitudes / resistance to change	**60**
Insufficient supervisory skills to implement Lean	**66**

Table 4.24
Survey List of barriers

There was a discrepancy regards the main barriers as seen by the survey respondents and those within the case studies; whilst the case studies reiterated:

- Cost,
- Culture and
- Insufficient internal funding as the highest.

The three highest within the surveys were:

- Insufficient supervisory skills,
- Employee attitudes,
- Insufficient workforce skills.

Equally whilst culture and cost were ranked quite high within case studies; they secured a mid ranking in the surveys. It was felt that this could be explained since often the gate-keepers who completed the survey were either management or Lean champions who had introduced Lean into the organisation.

4.2.1.3 Detailed analysis on barriers

The highest performing fifteen companies with view to the Performance Factor (the sum of the five category averages as already explained) showed a very strong and negative relationship with the following potential Lean barriers (all significant at 0.01 level, two tailed):

	Correlation	Sig
• insufficient understanding of the potential benefits	- 0.8	0.000
• insufficient external funding	- 0.7	0.002
• lack of internal funding	- 0.6	0.053
• insufficient senior management skills to implement Lean	- 0.8	0.003
• insufficient supervisory skills to implement Lean	- 0.7	0.003
• insufficient workforce skills to implement Lean	- 0.6	0.002
• the cost of the investment	- 0.6	0.002
• cultural issues	- 0.1	0.600

Despite, the fact that some of the ranking order of the quoted barriers may have varied between both the survey questionnaire and the case studies; the results provided an overwhelming indication that in the highest performing organisations, the Lean barriers are either not permitted to cultivate and / or do not prevent the organisation from advancing on its Lean journey. Captivatingly, the barriers mentioned before; namely the cost, insufficient workforce and supervisory skills were declared as high negative correlation values indicating that they were not an issue for the highest performing organisations. It should be noted that despite the significance being 0.6; the correlation for culture in the best performing organisations was still just - 0.1; this implies that even in the best performing organisations some cultural related issues were encountered. However, in spite of this, the remaining barriers were not permitted to develop. In order to further substantiate this, Chi-square analysis was undertaken on the potential barriers to Lean which substantiated few significant results; barriers due to insufficient understanding of the potential benefits, barriers due to insufficient supervisory skills to implement Lean and barriers due to insufficient workforce skills to implement Lean, appeared to be considerably less in the best performing organisations (Tables "A" and "B" Appendix 17).

4.2.2 Distinctive factors of the uppermost performers

Further detailed investigations on the best performing organisations revealed a strong and positive relationship with the following factors:

	Correlation	**Sig**
• The Aspirations of improving the supply chain management,	0.7	0.008
• People Average,	0.6	0.002
• Service quality,	0.6	0.003
• On-time delivery (customer defined),	0.6	0.003
• Depth and quality of strategic planning and	0.7	0.003
• Customer average.	0.7	0.004

Importantly, correlation of performance and the average for each category was as shown in Table 4.25. This revealed the importance of the "people" category which embraces the following individual indices:

- Employee perception surveys,
- Health and Safety per employee,
- retention of top employees,
- the quality of professional and technical development, and
- quality of leadership development

and the "Customer" indices; namely:

- market share by product group,
- customer satisfaction index,
- customer retention rate,
- service quality,
- responsiveness and
- on-time delivery.

It was enlightening to discover that the finance factors did not necessarily have a huge impact on performance as indicated in Table 4.25.

Correlation of Performance and the average of each category		
Category	**Correlation**	**Significance level**
Finance	0.142	0.003
Custom	0.602	0.002
Process	0.500	0.018 (sig at 0.5)
Future	0.40	0.11 (sig at 0.5)
People	0.70	0.008

Table 4.25
Performance and Average correlation

4.2.3 Lean Sustainability

Another important factor distinguishing the best performing organisations was identified as that one of Lean Sustainability which forms a critical component when judging whether Lean has been adopted as a philosophy; this is summarised for all the sixty eight organisations in Table 4.26A. Both the proportion of an organisation's departments operating under the Lean umbrella as well as the ratio of the organisation's employees operating under Lean conditions were used as important features. In the case of these fifteen organisations, the figure exceeded 72% for both parameters (Table 4.26B) as opposed to approximately 55% for the remaining organisations, as reflected in Table 4.26C.

Lean Sustainability – all surveyed organisations	
Provide an indication of the proportion of the organisation's departments operating under the Lean umbrella.	**58.6%**
Provide an indication of the proportion of the organisations employees operating under lean conditions.	**59.6%**

Table 4.26A
Spread of Lean

Lean Sustainability – Best performing organisations	
Provide an indication of the proportion of the organisation's departments operating under the Lean umbrella.	**72.5%**
Provide an indication of the proportion of the organisations employees operating under lean conditions.	**74.3%**

Table 4.26B
Spread of Lean

Lean Sustainability – remaining organisations	
Provide an indication of the proportion of the organisation's departments operating under the Lean umbrella.	**54.7%**

Provide an indication of the proportion of the organisations employees operating under lean conditions.	**55.4%**

Table 4.26C
Spread of Lean

4.2.4 Tools in application within the organisations

An important question posed in the survey questionnaire inquired (D2; appendix 1) "*from the list of Lean tools indicate which one(s) apply to your organisation*" Whilst, all organisations confirmed varying degrees of application, a thorough investigation of the best performing organisations revealed the following results regards the top three tools in operation:

- Continuous improvement – 91%
- 5s and general visual management - 90%
- attacking value and the seven wastes - 88%

Conversely, when the same question was posed to the remaining organisations surveyed, it indicated the same three tools. However, it was the level of application that varied as is depicted by the following results:

- Continuous improvement – 80%
- 5s and general visual management - 79%
- attacking value and the seven wastes - 71%.

Consequently, in exploring this situation further, it was decided to compare an average application of the top six tools listed for the best performing fifteen and the remaining organisations. Interesting results were discovered when an analysis was undertaken to deduce the application of the six top tools in place:

- the best performing organisations had an average of 82% application, whereas
- the remaining organisations had an average of 69% application.

4.2.5 Cultural differences between best and the rest

Equally, some of the cultural analysis of the Survey questionnaire undertaken in the sixty eight organisations provided a remarkable insight in presenting a possible explanation for the superiority of the better performing organisations. Organisations were asked to respond using a scale of 1-10 with "10" suggesting total agreement with the statement given (section E; Appendix 1). All the questions are sourced from the survey questionnaire (section E; Appendix 1). Table 4.27 depicts the results against the statements; for comparison the total percentage of responses that had quoted an 8, 9 or 10 were taken for each statement.

Statement	Score of the best performing	Score of the remaining

	organisations	organisations
Decisions within your organisation are made at the lowest level possible. An important gauge could well be whether the number of organisations levels have shrunk in the previous two years	40%	19%
There persists a clear and definite clarity of vision within the organisation concerning the Lean transformation so that the organisation recognises what the structure will resemble once the transformation is complete	40%	24%
There is evident a strategy of change and one in which the organisation clearly communicates how the goals will be accomplished	54%	35%
It is clearly evident who is championing the Lean transformation internally	73%	48%
A Lean training programme is clearly visible within the organisation and forms part of an effective and visible learning environment which can be assessed using an appropriate performance index, i.e., training hours / total employees	44%	24%
The organisation makes a conscientious effort to maximise stability in a changing environment whereby an attempt is made to reduce, i.e., schedule changes, program restructures and procurement quantities	66%	36%

Table 4.27
Cultural analysis from the Survey Questionnaire

Intriguingly, ten similar statements (as depicted in Table 4.27) were included on the survey questionnaire. In 60% of cases the best performing organisations confirmed a higher score against each of the respective statements. This meant that the cultural conditions in these organisations were more conducive towards Lean. The questions had been chosen in order to decipher the prevailing culture of each organisation. Consequently, it was found that more of the factors regarded as essential for a successful Lean implementation existed within the better performing organisations.

4.2.6 Indices of the best performers

It has been outlined that the best performers were construed as a result of the stated performance on the balance scorecard devised. Nonetheless, it was interesting to construe interesting variations between the best performing fifteen organisations and the remaining companies. Primarily, if we were to observe the results provided on the scorecard of both sets of organisations, the performance gap between the organisations becomes quite transparent. Table 4.28A depicts the scorecard results for the remaining organisations:

Performance of the remaining group of organisations		
% deterioration	Actual measurement	
Finance	Earnings per share	5.1
	Current ratio - [current assets - current liabilities]	6.3

	Rate of return on capital employed	7.2
	Profit after interest and tax	10
		7.2
Customer	Market share by Product group	6.4
	Customer retention rate	10.7
	Responsiveness (customer defined)	11.3
	Service quality	12
	Customer satisfaction index	12.7
	On - time delivery (customer defined)	13.7
		11.1
Process	Material costs	9.8
	Time to market for new products	11.1
	Capital efficiency	11.1
	Quality ratings	11.6
	Quality costs	12
	Manufacturing costs	12.5
	Quality of new product development and project management processes	12.6
	NPD lead time	13.6
	Finished goods inventory	13.8
	Labour productivity	13.9
	Defects of critical products / components	14.1
	Stock turnover	14.3
	WIP materials inventory	15.7
	Raw material inventory	15.8
	Space productivity	15.9
	Cycle time	16
		13.4
People	Retention of top employees	3.5
	Health and Safety per employee :	5
	labour turnover	5.7
	Quality of professional / technical development	5.7
	Quality of leadership development	5.8
	absenteeism	7.3
	accidents	7.5
	Employee Perception surveys	8.7
		6.2
Future	New market development	7.4
	New technology development	8.4
	Anticipating future changes	8.9
	Depth and quality of strategic planning	11.9
	% sales from new products (< 5 years)	12
		9.7

Table 4.28A
Performance of remaining organisations

A similar exercise was undertaken for the highest performing fifteen organisations; to reiterate the factors used to gauge the performance was simply the responses received from all the organisations against the thirty-six individual indices which were appropriately grouped into the five distinct categories. Table 4.28B illustrates the results from the best performing organisations:

Performance of the highest performing fifteen organisations		
% deterioration	**Actual measurement**	
Finance	Earnings per share	6.0
	Current ratio - [current assets:current liabilities]	13.3
	Rate of return on capital employed	14.9
	Profit after interest and tax	19.5
		13.4
Customer	Market share by Product group	6.0
	Customer retention rate	13.3
	Service quality	25.9
	On - time delivery (customer defined)	40.2
	Responsiveness (customer defined)	45.0
	Customer satisfaction index	53.7
		30.7
Process	Capital efficiency	15.5
	Material costs	20.3
	Quality costs	23.2
	NPD lead time	24.0
	Quality of new product development and project management processes	24.3
	Manufacturing costs	25.7
	Labour productivity	25.7
	Finished goods inventory	25.7
	Quality ratings	26.0
	Space productivity	26.0
	Time to market for new products	26.3
	Cycle time	26.6
	WIP materials inventory	27.8
	Defects of critical products / components	31.1
	Raw material inventory	32.7
	Stock turnover	32.7
		25.9
People	Health and Safety per employee :	13.7
	Quality of professional / technical development	15.7
	Quality of leadership development	17.7
	Employee Perception surveys	19.3
	absenteeism	19.7
	accidents	20.3
	Retention of top employees	22.7
	labour turnover	23.0
		19.0
Future	New market development	20.7

	Anticipating future changes	**25.3**
	New technology development	**26.0**
	% sales from new products (< 5 years)	**30.3**
	Depth and quality of strategic planning	**30.7**
		26.6

Table 4.28B
Best performing organisations

Interestingly, if we are to further analyse the indices and instead of viewing the individual indices, an initial look at the average performance of each category, the ranking order for the remaining organisations was as follows:

i. Process 13.4%
ii. Customer 11.1%
iii. Future 9.7%
iv. Finance 7.2%,
v. People 6.2%.

Likewise, a similar exercise was undertaken for the highest performing organisations and their ranking order is depicted below:

i. Customer 30.7%
ii. Future 26.6%
iii. Process 25.9%
iv. People 19%
v. Finance 13.4%

From the above one can make certain significant deductions; the importance of the indices related towards the "customer" and the "future" reflected by their higher ranking in the better performing organisations is clearly evident. Many Lean initiatives are driven merely at the factory level (Liker, 2004) and we can observe how the "process" indices ranked the highest amongst the remaining organisations, whereas it rated third for the best performing organisations. This too is an important disclosure since it shows that the best performing organisations perform well when it comes to the "customer" and the "future" indices.

It was important to delve further into the individual indices. An exploration into the top seven separate indices reiterates this point pertinently; the seven highest performing indices for the remaining organisations was as follows and shown alongside is one of the five categories to which each belongs to:

i. Cycle time 16% - process category
ii. Space productivity 15.9% - process category
iii. Raw material inventory 15.8% - process category

iv.	WIP Inventory	15.7% -	process category
v.	Stock turnover	14.3% -	process category
vi.	Defects of critical components	14.1% -	process category
vii.	Labour productivity	13.9% -	process category

Furthermore, a similar exercise was undertaken on the group of organisations comprising the best performing organisations. In order to make a direct comparison, an exploration of the highest performing seven individual indices was also undertaken. These are depicted below alongside the categories to which each belongs to:

i.	Customer satisfaction	53.7% -	customer category
ii.	Responsiveness	45% -	customer category
iii.	On-time delivery	40.2% -	customer category
iv.	Stock turnover	32.7% -	process category
v.	Raw material inventory	32.7% -	process category
vi.	Defects of critical products	31.1% -	process category
vii.	Depth and quality of strategic planning	30.9% -	future category

Fascinatingly, the top seven indices for the remaining group of organisations all belonged to the "process" category; conversely a similar detailed investigation of the top seven indices quoted for the group of best performing organisations illustrates that they actually belonged to three different categories; namely "customer", "process" and "future".

Moreover, the top three indices in reality belonged to the "customer" category which reinforced the importance placed upon the actual customer by the better performing organisations. It was also revealing to establish that not only was the seventh highest individual performance measure; namely "*Depth and quality of strategic planning*" but that also the eighth individual highest performance measurement, "*% sales from new products (< 5 years)*" also belonged to the "future" category. Essentially this helped to prove that the better performing organisations paid particular consideration towards ensuring that their position of representing a superior performance was actually maintained. This also strengthened the case for the scorecard since it implies that an organisation hoping to continue to perform well needs to pay attention towards its future strategy too. The key premise is that measuring the success of an organisation using only one time dimension may be misleading; short term corporate success, i.e., sales and cash position, may alter during the following quarter or year. The ability to view the future and define additional needs before competitors and customers are also critical success measures.

4.3 Factors influencing performance of each organisation

It was important to try and identify factors which contributed to the exceeded performance levels of the fifteen organisations; evidently, a cocktail of performance measures are required to accurately assess if an organisation has been successful through its decision to adopt Lean. In order to statistically verify the causal influences, discriminant analysis was undertaken using both the spearman and Pearson Rho correlation; the results are analysed in Table 4.29:

			Gtotal	Small / Medium/ Large organization
Kendall's tau_b	Performance	Correlation Coefficient	1.000	.431*
		Sig. (2-tailed)	.	.044
		N	15	15
	Small/Medium/Large organization	Correlation Coefficient	.431*	1.000
		Sig. (2-tailed)	.044	.
		N	15	15
Spearman's rho	Performance	Correlation Coefficient	1.000	.564*
		Sig. (2-tailed)	.	.028
		N	15	15
	Small/Medium/Large organization	Correlation Coefficient	.564*	1.000
		Sig. (2-tailed)	.028	.
		N	15	15
***. Correlation is significant at the 0.05 level (2-tailed).**				

Table 4.29
Rho Correlation analysis

Both Pearson and Spearman rho were used to make a judgement in order to identify the main factors considered to have contributed towards a better performance. The Kendall's tau test was used to identify factors contributing to the exceeding performance levels; Kendall's tau potentially indicated a significant difference in regards the performance factor (tau=0.431, N=15, $p<0.05$). In order to acquire added reliability and consistency the spearman's rho test was undertaken too; the spearman's rho test proceeded to confirm a considerable and significant difference (rho=0.564, $p<0.05$). In order to further clarify this point, supplementary analysis was undertaken with the intention to substantiate the main factors which could be easily identified as the causal influences acting as triggers towards the enhanced performance levels of some organisations. The causal measures become the result measures; in other words, examining this from the organisation's perspective, the value stream measures are tantamount to the causal measures. Alternatively, from a value stream's perspective, they become the result measures. This approach ensures that the performance goals and measures are linked and cascade from the strategy down to the value stream and to the cell.

Nonetheless, it should be recognised, every organisation is unique and needs to employ a framework intended to achieve its own strategic aspirations. Accordingly, if a strategic goal is to increase cash and sales flow by 25%, these have to expand at the value stream level, i.e., "sales per person" needs to increase by 25%. Furthermore, the standard work and cycle time in the process has to permit this increase in productivity. If the bottleneck, cell or process cannot accommodate this, the strategic goal will not be achieved. The measures need to identify the cell performances, in case one needs to be brought back into control; there exist a trigger in place to facilitate this process. The organisation needs to look at the Cell level measures; the type of indices that could be chosen are:

- Day-by-hour-report which analyses the work needed each hour,
- First time through quality and
- OEE.

Equally, the value stream measures need to examine how well the value stream is proceeding towards the performance targets designed for the future state market. Examples of the value stream measures are:

- Sales per person which looks at shipments compared to the people in the value stream,
- Average cost per unit examines the cost per person in the value stream, and
- First time through quality.

Table 4.30 lists those factors acknowledged from the Survey questionnaire analysis over the whole spectrum of organisations which were regarded to have influenced the performance levels of organisations.

Significant factors towards the overall performance of the organisation
Aspirations of higher profitability
Aspirations of improving the supply chain management
Aspirations of improved teamwork
Aspirations of improved employee performance
Aspirations of improved market share
Aspirations of increased competitiveness
Aspirations of elimination of waste
Applied the Kanban systems
Applied the Supplier base reduction
Applied the Attacking value and the seven wastes
Applied the Single piece flow operations time
Applied the Process mapping time

Table 4.30
Factors affecting organisational performance

Interestingly, the preceding investigation regards viewing Lean as a philosophy coupled with the literature suggests that for an organisation to view Lean as a philosophy requires a combination of factors to be in existence. Financial measures show the results of operations that occurred in the past; Lean organisations need to focus on the causes of desired results. The theme of the investigation focused on the "*leading indicators*", (Gautreau et al., 2001, page 153) such as cycle time that influence "*lagging indicators*" (Gautreau et al., 2001, page 153) that measures outcomes such as profits. Consequently, to achieve the value stream performance objectives such as lower lead times and greater productivity, companies need to undertake a program that alters the causal factors that contribute to the downstream goals. The DMP model builds upon the Balanced Scorecard by recognising the importance of establishing cause-and-effect relationships; if improved operational performance fails to improve financial performance, this indicates that the chain of cause-and-effect has not been established correctly and needs revision. Any organisation pursuing the Lean journey needs to adopt this quest. Consequently, the measures need to

- Reflect the Lean philosophy,
- address the improvements in the value stream
- encourage the adherence to standards, and
- ensure that the cell and value streams are linked towards the corporate objectives.

In the list depicted in Table 4.30, not only are the tools listed, which ideally approximately five or more would be required to be applied simultaneously at any stage of the implementation process; namely the:

- elimination of waste
- kanban systems
- supplier base reduction,
- single piece flow operation, and
- Process mapping.

Equally, there would be needed some significant cultural factors to be evident should any organisation aspire towards viewing Lean as a philosophy; namely:

- improved teamwork and
- Improving the supply chain management whereby the suppliers are not treated as adversaries.

Moreover, it is important to reiterate that the decision to embrace Lean should always be viewed as a business philosophy too; the best performing organisations also reflected the importance of:

- higher profitability,
- improved employee performance,

- improved market share,
- increased competitiveness and
- constant waste reduction.

The base line is that markets, technology, people and money all need to be attended to for a business to be successful.

4.4 Scorecard utilised in the analysis

A performance model was adapted in order to gauge the impact of Lean on organisations. A brief justification is initially presented for this decision followed by an explanation of the framework itself. Lean organisations need to be careful that their performance improvement activities are not just a numbers driven exercise. Equally, if the performance improvements are going to be meaningful, they ultimately need to result in some type of financial benefits to the respective organisation too. To avoid a non-value adding exercise, it is also important to only track meaningful projects. Ideally, the reported savings should be classified in to four categories:

- Tangible monies such as additional revenue as a result of new products or customers. Likewise, net savings need to be recognised only if, for example, time saved is utilised effectively on some new activity. Likewise, when concentrating on poor quality, the savings would include scrap reduction, reduced defects or warranty costs,
- Intangible benefits whilst the most difficult to quantify since they often need to be converted into demonstrable savings. Faster cycle times may have resulted through reduced set-up times. A direct saving would be whereby we could state the freed-up time is being used to produce additional products. Consequently, a calculation may be "*Number of minutes saved "x" by cost/hour of the production for that product*". Freed –up engineering or sales time could also be tracked provided the additional time is used elsewhere. Freed-up indirect time such as material handling, bill processing can be calculated too; "*cost of indirect time "x" hours saved*",
- Reductions in invested capital include those specific to the project such as specific part numbers and specific regions,
- Cost avoidance is also notoriously difficult to quantify. A point of caution is that this category can be abused. However, avoidance benefits are important and lead to strong emotive arguments. Real avoidance benefits could include:
  - safety problems,
  - losing a customer – customer retention,
  - environmental disasters,
  - Government compliance problems.

4.4.1 The Dynamic Multi-dimensional Performance model [DMP]

Whilst the Balanced Scorecard and the Success Dimensions models were seen as a major breakthrough in assessing organisational performance, both are prone to limitations. The Balanced scorecard was incomplete (Atkinson et al. 1997) because it fails to:

- emphasize sufficiently the contributions employees and suppliers make towards assisting an organisation to achieve its objectives,
- recognize the role of the community in monitoring the environment in which the company works,
- identify performance measures to assess stakeholders contributions (Smith, 1998),
- Distinguish between means and ends which is not very well defined; there exists no clear provision for very long term measures.

Moreover, while the "Success Dimensions" approach provides a framework over very short and very long-standing time frames, its primary limitation is that no specific operational measures are provided for any dimension. Equally, that the constructs "strategic leverage" and "creating the future" (page 190), do not easily translate into quantifiable variables for organisations (Maltz et al., 2003). Moreover, the 1996 model (Shenhar and Dvir's 1996) whilst having been empirically tested at the strategic business unit and project levels, it has not been tested at the corporate level. The lack of focus on an organisation's human capital is probably the main weakness of both the Balanced Scorecard and the Success Dimensions Models (Teach, 1998). Several companies (Strecker, 1999) have noticed the lack of people orientation in the Balanced Scorecard; Best Foods, now part of Unilever, for instance, has been using the Balanced Scorecard for years, but felt it necessary to add a fifth dimension "people development" (page 190). Another important rationale for utilising the proposed DMP framework for Lean enterprises is that it is a natural augmentation of the "Balanced Scorecard" and "Success Dimensions" (Shenhar and Dvir's 1996) models. The DMP examines various research streams, such as corporate entrepreneurship, strategy, process, product development, marketing, economics and finance.

One of the main contributing factors in the decision to utilise the DMP framework as a foundation evolves around the model's ability to explore the dynamic progression, representing multiple time horizons. This system had been promoted several years earlier (Hepworth, 1998). Recent estimates, (Silk, 1998), indicate that 60% of the Fortune 1000 companies either currently have or are experimenting with the balanced scorecard which means that there is considerable scope to utilise the principles of DMP. In order to combine the above into the Lean philosophy, the overriding consideration remains value (Rich, 2003;

Shah et al., (2003); Womack et al., 2003). The literature (Bicheno, 2004), views activities as either:

- value creating,
- non-value creating but unavoidable with present technologies or methods, and
- pure waste.

Consequently the issue of waste remains paramount and needs to be addressed through:

- process waste, i.e., changeover times,
- business waste, i.e., that which benefits managers,
- pure waste;

the latter needs to be eradicated and the former two minimised.

In direct reference to a Lean enterprise there exists a precedent for establishing performance measures (Dimancescu et al., 1997); a well crafted score card was promoted to be reviewed quarterly by management which embraces the following measures:

- earnings before tax and interest,
- the return on net assets,
- gross sales achieved,
- market share by product groups,
- quality ratings,
- price to product performance ratios,
- delivery performances,
- the defect rates on critical products / components,
- Health and Safety ratios per employee, i.e.,
  - accidents,
  - absenteeism and
  - labour turnover and
- employee satisfaction ratings.

The literature, (Sanger, 1998; Marshall et al., 2004 and Tangen, 2005), advocates caution since the application of the balanced scorecard requires a comprehensive understanding of the principles involved and significant commitment towards accepting the new philosophy. Many maintain (Gautreau et al., 2001) that the success measures should not be seen as an end in themselves but as a mechanism to direct future action.

4.4.2 The assessment for Lean

Consequently, the performance measures in assessing whether an organisation was successful as a result of adopting Lean espoused the DMP framework embracing the five dimensions together with the other guidelines offered (Kaplan and Norton, 1992, 1993, 2005; Bond, 1999; Wade, 1997 and Dimencescu et al., 1997). The following performance categories were used in line with the DMP framework (Maltz et al., 2003):

- financial,
- customer led indices,
- process,
- people and
- parameters looking at the organisation's future prospects.

However, to view Lean as a philosophy rather than a process, both technical and cultural viewpoints need addressing. Consequently, Table 4.31 depicts the template used to assess the impact of Lean on the organisation. The DMP framework has various characteristics which taken together distinguish it from other frameworks and addresses certain limitations of previous models. A major contributory factor is its multi-dimensional perspective, which accordingly offers a more comprehensive view of what organisational success truthfully means. Equally, the DMP framework depicts sufficient flexibility to be used by different organisations in different industries. The five major success dimensions (Maltz et al., 2003) serve as an integrated framework for looking at an organisation's overall performance. Whilst its relative importance may alter, the framework provides a solid foundation for assessing whether or not an organisation is successful.

Financial	Profit after interest and tax
	Rate of return on Capital employed
	Current ratio
	Earnings per share
Customer / Market measures	Market share by product group
	Customer satisfaction index
	Customer retention rate
	Service quality
	Responsiveness [customer defined]
	On-time delivery [customer defined]
Process	NPD lead time
	Cycle time
	Time to market for new products
	Quality of New product development and project management processes
	Quality costs
	Quality ratings
	Defects of critical products / components
	Material costs
	Manufacturing costs
	Labour productivity
	Space productivity

	Capital efficiency
	Raw material inventory
	WIP inventory
	Finished goods inventory
	Stock turnover
People	Employee perception Surveys
	Health and Safety per employee: - accidents - absenteeism - labour turnover
	Retention of top employees
	Quality of professional /technical development
	Quality of leadership development
Future	Depth and quality of strategic planning
	Anticipating future changes
	New market development
	New technology development
	% sales from new products

Table 4.31
Performance template

Table 4.31 provides the proposed Balanced Score Card along with the 36 individual indices split between the five categories. There is also a generic appeal about the measures employed as they can be applied to quite disparate organisations. Whilst the implementation of a comprehensive performance measurement system is not simple, the DMP framework provides a good barometer for multiple time horizons and facilitates the examination of a wider view of organisational success.

4.4.3 Case Study analysis

As part of the data capture undertaken in the case studies both managers and shop floor representatives were asked to complete questionnaires and participate in interview schedules. These took the format as summarised below and an important factor involved the feedback received regards their perception in reference to the impact of Lean on their respective organisations. The scorecard was used to deduce this feedback; the personnel involved in providing their observations were as follows:

- two managers interviewed in a semi-structured manner using interview schedules (appendix five),
- two shop floor operatives interviewed in a semi structured manner again utilising interview schedules (appendix seven),
- two different managers were requested to complete a questionnaire (appendix six),
- two different shop floor operatives were also asked to complete a questionnaire (appendix eight).

Table 4.32 provides as summary of all the operatives responses received from the questionnaires used in the seven case studies regards the impact of Lean on their organisation:

Actual measurement	AVERAGE % IMPROVEMENT
Company share prices	2.9
Has more cash available	6.4
Company profitability	6.8
Average Finance	5.3
Market share	5.4
Better relationship with customers	7.9
Better satisfied customers	8.9
Delivery records	10.0
Service quality	10.0
Average Customer	8.4
NPD lead time	4.6
Overall Cycle time	5.4
Quality of new product development	6.8
Quality Costs	8.2
Raw material costs	8.6
Finished stock	9.6
Average Process	7.2
Absenteeism	1.8
Labour turnover	3.2
The relationship between management and the shop-floor	3.2
Better communications	3.9
Average People	3.0
Sales from new products (< 5 yrs)	2.5
Looking for new markets	3.9
Investment in new technology	3.9
New product development	3.9
Average Future	3.6

Table 4.32
Operatives questionnaire views on Lean Successes

Furthermore, a different set of operatives were questioned utilising a Shop-floor interview schedule; Table 4.33 provides as summary of all the operatives responses received from the interview schedules used in the seven case studies regards the impact of Lean on their organisations:

Actual measurement	AVERAGE % IMPROVEMENT
Company share prices	3.9

Company profitability	**6.8**
Has more cash available	**8.2**
Average Finance	**6.3**
Market share	**4.6**
Better relationship with customers	**10.4**
Service quality	**12.1**
Delivery records	**12.1**
More satisfied customers	**12.5**
Average Customer	**10.3**
NPD lead time	**6.8**
Overall Cycle time	**7.1**
Quality of new product development	**7.9**
Quality Costs	**9.6**
Raw material costs	**12.1**
Finished stock	**12.5**
Average Process	**10.2**
Labour turnover	**0.7**
Absenteeism	**2.9**
The relationship between management and the shop-floor	**3.6**
Better communications	**5.0**
Average People	**3.0**
Looking for new markets	**2.1**
New product development	**2.5**
Sales from new products (< 5 years)	**3.2**
Investment in new technology	**6.4**
Average Future	**3.5**

Table 4.33
Operatives interviewed on the Lean Success

It was decided that responses to some indices would not be sought from the shop-floor; namely:

- earnings per share,
- NPD lead time,
- Capital efficiency,
- Labour efficiency,
- WIP stock,
- Defects of critical products / components and
- Quality of leadership development and anticipating new changes.

This was only undertaken with view to the information required and it was considered that the management representatives answering both the questionnaires (Table 4.34) and the interview schedules (Table 4.35) were better equipped to respond to these queries. Managers were also asked what Lean had attained within their respective organisations; the questionnaire results are summarised in the Table 4.34 and the interview schedules results in Table 4.35.

Actual measurement	% IMPROVEMENT
Earnings per share	1.8
Company share prices	4.3
Company profitability	8.2
Company liquidity	8.9
Average Finance	5.8
Market share	4.6
Service quality	9.6
Better relationship with customers	10.7
More satisfied customers	11.8
Delivery records	11.8
Average Customer	9.7
Labour efficiency	7.5
Capital efficiency	8.9
NPD lead time	9.3
Raw material costs	10.4
Overall Cycle time	10.7
Quality of new products	12.1
Finished stock	12.1
WIP stock	12.1
Quality Costs	12.5
Defects of critical products/components	12.5
Average Process	10.8
Labour turnover	1.4
Quality of Leadership development	1.4
Absenteeism	1.8
The relationship between management and the shop-floor	5.4
Better communication	6.1
Average People	3.2
Anticipating new changes	1.1
Sales from new products (< 5 yrs)	2.9
Looking for new markets	5.4
Investment in new technology	5.4
New product development	6.1
Average Future	4.2

Table 4.34
Managers questionnaire regards Lean Success

Table 4.35 provides a summary of the responses received from a different set of managers and this data was captured utilising interview schedules:

Actual measurement	% Improvement
Earnings per share	2.5
Company share prices	2.9
Company profitability	8.6
Company liquidity	10.4
Average Finance	6.1
Market share	7.5
Service quality	12.9
Delivery records	13.6
Better relationship with customers	13.6
More satisfied customers	15.4
Customer Average	12.6
NPD lead time	7.5
Quality of new products	8.9
Overall Cycle time	9.6
Quality Costs	10.4
Capital efficiency	11.1
Labour efficiency	11.8
Raw material costs	12.1
Finished stock	14.6
WIP stock	14.6
Defects of critical products/components	15.7
Average Process	11.6
Absenteeism	1.4
Labour turnover	2.1
Quality of Leadership development	4.6
Better communication	6.1
The relationship between management and the shop-floor	6.8
Average People	4.2
Anticipating new changes	2.1
Sales from new products (< 5 yrs)	2.5
Looking for new markets	4.3
New product development	5.4
Investment in new technology	6.4
Average Future	4.1

Table 4.35
Managers interviewed regard the Lean Successes

Fascinatingly, both the shop floor and managers felt Lean had improved their respective organisations' competitiveness. Some variation existed regards which performance indices were deemed to have performed better though the overall conclusion was that Lean had resulted in making their organisations stronger. This consensus indicates that once Lean has been implemented, the general response towards it is positive from both the operatives and the managers' perspective.

4.4.4 Survey Questionnaire

Equally the sixty eight organisations that participated in the survey simply substantiated the impact of Lean; this is depicted in Table 4.36:

	Actual measurement	% AVERAGE
Finance	Earnings per share	5.3
	Rate of return on capital employed	7.8
	Current ratio [current assets - current liabilities]	8.9
	Profit after interest and tax	12.1
	Average Finance	8.5
Customer	Market share by Product group	8.0
	Customer satisfaction index	15.6
	Customer retention rate	17.5
	Service quality	18.2
	Responsiveness (customer defined)	18.2
	On - time delivery (customer defined)	20.6
	Average Customer	16.4
Process	Quality of new product development and project management processes	12.1
	Material costs	12.1
	Time to market for new products	14.5
	Manufacturing costs	14.5
	Capital efficiency	14.8
	NPD lead time	15.2
	Quality costs	15.4
	Quality ratings	15.9
	Finished goods inventory	16.5
	Space productivity	16.5
	Cycle time	17.9
	Defects of critical products / components	18.1
	Raw material inventory	18.3
	Labour productivity	18.4
	WIP materials inventory	18.4
	Stock turnover	19.5
	Average Process	16.1
People	Health and Safety per employee :	6.9
	Retention of top employees	7.8
	Quality of prof / technical development	7.9
	accidents	8.4
	Labour turnover	9.5
	Quality of leadership development	10.0
	absenteeism	10.3
	Employee Perception surveys	11.1
	Average People	9.0
Future	Depth and quality of strategic planning	10.4

	Anticipating future changes	**12.3**
	New market development	**12.5**
	New technology development	**16.0**
	% sales from new products (< 5 yrs)	**16.0**
Average Future		**13.4**

Table 4.36
Survey responses regard the Lean successes

Once again all indices showed a positive impact of Lean on the organisation. Whilst the ranges varied within few of the indices the overwhelming message was that Lean had proven to be a positive impact on all the indices outlined.

4.5 The principal indices

Supplementary detailed analysis was considered imperative in order to deduce which of the individual performance indices contributed to the overall performance of the respective organisations. Consequently, statistical analysis was undertaken to investigate the correlation of the individual indices against the overall performance of the organisation. The following were highlighted as the most significant factors:

	Correlation	**Significance**
• Profit after interest and tax,	0.6	0.000
• Rate of return on capital employed,	0.7	0.000
• Current ratio (current assets: current liabilities),	0.6	0.001
• Customer satisfaction index,	0.6	0.001
• Customer retention rate,	0.6	0.000
• Responsiveness (customer defined),	0.5	0.000
• Defects of critical products/components	0.6	0.002
• Employee Perception surveys,	0.6	0.001
• Retention of top employees,	0.6	0.001
• Quality of leadership development,	0.6	0.001
• Depth of quality and strategic planning	0.6	0.001
• Anticipating future changes	0.5	0.002
• New market Development	0.5	0.001
• New Technological Development	0.5	0.001
• % of Sales from new products	0.6	0.002

A vitally important factor was confirmed by the above analysis regards the importance portrayed by the non-financial facet; whilst three pointed towards the core accounting indices; namely the profit after interest and tax, rate of return on capital employed and the current ratio (current assets - current liabilities) they were not considered to be any more important than many of the others listed. Another important deduction was the relevance of all the five categories listed since there are individual indices representing each of the five categories. This essentially, confirms that for an organisation to achieve a good performance, it needs to excel in each category.

It was necessary to confirm these findings in order to ensure that the results were conclusive. To accomplish this, an attempt was made to discover the association between the average for each category and the main performance figure for each respective organisation. As explained previously, the overall performance figure considered to reflect an accurate representation of an organisation's overall performance was the sum of the averages of the five categories listed in Table 4.37. Accordingly, further statistical analysis was undertaken to deduce the correlation between the average performance for each category and the overall performance for each organisation; the results are depicted in Table 4.37:

Relationship between the Average performance of each group and overall performance		
Category	**Correlation**	**Significance level**
Finance	0.7	0.001
Customer	0.7	0.002
Process	0.6	0.000
People	0.5	0.003
Future	0.7	0.001

Table 4.37
Association of average category and overall Performance

Remarkably, the association between the category average and the overall average was consistently strong proving that for an organisation to perform admirably; it certainly needs to excel in each category.

4.5.1 Relationship between the performance indices

Auxiliary meticulous analysis was undertaken to discover the relationship between the indices to achieve an insight into the key performance boosting indices. Spearman's Rho was used in small, medium and large organisations. Owing to the complex nature of the performance factors, an average figure was used for each category of indices; overall the five categories were as depicted in Table 4.37. Most revealing results were discovered in reference to the relationship between the indices. Initially for small organisations, as depicted in Table 4.38 there was a strong relationship between the following set of indices:

SMALL companies	Performance average			
	Finance Average	Customer Average	Process Average	People Average
Customer-Average	0.929			
Sig. (2-tailed)	0.0001			
Process-Average	0.833	0.880		
Sig. (2-tailed)	0.001	0.0001		
People-Average	0.602	0.660	0.748	
Sig. (2-tailed)	0.038	0.020	0.005	
Future-Average	0.502	0.629	0.253	0.393
Sig. (2-tailed)	0.096	0.028	0.427	0.207
N	12	12	12	12

Table 4.38
Relationship of performance within Small Companies

Similarly, for the medium sized organisations; the only strong relationship was found between the customer and the future indices as illustrated in Table 4.39

MEDIUM COMPANIES	Performance average			
	Finance Average	Customer-Average	Process-Average	People-Average
Customer-Average	0.419			
Sig. (2-tailed)	0.106			
Process-Average	0.010	0.323		
Sig. (2-tailed)	0.970	0.223		
People-Average	0.450	0.473	0.518	
Sig. (2-tailed)	0.080	0.064	0.040	
Future-Average	0.549	**0.614**	0.099	0.353
Sig. (2-tailed)	0.028	0.011	0.715	0.180

Table 4.39
Relationship of performance within medium Companies

Likewise a similar exercise was undertaken for the large organisations; the only relation found was that between the process and the customer indices as reflected in Table 4.40:

LARGE COMPANIES	Performance average			
	Finance-Average	Customer-Average	Process-Average	People-Average
Customer-Average	0.041			
Sig. (2-tailed)	0.804			
Process-Average	-0.054	**0.755**		
Sig. (2-tailed)	0.739	0.000		
People-Average	0.305	0.236	0.220	
Sig. (2-tailed)	0.056	0.142	0.172	
Future-Average	0.395	0.261	0.140	0.358
Sig. (2-tailed)	0.028	0.011	0.715	0.180

Table 4.40
Relationship of performance within Large Companies

There was a huge difference between small, medium and large organisations. For the medium sized organisations there was only one strong correlation; namely between the "customer" and the "future" sets of indices; for the larger organisations there was only one strong association found too; namely between the "customer" and the "process" sets of indices. However, for the small organisations there was a strong link between the following sets of indices:

- finance and customer: 0.929 correlation
- finance and process: 0.833 correlation
- finance and people: 0.602 correlation
- customer and process: 0.880 correlation
- customer and people: 0.660 correlation
- customer and future: 0.629 correlation
- process and people: 0.748 correlation

It was recognised that an overall correlation for the entire 68 organisations may provide a stronger statistical consensus and from which it would be possible to recognise the strong relationships between the sets of indices. Fascinatingly, when an analysis was undertaken for the overall 68 organisations, high and positive correlations (Pearson's) were found between the following as illustrated in Table 4.41; the table confirms the results specified earlier which indicated the most valuable performance indices.

All organisations	**Performance average**			
	Finance-Average	**Customer-Average**	**Process-Average**	**People-Average**
Customer-Average	0.37			
Sig. (2-tailed)	0.001			
Process-Average	0.46	0.64		
Sig. (2-tailed)	0.001	0.001		
People-Average	0.55	0.62	0.71	
Sig. (2-tailed)	0.001	0.001	0.001	
Future-Average	0.60	0.66	0.50	0.72
Sig. (2-tailed)	0.001	0.001	0.001	0.001

Table 4.41
Relationship of performance for all Companies

Tables 4.38 - 4.40 transmitted the importance of the non-finance indices. If Table 4.41 is used since it provides a better indication as it represents every organisation surveyed; the relationship of:

- Finance and future and
- The process indices and people is evident, but the
- Customer indices had a high correlation with process, people and future, whereas the

- Future indices besides the finance and the customer indices also had a strong relationship with the people indices.

Consequently the conclusion could be made that the most important indices affecting the overall performance of any organisation and in ranking order are as follows:

i. Future
ii. People and
iii. Customer indices.

This is enormously revealing since it shows the impact of the non-finance indices.

4.6 The Lean Audit results

As indicated earlier an extensive Lean Audit was undertaken in twenty companies between June 2007 and July 2008. A thorough, Discriminant analysis (Tests of Equality of Group Means) and Correlation analysis (using Spearman's Rho test) was performed in order to reveal the distinguishing factors in which the five best performing companies stood out from the others. From the audit undertaken, a maximum of 1,040 points could be scored by an organisation in an assessment covering twelve areas as explained in the next chapter. For explanation purposes the Table 4.42 outlines the seven stages of Lean the analysis advocates and the fundamental characteristics signifying each juncture. Table 4.43 illustrates how the scores have been divided amongst the professed seven phases of Lean:

Stages of a Lean Journey	
Seven Stages	**Indicative organisational characteristics**
Planning	No implementation; benefits evident but no infra-structure and no organisational decisions implemented
Developmental	Implementation started; pilot area selected and work commenced; no roll out; few tools with little subsequent commitment; may have been implemented in other areas; importance of culture not recognised
Mechanical	Pilot progressing well; few tools embedded within internal organisation but largely within manufacturing only; tools are implemented in a piecemeal fashion with little consideration of correlations; importance of culture not recognised
Enhanced	Pilot proven successful; roll out programme progressing in other key areas within internal organisation; predominantly manufacturing based; recognition that culture and organisational practices need addressing but few tangible signs visible towards accomplishing this
Holistic	Roll out programme on track; internal organisation nearly incorporated; suppliers embraced and signs towards integration of the whole value chain; organisational and culture developments still in their infancy
Innovative	Lean principles applied across the whole internal organisation; progress in integrating across the entire value chain; some cultural and organisational development issues fully embedded but further progress required; ingrained as a strategy

Ideological	Lean tools, culture and organisational practices alongside the ideology implemented across every component of the value chain; recognised as a combination of value streams, Lean viewed as the way of working with a quest for perfection apparent

Table 4.42
Lean Stages Clarified

Lean Assessment scoring system		
Lean stage	**Required Points**	**% of the maximum score of 1,040 points available**
Ideological	**936**	**>90%**
Innovative	**780**	**>75%**
Holistic	**624**	**>60%**
Enhanced	**468**	**>45%**
Mechanical	**312**	**>30%**
Developmental	**156**	**>15%**
Planning	**0 – 155**	**0% - 15%**

Table 4.43
Audit Scores

The thorough analysis was undertaken to pilot the Lean audit questionnaire; the best five performing companies from a sample of n=20 in the Lean Audit are depicted in Table 4.44 along with the scores they secured on the Lean audit:

The best performing audited organisations		
Organisation	**Audit Score**	**Lean stage achieved**
Vauxhall motors	78%	Innovative
Unilever	73%	Holistic
Corus Colours	67%	Holistic
Ina Bearing	64%	Holistic
Excel Electronics	61%	Holistic

Table 4.44
Best Performing audited organisations

4.6.1 Discriminant analysis of the top five audited organisations

A discriminant analysis finds the linear combination of features which best separate two or more classes of objects or events. It was necessary to reveal the distinguishing factors for the best performing companies. As a preamble the mean and standard deviation was undertaken for the twenty organisations audited and is summarised in Table 4.45:

		Mean	**Std. Deviation**	**Valid N (listwise)**	
Rest of companies	Turnover of the group last year	2.87	1.19	15	

	Number of employees	1298.53	1356.04	15	
	Aggregate gross assets	2.53	0.74	15	
	Lean Stage	4.33	0.82	15	
	TOTAL SCORE	471.53	119.04	15	
	PERCENTAGE AVERAGE	45.35	11.43	15	
	Overall safety, cleanliness and orderliness	18.13	4.42	15	
	Production and operational flow	27.67	6.83	15	
	Processes and operations	48.20	10.33	15	
	Visual management	26.27	6.64	15	
	Quality designed into the product	65.60	17.96	15	
	Continuous improvement	43.33	12.86	15	
	Lean change strategy	53.60	15.59	15	
	Lean sustainability	33.60	12.21	15	
	Culture employee oriented	40.67	9.19	15	
	Culture - organisational practises	51.80	14.86	15	
	Lean treated as a business	33.40	10.68	15	
	Philosophy	29.27	8.71	15	
	Number of employees	2.07	0.80	15	
Best 15	Turnover of the group last year	2.60	1.34	5	
	Number of employees	719.60	928.88	5	
	Aggregate gross assets	2.00	1.00	5	
	Lean Stage	2.80	0.45	5	
	TOTAL SCORE	703.60	80.68	5	
	PERCENTAGE AVERAGE	67.66	7.76	5	
	Overall safety, cleanliness and orderliness	21.60	2.70	5	
	Production and operational flow	32.60	6.31	5	
	Processes and operations	58.20	14.62	5	
	Visual management	35.40	2.61	5	
	Quality designed into the product	84.80	10.43	5	
	Continuous improvement	58.00	13.04	5	
	Lean change strategy	81.60	10.45	5	
	Lean sustainability	52.80	3.49	5	

	Culture employee oriented	67.80	5.93	5	
	Organisational culture - organisational practises	89.00	9.46	5	
	Lean treated as a business	64.80	6.76	5	
	Philosophy	57.00	7.62	5	
	Number of employees	1.80	0.84	5	
Total	Turnover of the group last year	2.80	1.20	20	
	Number of employees	1153.8	1265.99	20	
	Aggregate gross assets	2.40	0.82	20	
	Lean Stage	3.95	1.00	20	
	TOTAL SCORE	529.55	149.81	20	
	PERCENTAGE AVERAGE	50.93	14.40	20	
	Overall safety, cleanliness and orderliness	19.00	4.28	20	
	Production and operational flow	28.90	6.90	20	
	Processes and operations	50.70	11.97	20	
	Visual management	28.55	7.10	20	
	Quality designed into the product	70.40	18.26	20	
	Continuous improvement	47.00	14.15	20	
	Lean change strategy	60.60	18.89	20	
	Lean sustainability	38.40	13.60	20	
	Culture employee oriented	47.45	14.66	20	
	Organisational culture - organisational practises	61.10	21.32	20	
	Lean treated as a business	41.25	16.98	20	
	Philosophy	36.20	14.83	20	

Table 4.45
Basic Data of the audited organisations

Most enlightening results were found based on Wilk's Lambda and related to the strategies:

- Overall safety, cleanliness and orderliness (λ=0.870),
- Production and operational flow (λ=0.899); and
- Processes and operations (λ=0.862)

showed to be not different for the best performing group of companies (which means they are common characteristics only for the five best), and may be a distinguishing factor in which these five organisations differed from the other companies. The tests of equality are summarised in Table 4.46. Within-groups variance is a measure of dispersion around the mean, equal to the sum of square deviations from the mean divided by one less than the number of cases. Tolerance is a statistic that determines how much the independent variables are linearly related to one another. In practice these variables should not be considered (tolerance is greater than 0.001) but with the exception of these, the percentage average was valid (0.0001).

Best performing companies	**Wilks' Lambda**	**F**	**df1**	**df2**	**Sig.**
Lean Stage	.535	15.661	1	18	**.001**
TOTAL SCORE	.526	16.197	1	18	**.001**
PERCENTAGE AVERAGE	.526	16.214	1	18	.001**
Overall safety, cleanliness and orderliness	.870	2.678	1	18	.119
Production and operational flow	.899	2.022	1	18	.172
Processes and operations	.862	2.873	1	18	.107
Visual management	.673	8.742	1	18	**.008**
Quality designed into the product	.782	5.024	1	18	**.038**
Continuous improvement	.788	4.848	1	18	**.041**
Lean change strategy	.566	13.786	1	18	**.002**
Lean sustainability	.607	11.658	1	18	**.003**
Culture employee oriented	.324	37.530	1	18	**.000**
Organisational culture – organisational practises	.399	27.072	1	18	**.000**
Lean treated as a business	.325	37.381	1	18	.000**
Philosophy	.310	40.154	1	18	.000**

Table 4.46
Wilk's Lambda

[** Due to the high Within-Groups Variance (a measure of dispersion around the mean), the significance in the Discriminant Analysis should not be considered for these variables.]

A Summary of Canonical Discriminant Functions Wilks' Lambda is provided in Table 4.47:

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	**.013**	43.817	16	**.000**

Table 4.47
Wilk's Lambda Summary

Wilk's Lambda is a multivariate test of significance (also called U statistic); Lambda ranges between 0 and 1, with values close to 0 indicating the group means are different and values close to 1 indicating the group means are not different.

4.6.2 Spearman's Rho Correlations

Based on the same assumptions the most important correlations from the Lean Audit supporting the previous Discriminant Analysis were in fact discovered for the following strategies:

- Lean sustainability ($r=0.673$; $p \leq 0.001$),
- Culture employee oriented ($r=0.753$; $p \leq 0.0001$),
- Organisational culture - organisational practises ($r=0.731$; $p \leq 0.0001$),
- Lean treated as a business ($r=0.752$; $p \leq 0.0001$),
- Philosophy ($r=0.731$; $p \leq 0.0001$) and
- Lean change strategy ($r=0.652$; $p = \leq 0.002$).

The above reflected significantly high correlations with the best performing group of companies. Essentially, what this result shows is that in the Lean Audits undertaken, the five best performing organisations demonstrated high correlations with the predominant components deemed as pre-requisite should an organisation have genuine aspirations of viewing Lean as a philosophy. These are factors which would facilitate an authentic and wider adoption of Lean which ultimately could suggest that the organisation is adopting Lean as a philosophy; namely:

- sustainability,
- culture,
- needing to treat Lean as a profitable commercial initiative too,
- Lean change strategy and the
- philosophy indices themselves.

Interestingly, whilst technical tools are vital for Lean success, the correlations were not particularly significant for the following categories as depicted in Table 4.48:

Category of indices	Correlation Coefficient
Production and operational flow	0.321
Processes and operations	0.391
Quality designed into the product	0.391
Continuous improvement	0.451

Table 4.48
Correlation coefficient

4.7 Supplementary analysis

4.7.1 Perception of Lean

Within the seven Case Studies it was interesting to gauge what both managers and operatives felt the impact of Lean would mean for them on a purely personal level; the results are summarised in Tables 4.49 and 4.50; (A Scoring scale was offered whereby 1 = strongly agree; 5 strongly disagree with the statement)

Shop floors view of Lean on a purely personal level	AVERAGE SCORE

My job is more secure	**2.0**
I will encounter more pressure	**2.1**
Better career prospects	**2.6**
Will result in more pay	**3.5**

Table 4.49
Shop Floor's View of Lean on a personal basis

Managements view of Lean on a purely personal level	AVERAGE SCORE
I will encounter more pressure	**1.9**
My job is more secure	**2.3**
Better career prospects	**2.7**
Will result in more pay	**3.5**

Table 4.50
Managers' view of Lean on a personal basis

Surprisingly, there was considerable agreement between the operatives and management; both did not necessarily feel Lean will result in more pay or better career prospects; nonetheless, they felt that as a result of Lean their job would become more secure and ironically that they may encounter more pressure as a result of the organisation's decision to adopt Lean.

4.7.2 Lean adoption

Within the seven Case studies, it was important to investigate the original rationale for the adoption of Lean in the first instance. Primarily, the management representatives were asked their views on why they considered that their respective organisations had embarked upon the Lean journey. Interestingly, the shop floor representatives within the seven organisations were posed the same question; the score ranged from 1 = strongly agreeing with the statement; 5 = strongly disagreeing. Revealingly, Tables 4.51 and 4.52 indicated total agreement on the three main reasons regards why it was felt that the organisations initially embraced Lean; in ranking order these were:

i. To improve performance,
ii. Competitor pressure,
iii. Customer pressure

Ironically, both the managers (Table 4.51) and the operatives (Table 4.52) ranked "better working conditions" lower.

Managers assertion on why Lean was initially embarked upon		
	Average score	**Scale**
To improve performance	1.1	Strongly Agree
Competitor pressure	1.9	Agree

Customer pressure	2.3	Agree
Create team spirit/motivational tool	2.8	Somewhat Agree
Better working conditions	2.9	Somewhat Agree
Owner/Investor pressure	3.0	Somewhat Agree
As a result of attending a special event/conference	3.9	Disagree

Table 4.51
Managers view on Lean adoption

The shop floor representatives were asked the same question regards their opinion for the adoption of Lean by the organisation:

Shop Floor's opinion on why initially the organisation adopted Lean		
	Average score	**Scale**
To improve performance	1.5	Agree
Competitor pressure	1.7	Agree
Customer pressure	2.2	Agree
Better working conditions	2.7	Somewhat Agree
As a result of attending a special event/conference	3.9	Disagree

Table 4.52
Shop Floors view on Lean adoption

Equally the Survey questionnaire undertaken in 68 organisations asked the same question and the results are summarised in Table 4.53; it outlines the initial reasons for the adoption of Lean. The main gate-keepers were asked this question and probably provided a better overall indication for the introduction of Lean into their respective organisations:

Why was Lean initially adopted by the organisation	
Became aware of the benefits at a special event / conference	**22%**
Pressure from Investors / owners	**43%**
Promoted by a group of individuals from within the organisation	**45%**
Learned through experience with other companies	**48%**
Pressure from customers	**56%**
Create team Spirit / Motivational tool	**57%**
Competitive pressures	**78%**
To improve performance (efficiency, productivity, profitability)	**90%**

Table 4.53
Survey responses regards why Lean was adopted

Interestingly, there was concurrence with both the case study results of the shop floor and management; the two top reasons for Lean are consistent:

- Improve performance and

- Competitor pressures; equally, the

The least likely reason too is consistent; namely as a result of attending a special event/conference. In order to widen the analysis it was felt fitting to construe whether the responses depended on the size of the organisation. Interestingly, there was an overall concurrence amongst the surveyed organisations regards the key triggers towards Lean as depicted in Table 4.54; the top five reasons for adopting Lean are named for each sized organisation:

Top five reasons for adopting Lean		
Small sized organisation	**Medium sized organisation**	**Large sized organisation**
Improve performance – 98%	Improve performance – 89%	Improve performance - 89%
Competitive pressures – 81%	Competitive pressures – 83%	Competitive pressures – 75%
Team spirit – 63%	Team spirit – 53%	Customer pressures – 59%
Customer pressure – 58%	Customer pressure – 50%	Create team spirit – 57%
Investors / owners – 41%	Individuals within the organisation – 46%	other companies – 53%

Table 4.54
Survey responses regard triggers

Captivatingly, there was total agreement with four triggers amongst all sizes of organisations:

- improve performance,
- competitive pressures
- customer pressure and
- the creation of a team spirit.

4.7.3 The Lean aspirations

Equally, an analysis of the case studies permitted an inquiry in to what the operatives and management considered to be the main aspirations from Lean within their organisations; the shop floor questionnaire exposed the following results summarised in Table 4.55:

Shop-floor's questionnaire assessment on the adoption of Lean		
	Average score	**Scale**
Reduce down time	1.1	Strongly Agree
Improve our competitiveness	1.1	Strongly Agree
Reduce any waste.	1.1	Strongly Agree
To carry less stock	1.2	Strongly Agree
Lower costs	1.3	Strongly Agree
Higher productivity	1.4	Strongly Agree
Improve worker production	1.5	Agree

Improve market share	1.5	Agree
Higher profitability	1.6	Agree
Improve customer service	1.7	Agree
Improve relations with suppliers/customers	2.4	Agree
Improve relations between shop floor and management	2.4	Agree
Improve communications between departments	2.4	Agree
Better teamwork	3.0	Somewhat Agree

Table 4.55
Shop floor's view (Questionnaire) on Lean aspirations

Equally the Shop Floor interview schedules whereby a different set of respondents were asked the same question, revealed the following results captured in Table 4.56:

Shop-floor's assessment on why Lean was embraced by the organisation	
	AVERAGE %
Improve relations with suppliers/customers	44.3
Better teamwork	46.4
Improve relations between shop floor and management	48.6
Improve communications between departments	49.3
Improve customer service	71.4
Improve market share	75.0
Reduce any waste	81.4
Become more competitive	82.1
Higher profitability	84.3
Higher productivity	86.4
Improve worker production	87.9
To carry less stock	88.6
Reduce down time	90.7
Lower costs	92.1

Table 4.56
Shop floor's view (Interview) on Lean aspirations

Ironically there existed a extremely high degree of concurrence since the same top nine factors were stated in both the shop floor questionnaires and the interview schedules regards the aspirations from Lean. Whilst the ranking between the two sets varied slightly, the level of agreement regards what Lean would accomplish is summarised in Table 4.57:

Main trends between shop floor questionnaires and interviews	
Questionnaires – top nine scores	**Interview schedules – top nine scores**
Reduce down time	Lower costs
Improve competitiveness	Reduce down time
Reduce waste,	To carry less stock
Carry less stock,	Improve worker production
Lower costs	Higher productivity
Higher productivity	Higher profitability
Improve worker production	Become more competitive
Improve market share	Reduce waste

Higher profitability	Improve market share

Table 4.57
Shop Floor trends on Lean aspirations

A similar exercise was undertaken for the managers within the seven Case Study organisations. Once again questionnaires and interview schedules were used to determine their views regards what they felt their respective organisations hoped to achieve from Lean. Remarkably, there existed a considerable degree of agreement between both the managers and operatives as depicted in Table 4.58, regards the Lean objectives of their organisations.

Main trends between Management questionnaires and interviews	
Questionnaires – top nine scores	**Interview schedules – top nine scores**
Higher productivity	Lower costs
Lower costs	Reduce downtime
Reduce down time	Higher productivity
Improve delivery records	Higher profitability
Improve efficiency	Improve efficiency
Carry less stock	Reduce waste
Higher profitability	Become more competitive
Reduce waste	Attain improved delivery records
Become more competitive	Improve customer service

Table 4.58
Managers trends on Lean aspirations

Whilst there was total concurrence between operatives, there were only three aspects mentioned by the managers and not the operatives:

- Improve efficiency,
- Attain improved delivery records and
- Improve customer service.

A similar exercise was undertaken in the 68 companies that had agreed to complete the survey questionnaire and the intention was to further explore the main objectives of Lean within the respective organisations; this is summarised in Table 4.59:

Lean Objectives	%
Improved market share	**56**
Improve the supply chain management	**64**
Improved teamwork	**67**
Attain improved delivery records	**71**
Improved employee performance	**72**
Reduced lost or down time	**73**
Generally carry less stock : finished, WIP and raw materials	**77**
Improved customer service	**78**
Increased competitiveness	**81**
The elimination of waste	**83**
Lower manufacturing costs	**86**
Increased efficiency	**87**
Higher profitability	**89**
Higher productivity	**90**

Table 4.59
Survey responses regard the Lean aspirations

Interestingly, whilst there was overall agreement within the case studies between the shop-floor and management; the irony was that the lowest scores recorded in the 68 surveyed organisations were for:

- Improved market share,
- Improve supply chain management and
- Improved teamwork.

In comparison, The Manufacturing Foundation (2004) advocated that the fundamental prompts for organisations to embrace Lean were as follows:

- Customer pressure - 28%
- Corporate initiative - 21%
- Competitor pressure - 11%

Equally the Manufacturing Foundation (2004) reiterated the main targets organisations in Britain hope to achieve through Lean were:

- Reduce costs - 37%
- Improve product quality - 15%
- Reduce manufacturing lead time - 11%
- Improve service quality - 9%

The "Manufacturer" (2002) in a survey based on an hundred interviews with Production Directors and managers in UK-Based manufacturing companies revealed the following results regards what their understanding of Lean was:

- 45% stated that the aim was to reduce waste,

- 24% stated that the aim was to cut costs.

The Manufacturing Foundation findings (2004) abridged in Table 4.60 also revealed the key triggers that enabled companies on to the Lean Journey:

The triggers for organisations to start their Lean journey:	
Triggers	**%**
Customer pressure	28
Corporate initiative	21
Competitors	11
Internal teams	9
Recruitment of Lean capability	8
Training courses	6
Examples of benefits	5

Table 4.60
Key triggers of Lean

The importance of key stakeholders plays a prominent role. The 21% figure of corporate initiatives does imply that larger organisations are driving the Lean agenda independently of specific customer or market pressures. Equally, when they were asked with regard to their expectations from Lean; an outline of the responses from the 77 companies that responded felt Lean would:

- Reduce costs - 52%
- Improve on time delivery - 16%
- Reduce manufacturing lead time - 13%
- Increased profitability - 10%

The pre-eminence of the objective to reduce costs fits with the strong emphasis from most Lean implementations. In order to undertake a more detailed investigation, on the organisations that had consented to complete the survey questionnaire, it was decided to investigate whether there existed differences when the size of the organisation was taken into account. Tables 4.61a, b and c summarise the findings; it was decided to look at the small, medium and large sized organisations to assess whether the aspirations varied depending on the size of the entity in question.

Aspirations from Lean of the Small organisations	
Improved market share	46%
Improve the supply chain management	47%
Attain improved delivery records	66%
Generally carry less stock : finished, WIP and raw materials	69%
Reduced lost or down time	70%
Improved customer service	72%
Improved teamwork	73%
The elimination of waste	80%
Improved employee performance	83%
Lower manufacturing costs	87%
Higher profitability	96%
Higher productivity	96%
Increased efficiency	96%
Increased competitiveness	97%

Table 4.61a
Aspiration from Lean of the smaller organisations

Similarly, the analysis looked at the medium sized organisations and this is depicted in the Table 4.61b:

Aspirations from Lean of the Medium organisations	
Improve the supply chain management	53%
Improved teamwork	56%
Improved market share	59%
Reduced lost or down time	70%
Improved employee performance	72%
Generally carry less stock : finished, WIP and raw materials	73%
Attain improved delivery records	76%
Increased efficiency	83%
Improved customer service	84%
Increased competitiveness	84%
The elimination of waste	87%
Lower manufacturing costs	92%
Higher profitability	93%
Higher productivity	97%

Table 4.61b
Aspiration from Lean of the Medium organisations

Similarly, the analysis looked at the large sized organisations and this is depicted in the Table 4.61c:

Aspirations from Lean of the Large organisations	
Improved market share	**58%**
Improved teamwork	**69%**
Improved employee performance	**69%**
Attain improved delivery records	**71%**
Improve the supply chain management	**74%**
Reduced lost or down time	**75%**
Increased competitiveness	**76%**
Improved customer service	**77%**
Generally carry less stock : finished, WIP and raw materials	**81%**
The elimination of waste	**82%**
Lower manufacturing costs	**83%**
Higher profitability	**85%**
Higher productivity	**86%**
Increased efficiency	**86%**

Table 4.61c
Aspirations from Lean of Larger organisations

Besides one variation, there was total agreement regards the top five aspirations from Lean between the organisations of varying sizes; the top five were as follows:

i. increased competitiveness,
ii. increased efficiency,
iii. higher productivity,
iv. higher profitability and,
v. lower manufacturing costs.

Ironically:

- improved teamwork and,
- improving the supply chain management

were amongst the lowest quoted aspirations from Lean.

4.7.4 Progress of Lean

Management representatives through interviews (Table 4.62) and the shop floor also via interviews (Table 4.63) in the seven case study organisations were asked regards how Lean was progressing within their organisations. It was important to gauge this feedback since Lean is viewed as a long term journey; this aspect is explored at length in the next chapter whereby the journey is split into seven overlapping stages although each one is associated with several distinct characteristics. Consequently, once an organisation embarks upon the Lean journey, it is crucial that perpetual evolution is maintained.

Managers Interview schedules opinion on the progress of Lean within their own organisation	%
Appropriate training is provided to operate Lean.	40
Workers approach is right to implement change and accept Lean.	42
I have the necessary tools to implement Lean	46
Appropriate time is given to make improvements	47
The Tools used in the company are of good quality	49
Organisational culture aids Lean	50
Middle management's attitude is appropriate for Lean	54
Senior management's attitude is right to accept Lean	57

Table 4.62
Managers interviewed regards progress of Lean

Equally Table 4.63 summarises the findings of the interview schedules undertaken with the shop-floor representatives:

Shop Floor interview schedules response to Lean progress	Average %
Appropriate training is provided to operate lean	31.4
Appropriate time is given to make improvements	32.9
Management attitude/commitment is right to accept Lean.	33.6
You have the necessary tools to implement lean	38.6
The Tools used in the company are of good quality	41.4
Organisations culture aids Lean	42.1
Workers approach is right to implement change and accept Lean	51.4

Table 4.63
Shop Floors interviewed regards the Progress of Lean

Equally within the questionnaires conducted in the seven case studies an attempt was made to determine the progress of Lean in each organisation. The shop floor questionnaire responses are summarised in Table 4.64. Likewise, the managers reaction is summarised in Table 4.65 (The scoring was as follows; 1 = total agreement and 5 = total disagreement with the statement made). Interestingly, there was total agreement amongst the shop floor respondents irrespective of whether the questionnaire or the interview schedule had been used. The shop floor felt that the issues centred close to the following in ranking order:

i. a lack of training,

ii. insufficient time to make improvements, and

iii. the management attitude / commitment towards Lean.

Ironically the shop floor considered that their attitude was appropriate towards Lean; surprisingly, culture and having the right tools scored better than might have been expected.

Shop Floor questionnaire responses to Lean progress	Average Score
Workers approach is right to implement change	**2.7**
Organisations culture aids Lean	**3.1**
I have the necessary tools to implement Lean	**3.5**
Tools used are of good quality	**3.5**
Management attitude/commitment is right to accept Lean	**3.5**
Appropriate time is given to make improvements	**3.7**
Appropriate training is provided	**3.9**

Table 4.64
Operatives questioned regards the Progress of Lean

Interestingly, the same question was posed to managers within the seven organisations too; (bearing in mind that the scoring guide was as follows; whereby 1 = total agreement and 5 = total disagreement with the statement). There was some element of disagreement between the interview schedules and questionnaires. Whilst both implied that senior and middle managements attitude was appropriate for Lean and they both questioned the workers attitude towards Lean; the questionnaire responses cast doubt on the prevailing culture whereas the interview schedule scored it the third highest. An explanation could be a degree of unwillingness from senior management to admit that the prevailing culture poses an issue. Table 4.65 summarises the responses received from the questionnaires whilst Table 4.62 summarised the management views gauged from the interview schedules.

Management questionnaire replies to Lean progress	Average score
Senior management attitude/commitment is right to accept Lean.	**2.8**
Middle managers approach is right to implement Lean	**2.8**
Tools used are of good quality	**3.0**
I have the necessary tools to implement lean	**3.1**
Appropriate time is given to make improvements	**3.1**
Appropriate training is provided	**3.2**
Workers approach is right to implement change	**3.4**
Organisations culture aids Lean	**3.4**

Table 4.65
Managers questioned regards the Progress of Lean

Ironically, whilst generally the managers and operatives agreed with their peers; there was considerable disagreement between the groups; managers, for instance, felt that the attitude of managers was appropriate for Lean to prosper. Operatives, however, considered this not to be the case. Equally, operatives felt the workers approach to Lean was right whereas, from the managers interviewed only 42% felt this to be the case. The purpose of this question was to extract how perceptions will vary amongst a company's employees. Accordingly, for Lean to flourish, these differences will need to be addressed

4.8 Culture

4.8.1 Case Study Analysis on Culture

Within the seven organisations, a set of questions were devised which attempted to explore the prevailing culture of the respective organisations; similar questions were asked to both the shop floor and the management representatives. Questions were posed and responses received from the operatives using a questionnaire and an interview schedule. The results are summarised in Appendix Eighteen. A comparison of the significant results from the Case Studies from both the shop-floor and management exposed the following results depicted in Table 4.66 which endeavours to provide an overall synopsis of the data in Appendix Eighteen.

Statement	Questionnaire		Interview schedule	
	Strongly disagree / disagree %	Somewhat agree / Agree %	Strongly disagree / or disagree %	Somewhat agree / Agree %
Decisions in the organisations are made at the lowest level possible	21.4	78.6	28.6	71.4
The shop-floor is listened to more widely than was the case before Lean	0	100	21.4	78.6
	42.9	57.1	42.9	57.1
All management levels are listened to more widely than was the case before Lean	0	100	14.3	85.7
The organisation's direction and destination for 5 years is now much clearer	14.3	85.7	0	85.7
	35.7	57.1	35.7	64.2
The company has one particular person directing	0	64.3	0	71.4

operations and the proposals are clearly communicated	14.3	71.4	7.1	78.6
People are clear regarding their expectations from Lean	35.7	57.1	14.3	71.5
	50	50	21.4	78.5
There is adequate training to assist the progress of Lean	21.4	71.4	28.6	64.3
	64.3	35.7	21.4	50
All managers' tiers seem to be pulling in the same direction to make Lean work	21.4	71.5	14.3	85.7
	50	50	57.1	42.8
The company is now a better place to work in since the introduction of Lean	7.1	92.9	7.1	85.7
	35.7	64.3	14.3	85.7
I fully understand why Lean is needed in the organisation	14.3	71.4	7.1	57.2
	28.6	57.1	21.4	78.6
The various departments seem to work better and have a healthier relationship than was the case prior to Lean	7.1	92.8	14.3	78.5
	14.3	85.7	28.6	71.4
The outcomes of Lean have been communicated thoroughly	14.3	78.6	7.1	78.6
	50	50	21.4	50
Lean metrics are clear to observe and the information is cascaded downwards regularly	35.7	64.3	21.4	71.2
	57.1	35.7	42.9	35.7
Greater efforts are made to involve suppliers than was the case before Lean	14.3	85.7	14.3	85.7
	21.4	71.4	28.5	42.9

Greater efforts are made to involve customers than was the case before Lean	**14.3**	**85.8**	**21.4**	**71.5**
	28.6	**71.4**	**42.9**	**42.9**
The Lean journey is linked to the mission statement / vision	**14.2**	**85.7**	**14.3**	**78.5**

Key

= question only posed to managers = responses from the shop floor

Table 4.66
Managers and Shop Floors' cultural perception

The aforementioned analysis illustrated the importance of culture and its relevance towards ensuring a successful Lean implementation. Consequently within each of the seven case studies both the shop floor and the management nominees were asked questions in order to gauge the prevailing culture and whether it facilitated or hampered the progress of Lean in their respective organisations. Stimulating results were found from the overall Case study analysis:

- of the thirteen statements posed to both the shop floor and management, every answer received from the operatives scored less favourably,
- two responses were partly expected:
  - on the question of whether "*shop-floor is listened to more widely than was the case before Lean*:"
    management 100% (questionnaires) and 78.6% (schedules) agreed
    shop-floor 42.9% (questionnaires) and 42.9% (schedules) disagreed,
  - on the question "*managers' tiers seem to be pulling in the same direction to make Lean work*"
    management 21.4% (questionnaires) and 14.3% (schedules) disagreed,
    shop-floor 50% (questionnaires) and 57.1% (schedules) disagreed,
- equally there were some reactions which certainly created major concerns:
  - on the question of whether "*adequate training to assist the progress of Lean*" is available:
  management 21.4% (questionnaires) and 28.6% (schedules) disagreed,
  shop-floor 64.3% (questionnaires) and 21.4% (schedules) disagreed,
  - on the question of whether "*Lean metrics are clear to observe and the information is cascaded downwards regularly:*"

management 35.7% (questionnaires) and 21.4% (schedules) disagreed,
shop-floor 57.1% (questionnaires) and 42.9% (schedules) disagreed,
- on the question of whether "*the outcomes of Lean have been communicated thoroughly:*"
management 14.3% (questionnaires) and 7.1% (schedules) disagreed,
shop-floor 50% (questionnaires) and 21.4% (schedules) disagreed,

- nonetheless, whilst not totally harmonious, some minor optimism should be retained; research shows that Lean needs to be extended to the whole value chain (Liker, 2004);
  - on the question of whether "*the various departments seem to work better and have a healthier relationship than was the case prior to Lean*":
  management 7.1% (questionnaires) and 14.3% (schedules) disagreed,
  shop-floor 14.3% (questionnaires) and 28.6% (schedules) disagreed;
  - on the question of whether "*greater efforts are made to involve suppliers than was the case before Lean:*"
  management 14.3% (questionnaires) and 14.3% (schedules) disagreed,
  shop-floor 21.4% (questionnaires) and 28.5% (schedules) disagreed;
  - on the question of whether "*greater efforts are made to involve customers than was the case before Lean:*"
  management 14.3% (questionnaires) and 21.4% (schedules) disagreed,
  shop-floor 28.6% (questionnaires) and 42.9% (schedules) disagreed.

The results indicated that either one or a combination of more than a single factor such as:

- the perception of Lean,
- the established confidence within Lean and
- the method by which Lean is communicated within the respective organisations

necessitates varying degrees of attention as intimated in the case studies enclosed (Appendices Ten – sixteen); this is reiterated within the appendices for the seven organisations in question.

4.8.2 Survey questionnaires

Once again the sixty eight organisations were asked a set of ten questions which were intended to deduce the prevailing culture of the organisation and specifically to gauge whether it was conducive to Lean. Against each statement the organisation's representative was encouraged to award a score of between "1" to "10"; a "1" signifying total agreement with the statement in reference to the organisation; a "10" indicating that there was total disagreement with little relevance in reference to the organisation. By way of summary, an indication is given of the low scores recorded (9,10) the mid scores (5,6) and top score (1,2) recorded in Table 4.67:

Statement made on the Survey questionnaire	% recorded 1 or 2	% recorded 5 or 6	% recorded 9 or 10
Decisions within your organisation are made at the lowest level possible. An important gauge could well be whether the number of organisation levels have shrunk in the previous two years.	6%	36%	10%
There persists a clear and definite clarity of vision within the organisation concerning the Lean transformation so that the organisation recognises what the structure will resemble once the transformation is complete	4%	31%	13%
There is evident a strategy of change and one in which the organisation clearly communicates how the goals will be accomplished	3%	31%	19%
Responsibilities regards the Lean transformation have been assigned	6%	30%	17%
It is clearly evident who is championing the Lean transformation internally	4%	17%	36%
A Lean training programme is clearly visible within the organisation and forms part of an effective and visible learning environment which can be assessed using an appropriate performance index ,i.e., training hours / total employees	8%	32%	19%
There is clear evidence of Lean leadership at all levels within the entire organisation and this can be witnessed by the existence of lean facilitators at various levels of the hierarchy.	13%	40%	6%
The organisation promotes a culture which maintains the challenges of existing processes by proactive systems such as "Standard operating procedures"	1%	26%	34%
The organisation offers customer assistance to suppliers and maintains "Supplier Development Teams"	22%	19%	14%
The organisation makes a conscientious effort to maximise stability in a changing environment whereby an attempt is made to reduce, eg., schedule changes, program restructures and procurement quantities	4%	29%	7%

Table 4.67
Survey responses on Culture

Overall the survey results reinforced the Case Study analysis; out of ten questions asked:

- A "1" and "2" were only recorded for two questions,

- The average score for "5" and "6" over the ten questions was 28.9% (over quarter of the respondents)
- The average score for "9" and "10" over the ten questions was 17.5% (nearly one in five of the respondents).

By way of a synopsis, evidently the cultural factors were not embedded in the organisations and this would have had a detrimental effect on the overall organisational efficiency.

4.9 The "Halo Effect"

Despite the analysis from this investigation it is important to take into consideration the caveat that Rosenzweig (2009) identifies. He suggests that it is important to reach a clearer understanding of what drives success and failure; to determine the main drivers of company performance and not erroneously make the same mistakes elements of other academic research has whereby they have merely described the high performers. Whilst the pitfalls of making a simple list of key factors found in the best performing organisations is fully recognised, this investigation's analysis permits a clearer understanding of success. By using surveys alongside case studies whilst supplemented by the extensive Lean audit undertaken in twenty organisations the cause and effect has been clearly established. In essence two separate mechanisms were utilised to achieve a consensus; by utilising the adapted scorecard embracing 36 separate indices the analysis initially showed that larger organisations performed better since:

- Lean was applied more widely within the organisations,
- Additional cultural factors were existent in these organisations,
- A wider application of Lean tools was found and
- The tracking of Lean was more meticulous.

Likewise, the best performing fifteen organisations when the scorecard was applied revealed high negative correlations with the potential barriers discovered in other organisations. Similarly, a better tool application, higher number of cultural factors and a wider application of Lean when applied to employees and departments was discovered. Furthermore, the Lean audit also revealed high correlations with the following categories:

- Sustainability (application of Lean amongst employees and departments),
- Culture (both relating to organisational practices and when focussed to the employees),
- Treating Lean as a business initiative too,
- Philosophy (formal strategic planning and appropriate metrics were selected),
- Lean change strategy adopted.

This meant that the cause and effect could be determined as the above factors illustrated high correlations with enhanced performance levels. The "Halo Effect" (page 14) assisted to shift the thinking in this investigation from one that looks for a formula for success, towards one that sees the world in terms of probabilities. Business performance is inherently relative and not absolute. An organisation could improve on many of its objectives yet find its profits and market share still declining because its competitors have performed better on similar measures. Lean is about doing things differently and making choices under conditions of uncertainty.

4.10 Summary of the overall analysis

Having indicated that the primary objective was to decipher whether organisations viewing Lean as a philosophy performed better, an accurate measurement was required to enable this process to take place. Evidently, the traditional performance measures do not work in a Lean environment. The Performance Factor (the sum of the five category averages from the adapted scorecard used in this research) was considered to provide a clear-cut indication of each organisation's performance. The Performance factor took into account the overall 36 indices looking at the respective organisations:

- Financial standing,
- Customer related indices,
- Process based performance,
- People and
- Indices looking at the organisation's future prospects.

The data was obtained from survey questionnaires undertaken in 68 organisations and seven extensive Case Studies of varying sizes and operating in diverse manufacturing sectors. Correlational analysis of groups was successfully performed using the Spearman's Rho test. Chi-Square analysis was also utilised to substantiate the correlation analysis. Whilst the affect on the various indices differed, albeit small, medium or large organisations stipulated that Lean had a positive impact on their company performance as will be clarified in due course.

An important complementary finding was that larger organisations proved to be more successful as a consequence of implementing Lean. The overall analysis tended to focus towards several factors contributing towards this situation. An important aspect being that Lean was adopted more extensively in larger organisations; an investigation of the application of Lean across an organisation's value chain found that 20% of smaller organisations, 25% of medium sized and 40% of the larger organisations stated that they administered Lean across the whole value chain. In inquiring whether the continuous improvement of the supply chain was an on-going aspiration; 47% of small, 53% of medium and 74% of the larger organisations stated that they continue to aspire towards this objective despite larger organisations already performing better than their counterparts.

Likewise, a greater number of the cultural features were found to be more conducive in the larger organisations. Similarly the literature states that a combination of the appropriate tools and culture is required for Lean to succeed. It was found that there was a wider application of the Lean tools in the larger organisations; an exhaustive analysis of the top six tools was carried out to determine the average length of application. It was discovered that the average length the top six quoted Lean tools had been in operation was 3.1 years for medium sized organisations, 3.3 for the small and 4.7 for the large sized organisation. It was also discovered that a more robust tracking system existed within the larger organisations. A scrutiny of the 68 organisations surveyed regarding the tracking of Lean results both weekly and monthly found the following results; 50% of the smaller organisations tracked both weekly and monthly; 38% weekly and 63% monthly for the medium whereas it was 60% and 83% respectively for the larger organisations.

A detailed investigation was undertaken to determine the reason for some organisations performing much better. An exhaustive analysis of the top 15 organisations based on the performance factor revealed numerous possible contributory factors. Primarily a strong and negative association with many of the potential barriers to either adopt Lean or to widen its implementation was discovered in the better performing organisations. There was an overwhelming indication that in the highest performing organisations the Lean barriers were either not permitted to cultivate and/or to prevent the organisation from advancing on its Lean journey. There also existed a strong correlation with the "people" (0.7 correlation at 0.002 significance) and "customer" indices (0.6 correlation at 0.008 significance). The "people" category consists of Employee perception surveys, Health and Safety per employee, retention of top employees, the quality of professional and technical development and the quality of leadership development. The "Customer" indices accounted for market share by product group, customer satisfaction index, customer retention rate, service quality, responsiveness and on-time delivery. It was revealing to discover that finance factors did not necessarily have a huge impact on performance. Similarly an investigation on the sustainability of Lean was undertaken and two factors chosen to measure this were:

- The proportion of an organisations departments operating under Lean, and
- the percentage of the organisation's employees operating under Lean conditions.

The best performing organisations revealed figures of 72.5% and 74.3% whereas the remaining displayed figures of 54.7% and 55.4% respectively. In the same way, an analysis of the top six listed Lean tools in adoption established that the best performing 15 organisations had an average application of 82% compared with 69% found to be the case in the remaining organisations. The cultural analysis also provided a remarkable insight in explaining the superiority of the better performing organisations. In 60% of the questions devised to establish an organisation's culture, it was exposed that the best performing organisations scored higher than the responses received from the respondents in the remaining organisations.

Inevitably, whilst the highest performers reflected superior scores on the respective indices, the spread of the indices was very revealing. An enquiry into the best performing seven individual indices for the remaining organisation revealed the following results:

- Cycle time 16% - process category
- Space productivity 15.9% - process category
- Raw material inventory 15.8% - process category
- WIP Inventory 15.7 - process category
- Stock turnover 14.3% - process category
- Defects of critical components 14.1% - process category
- Labour productivity 13.9% - process category

However, when we analyse the best seven indices of the highest performers, we find that they were as follows:

- Customer satisfaction 53.7% - customer category
- Responsiveness 45% - customer category
- On-time delivery 40.2% - customer category
- Stock turnover 32.7% - process category
- Raw material inventory 32.7% - process category
- Defects of critical products 31.1% - process category
- Depth and quality of strategic planning 30.9% - future category

Interestingly, the top seven indices for the remaining organisations all belong to the "process" category; conversely, the top seven indices quoted for the best performing organisations belonged to three different categories; namely "*customer*", "*process*" and "*future*". The importance of the "future" category should not be undervalued; it implied that these organisations were determined to retain their position of superiority. Likewise, in an investigation of the association between the most significant indices and the overall performance, the most significant in ranking order were as follows:

i. The future indices,
ii. The people indices and followed by the
iii. Customer indices.

This essentially revealed the importance of the above categories in comparison to the impact of the financial indices.

Furthermore, the comprehensive Lean audit undertaken in twenty organisations confirmed the aforementioned summary of the results. Initially, supportive results were found based on the Wilk's Lambda and related to the strategies:

- Overall safety, cleanliness and orderliness (λ=0.870),
- Production and operational flow (λ=0.899); and
- Processes and operations (λ=0.862)

which showed to be not different for the best performing group of companies (which means they are common characteristics only for the five best), and may be a distinguishing factor in which these five organisations differed from the other companies. Nevertheless, more comprehensive results were discovered whereby the most important correlations from the Lean Audit supporting the discriminant analysis were for the following strategies:

- Lean sustainability ($r = 0.673$; $p \leq 0.001$),
- Culture employee oriented ($r = 0.753$; $p \leq 0.0001$),
- Organisational culture - organisational practises ($r = 0.731$; $p \leq 0.0001$),
- Lean treated as a business ($r = 0.752$; $p \leq 0.0001$),
- Philosophy ($r = 0.731$; $p \leq 0.0001$) and
- Lean change strategy ($r= 0.652$; $p = \leq 0.002$

demonstrated significantly higher correlations with the best performing companies. Essentially, what this result shows is that in the Lean Audits undertaken, the five best performing organisations demonstrated high correlations with components of what depicts that an organisation is treating Lean as a philosophy; namely:

- sustainability,
- culture,
- needing to treat Lean as a business,
- the Lean change strategy and the
- philosophy indices themselves.

Nevertheless, from the surveys, case studies and the Lean audit undertaken it was revealed that no organisation was deemed to be viewing Lean as a philosophy. Several explanations could be forwarded for this but the prevailing culture was perceived as the most noteworthy contributing factor. The survey questionnaire (appendix one) had ten questions which focused on the culture of the respective organisation. Against each statement the organisations' representative was encouraged to score between "1" to "10"; a "1" signifying total agreement with the statement; a "10" indicating that there was total disagreement and no relevance of the statement in reference to the organisation. Overall the survey results reinforced the Case Study analysis; out of ten questions asked, a "1" and "2" were only recorded for two questions; a "5" and "6" over the ten questions was achieved in 28.9% of occasions (over quarter of the respondents); the average score for "9" and "10" over the ten questions was 17.5% (nearly one in five of the respondents). By way of a synopsis, evidently the cultural factors were not embedded in the organisations and this would have had a detrimental effect on the overall organisational efficiency.

4.11 Conclusions

It should be clarified at the onset, that whilst the analysis confirmed that organisations viewing Lean as a philosophy performed better, there was no evidence of any organisation at that juncture. The investigation exposed a number of crucial contributory factors. Whilst there was total harmony amongst the sixty-eight organisations regards the top five aspirations from Lean; namely:

i. increased competitiveness,
ii. increased efficiency,
iii. higher productivity,
iv. higher profitability and
v. lower manufacturing costs.

However, the lowest quoted aspirations from Lean within the surveyed organisations were as follows:

- improved market share,
- improve supply chain management and
- improved teamwork.

Likewise, within the Case studies (Appendices Ten – Sixteen) either one or a combination of factors from the following:

- the perception of Lean,
- the established confidence within Lean and
- the method by which Lean is communicated within the respective organisations

were highlighted as requiring varying degrees of reflection. The surveyed organisations were requested to score against each of the ten statements trying to construe the prevailing culture of their organisation. A scoring scale of 1-10 was utilised; a "1" signifying total agreement with the statement in reference to the organisation. Overall the survey results reinforced the Case Study analysis; out of the ten questions asked:

- The average for "1" and "2" over the ten questions was only 7.1%,
- The average score for "5" and "6" over the ten questions was 28.9% (over quarter of the respondents)
- The average score for "9" and "10" over the ten questions was 17.5% (nearly one in five of the respondents)

Evidently the cultural factors were not embedded and this would have had a unfavourable effect on the respective efforts to implement Lean.

Furthermore, barriers to broaden the application of Lean assisted to illuminate why organisations have failed to reach the juncture whereby Lean is viewed as a philosophy. The top seven barriers identified in ranking order were as follows:

i. Insufficient supervisory skills,
ii. Employee attitudes / resistance to change,
iii. Insufficient workforce skills to implement Lean,
iv. Insufficient senior management skills to implement Lean,
v. Insufficient management time,
vi. Cultural issues and the
vii. Cost of investment.

Bearing in mind the significance of both employee attitude and culture, the obstacles faced can be fully appreciated. In an effort to establish sustainability; namely the proportion of departments and employees operating under Lean within the organisations surveyed; the situation exposed that only 58.6% of the departments and 59.6% of the employees operated under Lean conditions. Equally, whilst the managers who contributed in completing the surveys may have embellished some responses; only 30% of the companies alluded to attempting to apply the Lean principles across the whole value chain.

Equally, an important subsidiary factor revealed that larger organisations performed better which generally concurs with the prevailing literature. Nonetheless, in a effort to assess the underlying reasons for the enhanced performance of the top fifteen organisations, it was endorsed that:

- fewer barriers would be allowed to manifest,

- the importance of the "people" category which embraces the following individual indices: *employee perception surveys, Health and Safety per employee, retention of top employees, quality of professional and technical development, and the quality of the leadership development*; together with the "Customer" indices; *namely market share by product group, customer satisfaction index, customer retention rate, service quality, responsiveness and on-time delivery* were clearly made evident,
- there was a wider application of Lean in regards the organisation and its value chain,
- Lean sustainability; for the best performing organisations it was 72.5% of the departments and 74.5% of employees operating under Lean. In contrast, it was 54.7% of the departments and 55.4% of the employees in the remaining organisations. This was reinforced by a correlation of 0.7 at a 0.008 significance level in reference to the aspiration of improving the supply chain management in these organisations,
- Tools in application; the best performing organisations had an average of 82% application, whereas the remaining organisations had an average of 69%,
- A considerably higher number of cultural factors were in existence in the better performing organisations. In 60% of the cases the better performing organisations confirmed a higher score against each of the cultural questions posed,
- The financial indices were not considered any more important than the remaining and the significance of all the five categories was conveyed,
- the most important indices affecting the overall performance in ranking order were the: *Future, People* followed by the *customer* indices,
- The tools listed as having a high correlation with the best performing companies were *elimination of waste, kanban systems, supplier base reduction, single piece flow operation, and process mapping*. Equally, *improved teamwork and improving the supply chain management* played a prominent role. Likewise, they recognised the importance of *higher profitability, improved employee performance, improved market share, increased competitiveness and constant waste reduction,*
- a full Lean implementation requires considerable investment; an important contribution of the research also focused upon the entire requirements or inputs should any organisation be earnest regards its Lean journey. Too many organisations embark upon this journey without a full comprehension of the total expectations (Ransom, 2008; Lee, 2008). Consequently, the audit questionnaire acts as an excellent review and proceeds to enlighten an organisation of the requirements if it is to be triumphant in implementing Lean,
- Whilst the Lean audit identified the stage of the Lean journey an organisation had attained; the Lean audit results confirmed that Lean sustainability ($r = 0.673$; $p \leq$

0.001), Culture employee oriented ($r = 0.753$; $p \leq 0.0001$), Organisational culture - organisational practises ($r = 0.731$; $p \leq 0.0001$), Lean treated as a business ($r = 0.752$; $p \leq 0.0001$), Philosophy ($r = 0.731$; $p \leq 0.0001$) and the Lean change strategy ($r = 0.652$; $p = \leq 0.002$) demonstrated significantly higher correlations with the Best performing companies,

Consequently, those organisations which performed better depicted all of the characteristics deemed necessary should an organisation regard itself as treating Lean as a philosophy. They were able to demonstrate sustainability, an appropriate culture, the need to treat Lean as a business, a Lean change strategy, encountered fewer barriers, had a wider application of Lean across the organisation and a better overall tool application. The Lean audit results reinforced the findings, since those organisations accomplishing better results also scored high on the philosophy indices themselves. Nonetheless, in line with the thinking of Rosenzweig (2009) to achieve high performance, companies must do more than follow formulas; they must differentiate themselves from rivals by making choices under conditions of uncertainty.

The next Chapter utilises the decisive inputs observed as the vital determinants of Lean already discussed; namely what measures a respective organisation has to incorporate should it wish to embrace Lean as a philosophy. The core factors it needs to consider are that:

- the correct processes are installed,
- the appropriate tools are embraced,
- ensure the progress of Lean is tracked,
- a conducive culture is in existence, and
- Whether Lean has enabled the organisation to become more successful?

Consequently, a Lean audit was devised to clarify this Lean journey and it was undertaken in twenty organisations in order to assess how pertinent the framework was. The chapter clarifies both the audit and summarises the responses from the respective organisations regarding its aptness.

CHAPTER FIVE
THE LEAN JOURNEY

5.1 Introduction

This chapter resolves a decisive component of the research by identifying precisely what is meant by the term, "*a genuine Lean organisation*". This formed an output of the research conducted. Whilst extensive preceding research attempts to reflect the condition of Lean in organisations, there existed a void of a comprehensive Lean audit distinctively examining:

- Whether Lean had been adopted by an organisation as a philosophy, and to
- Specifically deduce the phase of Lean an organisation had reached.

The chapter ultimately looks at the extensive Lean audit which was developed along with the results as a direct consequence of testing it in twenty organisations indicative of small, medium and large British manufacturing companies. By accepting the premise that Lean should always be considered as a journey, it is critical to be able to identify the voyage an organisation is required to undertake in its quest to be regarded as a genuine Lean organisation.

5.2 Conception of the Audit

It was particularly during the Case studies undertaken in seven disparate organisations between January 2004 and July 2007 that the need for a suitable audit became apparent. Within the analysis gathered for the Case studies (Appendices 10-16) it was considered obligatory to be able to feedback to the organisations regards the juncture of Lean that the respective organisation's Lean journey had reached. Consequently, the actions required should the organisation be earnest in its quest to embrace Lean as an ideology. As an employee of Royal Doulton Plc, the audits of:

- Henderson et al., (2003) and
- Iwao Kobayashi (1996)

were utilised but their aptness was always in doubt owing to reasons outlined subsequently. Furthermore, the literature review had already identified the need for a specific audit since the frameworks identified assist to ascertain the state of a Lean implementation, though two particular deficiencies were identified:

- The audits did not wholly investigate the true state of Lean as evidently a heavy reliance on the operational aspects of Lean was discovered; consequently, the sustainability and ideological facets relating to Lean were largely ignored, and
- The clear correlation of the audit results to an organisation's position on its Lean journey was not clearly acknowledged.

Likewise, both the surveys which were undertaken between November 2003 and October 2007 and the Case studies identified the various ingredients necessary should an organisation hope to succeed at implementing Lean; namely:

- Appropriate reasons for the adoption of Lean,
- Mechanisms to tackle the barriers to Lean,
- The process adopted to track the results of Lean,
- Aspirations from Lean,
- Extent of adoption,
- The tools adopted,
- The cultural factors and the need to
- Measure the impact of Lean on various performance indices.

Consequently, it was necessary to be able to establish how these factors were measured.

5.2.1 Development of the Lean Audit

Crucially all twelve categories with the accompanying set of indices for each cluster were used in the assessment. Having implemented Lean in Royal Doulton Plc (one of the case studies utilised) the importance of culture, change and sustainability became apparent and naturally formed areas to scrutinize in a Lean appraisal. During the compilation process it transpired that indices relating to culture had a natural focus relating to either the organisation as a whole or the employees as individuals. Consequently the decision was made to utilise two distinct categories. The importance of the Lean tools and the corresponding technical components was drilled into the training received and assisted to formulate the flow, processes and design of quality indices. The importance of safety and the general visual management are perceived as complimentary factors and a decision was made to develop specific suites of indices. Whilst, it would have been possible to combine continuous improvement with change, it was deemed vital to keep them separate since change and culture were considered to play a prominent role in all Lean implementations. Likewise, any organisation deciding to implement Lean should consider its impact on the business performance which accounted for these respective set of indices. Finally, whilst the notion of Lean philosophy embraces all the aspects mentioned, there were certain specific criteria not logically assimilating into another category and helped to form a separate group; consequently the categories were:

- Overall safety, cleanliness and order,
- Production and operation flow,
- Process and operations,
- Visual management,

- Quality designed into the product,
- Continuous improvement,
- Lean change strategy,
- Lean sustainability,
- Culture – employee oriented,
- Organisational culture – organisational practices,
- Lean treated as a business and
- Lean philosophy.

5.3 Evaluation of the assessment tools

Often the literature mistakes the Lean measures as an audit assessment of Lean (Schonberger, 1987). Likewise, the QCDMMS measures (Bicheno, 2004) facilitate continuous improvement but lack the versatility of assessing the status of an organisation's overall Lean journey. Goldratt (1990) heavily focuses on an organisation's supply chain alone. The DTI 7 measures are an improvement to the previous contributions and can be utilised to improve production performance throughout manufacturing. Nonetheless, they along with Goodman (2002) and Shah et al., (2007) neglect to recognise the impact of change management and culture on an organisation's quest to implement the Lean philosophy. Likewise, Schonberger (1996), Iwao Kobayashi (1996), Goodman (2002), Mann (2005) Henderson et al., (2003) and Lee (2007) attempt to incorporate Lean beyond the manufacturing divisions of an organisation and consider suppliers (Lee, 2007) and marketing (Goodman, 2002); however, they are still heavily focused on performance and neglect to comprehend the need to view Lean as an philosophy as conducted by Toyota. Schonberger (1996) neglects to appreciate the real impact employees have on Lean.

Kobayashi's "20 keys" concentrate on bringing together 20 of the world's best manufacturing improvement approaches; to integrate them into a dynamic system whereby enabling companies to adapt to a continuously changing economic and competitive environment. Whilst Kobayashi (1996) attempts to integrate the importance of certain workplace practices such as teamwork and empowerment the indices relating to the impact of and on people are largely ignored. The EFQM Excellence model is the most widely used organisational management framework in Europe, used by at least 30,000 organisations across more than 25 European countries and increasingly outside Europe, particularly in the Middle East and South America. (WWW. Bpic, 2009). When used as a tool for assessment, it delivers a picture of how well the organisation compares to similar or very different kinds of organisation. The model can be used as a business-wide framework in a holistic, focused and practical way. The full power of the excellence model is realised from the linkages between the results and enablers which assists to identify potential areas for improvement. These linkages may be found at two levels; across the model itself between the results and enablers and the second level of linkages is within each criterion, e.g, for "Policy and strategy". The sub-criteria follow a logical sequence, and identifying which part of the chain may be weak leads to ideas for improvement. The model has other benefits apart from those derived from the self assessment. The EFQM can be considered as a guide to the introduction of a TQM initiative since the model synthesises the principles or fundamental concepts of TQM in clear and concise language. The EFQM Business Excellence model (2000) has come under some scrutiny; Bou-Lluser et al., (2005) state that the empirical research on the causal relationships within the model is still limited since it is mostly based on studies that test isolated associations. Equally, whilst the EFQM excellence model recognises the need to adopt a holistic view in quality systems it remains a well used general assessment framework and is not specific enough for Lean

Goodson's Rapid Plant Assessment (RPA) process, allows a team to gauge a factory's leanness accurately solely from visual cues and conversations with employees. At the heart of the RPA process are two assessment tools:

- the rating sheet and
- the questionnaire.

The first contains 11 categories including safety, scheduling, inventory, teamwork, and supply chain that determines a plant's leanness. The second features 20 yes-or-no questions that focus thinking within the categories. The tool is aimed at effective benchmarking and assessment of supplier plants; after a plant tour the team can make an assessment using the Goodman methodology. The main benefits are that in total eleven categories are utilised; each rated from poor to best in class. The categories evaluate customer satisfaction, safety and H&S issues. Moreover, HR is not ignored and indices evaluate teamwork and motivation. Furthermore, supply chain integration is also recognised worthy of investigation. Finally, overall the model is easy to learn, quick to put into practice, and it produces results in a day or less. However, there are certain short-comings associated with Goodson's RPA; it generally fails to encapsulate Lean as a never ending journey. Overall Lean is not viewed as an ideology which consequently means, the sustainability indices are not paid sufficient attention. Moreover, the change process is not directly examined though the model makes reference to a recognition of employees and work force involvement. Finally, it is considered that the indices are viewed in isolation and that little evidence exists of the real associations between the categories

Schonberger (1996) generally could be regarded to be a succinct guide to Leaner operations. This is assisted by the fact that whilst looking at customers, work force involvement, training, and marketing it also evaluates the overall concept of waste including variation and root cause ideology. The impact of performance measurement is examined to a degree and generally the indices direct organisations to become more demand led and to be organised by customer groups. Furthermore, the model permits comparisons to be made with other organisations; consequently a benchmarking exercise is possible. However, there exist certain concerns with Schonberger's model too. It generally fails to encapsulate that Lean is and should be viewed as a journey. Equally, since the whole ideology of Lean is not fully encapsulated, the sustainability indices are not paid sufficient attention; likewise, the change process is not directly examined although it makes reference to the recognition of employees and work force involvement.

Kobayashi (1996) gained momentum both as a manufacturing and implementation guide to Lean. Through the analysis it is possible to make comparisons with other organisations which facilitates a benchmarking exercise to be undertaken. A five point scale is provided for each key in order to initiate a self assessment exercise to be undertaken with the categories spanning between level 1 "beginner" to 5 "ideal". Besides having good links with other keys; in order to be able to perform well in one area, it is necessary for an organisation to shine in most of the remaining keys. Additionally, the model fittingly assesses waste, 5S, team working, continuous improvement, cross functional working and looks at supplier relations too. Conversely, Kobayashi's model (1996) displays several deficiencies too. It scrutinizes the processes and operations, but does not inspect in depth into the role of Lean change. The whole concept of sustainability and culture are not paid sufficient emphasis which consequently results in the area of culture and the need to treat Lean as an ideology being neglected largely. Furthermore, since the heavy concentration is devoted towards the shop-floor, the main issue whereby it is imperative that Lean should result in positive business results is generally neglected too.

Goodson (2002) and Shah et al., (2007) assessments are devoid of the necessary organisational development requirements if Lean is to flourish. Equally, Mann (2005) Henderson et al., (2003) Lee (2007) and Shah et al., (2007) fail to appreciate the real impact of culture on Lean success. Lee (2007) appropriately focuses on the nine key areas of manufacturing extensively. Moreover, he proceeds to evaluate the nature of team work within the organisation and looks at the need to build lasting and effective relationships with the suppliers. Conversely, the importance of sustainability, the change process and culture are not fully recognised by the indices utilised. This means that the need to treat Lean as an ideology is not fully recognised. Moreover, Lee's audit (2007) does not encapsulate the need to treat Lean as a business ideology.

Henderson et al., (2003) rightly examines in detail the processes and the role six sigma plays in a Lean implementation. Similarly, the audit concentrates on teamwork and change management through the "continuous pursuit of perfection" (page 279) indices. However Henderson et al., (2003) do not dissect in sufficient depth the role sustainability and culture play in a successful Lean implementation; consequently the need to treat Lean as an ideology is not pursued within the investigation. A vital ingredient also missing within the audit is the need to assess whether an organisation's Lean efforts have resulted in a better business performance. Whilst each Lean failure (Parks, 2002; Mann, 2005) can be attributed to a different cause, underlying all of them are the entrenched issues of corporate culture and change management. Lee (2007) rightly selects quality as a category but then proceeds to opt for four questions whereby three have a heavy SPC focus; the other seeks to establish the defect rates.

Shah et al., (2007) initially attempt to clarify the concept of Lean by developing and validating a multi-dimensional measure of Lean. The results are split into three sections:

- *what* is lean production (i.e. identify critical factors),
- *how* are the various factors of lean production related to each other, and
- *why* are they related.

Admirably, they look at ten factors regarded to constitute the operational complement; i.e, supplier development, customer involvement and the process categories. They stress that it is the complementary and synergistic effects of the ten distinct but highly inter-related elements that give Lean its unique character and its superior ability to achieve multiple performance goals. Shah et al., (2007) rightly promote that none of the individual components are equivalent to the system, but together they *constitute* the system. However, the audit looks at process and operations, but does not evaluate in sufficient depth the role of Lean change, sustainability and culture should an organisation hope to secure the benefits of Lean. Like many other models, the indices do not fully recognise the need to measure the performance of Lean in order to construe the true impact Lean has had on the organisation.

Mann's audit (2005) was a result of conclusions he reached that although the Lean tools were in place for operators, supervisors did not intuitively understand how to manage the changes.

According to Mann, the "Four Principal Elements of Lean Management" well represented in his audit are:

i. Leader standard work
ii. The visual controls
iii. The daily accountability process, and
iv. Leadership discipline.

Mann's (2005) eight categories of process and behaviour define an assessment with 5 levels; with 1 = pre-implementation; to 5 = sustainable system. His audit provides a good method of self assessment which evaluates processes carefully and process improvement in considerable detail and closely scrutinises process improvement too. Nonetheless, the negatives are that whilst his audit looks at the control and accountability process there is a derisory emphasis placed upon performance measurement. Similarly, Lean is not viewed as a journey and the measures are too static and not meant to promote improvement. Inherently, insufficient emphasis is placed upon culture and change measurements within the audit.

The Shingo Prize is very flexible and can be applied to all industries, public or private sector, profit or non profit sectors, and individual sites, plants or entire businesses. Moreover, the Shingo prize criteria facilitates to reduce confusion, clarifies objectives and provides profoundly useful feedback to organisations that have elected to pursue this prize. Equally, the Shingo Prize criteria altered after the criticism received for awarding a prize to Delphi which subsequently went bankrupt. The prize has evolved from a manufacturing prize to one broadened to "operational excellence." Additional categories were added for the public sector and research. However, the Shingo Prize inherently possesses certain limitations too. The assessment process is extremely protracted and involves six stages. Theses processes include:

i. The initial application for the shingo prize, or the silver or bronze medallions; generally one year before the intended "Achievement Report",
ii. Achievement reports are submitted and reviewed and this often involves a 30 days lead time. This should be written in the format that closely aligns it to the Shingo Prize model and up to 75 pages in length. Typically a Lean mature organisation will take six months preparing their achievement report and can receive notification of their award status in a further three months
iii. Reports with positive recommendations receive a site visit by examiners; this often happens 30-60 days after the application notification
iv. Based on a site visit; recommendations are made to the "Executive Committee" for bronze or silver medallion or Shingo prize

v. Organisations are notified no later than 30 days after the site visit; Official recognition occurs at the annual conference, or Regional conference where applicable; applicants receive written feedback

vi. Organisations desiring additional recognition at local facility may request Shingo representative whereby, travel expenses would need to be covered.

Furthermore, the costs involved with the application can be excessive; the application fee is £1,200 for a small category and £3,600 for a large category. The "Achievement Report" can cost between £6k and £11k for large organisation; £2.5k for medium and £1k for small companies. The site visit can amount to £6k to £11k for larger organisation. Clients are expected to attend a two workshop; (www shingo) and the cost of attending is nearly £900 per candidate. Moreover, the decision is always final with no appeal; the awards are valid for five years at which point the organisation must re-challenge for the prize.

It is important to pursue the prize not for the sake of the prize but to view the prize as the results made possible not only from the customers but for all stakeholders; implementing tools for the purpose of winning a prize is like cramming for an exam - can achieve a high score but not excellence. The Kotani forging plant near Himeji, for example, (Miller, 2008) would probably not score highly on the Shingo Prize criteria as there are no cells, no 5S, no kanbans, and no instruction sheets. Yet Kotani is a second tier supplier to Toyota with sales per employee over twice the US average for forging shops and has achieved its results by focusing on technology. Furthermore, Table 5.1 (summarised from information received in Miller, 2008) depicts results of organisations based on public reports. Whilst the Shingo Prize winners were 10% more profitable, they lost market share and cut costs whilst their competitors did the opposite.

	Sales growth %	**Profitability %**	**Employment growth %**
All Shingo Winners	13	6.38	-0.54
All competitors of winners	14.71	5.8	1.26
Shingo Prize winners <\$10B/year in sales	9.14	3.63	-3.64
Competitors of winners <\$10B/year in Sales	14.09	6.1	0.84

Table 5.1
Performance in the Market

Waddell et al., (2006) somewhat critically have taken the Shingo Prize to task for awarding prizes to operations like Delphi that were considered to have failed to declare sufficiently high levels of profit. Graban (2007) suggests that if you invested in the Shingo prize winners since 2001, you would have secured a net return of -0.75%. Even if Delphi is removed from this equation the net return of Shingo Prize winners is still -0.55%. Understandably there are other factors involved in a company's performance though this does make an interesting data point.

Overall any assessment needs to grasp the concept of quality in an assessment of an organisation's Lean journey. The criteria chosen have to be selected very carefully. The criteria selected also need to assess whether Lean is viewed as a journey, which subsequently means that it will be sustained. Organisations could be creating value presently but whether they will be doing similarly in five years time is not addressed by any of the assessments outlined. Lee (2007) and the Business Excellence Model (2000) fail to support the notion of viewing Lean as a voyage. Equally, Mann (2005) Henderson et al., (2003) Lee (2007) and Shah et al., (2007) are also guilty of not recognising the importance of organisational development needs of Lean, such as:

- the organisation's culture,
- the Lean pay systems,
- the performance reward systems,
- the Lean measurement systems,
- impact on and of the workforce and the
- Change management process.

Whilst mention was made of the DTI Seven measures promoted by the *Industry Forum* of the *Society of Motor Manufacturers and Traders* (SMMT) under the umbrella of quality, cost and delivery (Q,C,D); they are intended to assist a structure for continuous improvement, raising levels of customer satisfaction whilst greatly improving the management of production. Undoubtedly, measuring QCD provides significant advantages:

- Precision; these measures can highlight the priorities for improvement in production management with clarity and focus,
- Simplicity since even a complex manufacturing process can identify a straightforward route towards performance improvements,
- Feedback, as the seven QCD measures can be used to quantify the results of changes to the process. The effect of a change can be compared with the status of the process prior to the change. QCD provides rapid feedback and quantifiable numeric comparisons,
- Benchmarking since QCD provides the basis for tangible comparison with benchmarked processes or the performance of a benchmark company. This will highlight processes which offer better methods and practices,

- a bottom line gauge as the business survival is dependent on the profit generated from satisfying customers. QCD is a robust production tool which has a measurable impact on manufacturing efficiency; it assists to improve competitiveness, develop businesses and increase profit.

However, these measures are designed to provide a reasoned and overall analysis of production performance and provide the basis of continuous measurement and improvement but are not intended to be treated as a Lean audit. Likewise, Bicheno's (2009) essential measures of Lean; namely:

- lead time,
- customer satisfaction,
- schedule attainment and,
- inventory turns.

Similarly, Goldratt's (1990) proposed measures for supply chain effectiveness:

- throughtput dollar days and
- inventory dollar days.

Furthermore, the QCDMMS; an acronym for a set of measures that many Lean organisations exhibit at each line or area: (Henderson et al., 2003)

- Quality,
- Cost,
- Delivery performance,
- Morale,
- Management and
- Safety

are commendable measures to aid efficiency but not intended to be utilised as an audit to measure Lean. Table 5.2 provides a summary by emphasising the most salient points of the Lean audits discussed and evaluated earlier.

The Relative strengths and weaknesses of the prominent Lean audits considered		
The Lean audit	**Strengths of the approach**	**Weaknesses of the approach**
Eugene Goodson	• It's easy to learn, quick to put into practice, and it produces results in a day or less • Looks at customer satisfaction, safety and H&S issues, • Looks at HR i.e, teamwork and motivation,	• the sustainability indices not paid sufficient attention, • the change process not directly examined though makes reference to recognition of employees and work force involvement • indices viewed in isolation and little evidence exists of the real associations between the categories

Shingo Prize	• Its flexibility and application which can be applied to all sectors, • The criteria reduces confusion and assists to clarify objectives, • The criterion has altered to mirror expectations	• Protracted assessment process, • The application costs involved may deter some organisations, • Considerable debate remains regards its business value
EFQM Excellence model	• As an assessment model, it can facilitate benchmark comparisons • The linkages between the enablers and the results • Permits other benefits of self assessment such as a guide to TQM	• A general framework and not specific towards Lean • The empirical evidence of the correlations is unclear • Does not specifically identify the stage of a Lean journey achieved
Schonberger's principles	• Looks at the role of performance measurement • The measures direct organisations to become more demand led, to be organised by customer groups • Comparisons can be made with other organisations; consequently a benchmarking exercise is possible,	• fails to encapsulate it as a journey and consequently does not view Lean as an ideology, • the sustainability indices not paid sufficient attention, • the change process not directly examined though makes reference to the recognition of employees and work force involvement
Kobayashi	• Comparisons can be made with other organisations; consequently a benchmarking exercise is possible, • Good links with other keys; to perform well in one area, it is necessary for an organisation to shine in most of the keys • Looks at waste, 5S, team working, Continuous improvement, cross functional working, and the supplier relations,	• Looks at process and operations, but insufficiently into the impact of change on Lean, • Consequently culture and the need to treat Lean as an ideology is not examined, • Main issue – Lean should result in results – whole area not looked at in any depth,
Mann's audit	• Provides a solid and effective method of self assessment • Looks at processes associated with Lean carefully • Looks at overall process improvement and kaizen ideology	• whilst looks at the control and accountability process – insufficient emphasis on performance measurement • Not viewed as a journey and measures too static and not meant to promote improvement • Culture and change not paid sufficient emphasis
Henderson	• Looks at overall processes and the role of six sigma • Also concentrates on teamwork and change management through the "continuous pursuit of perfection" indices	• Sustainability and culture not paid sufficient emphasis, • Consequently culture and the need to treat Lean as an ideology not examined, • Main issue – Lean should result

	• Widens the concept of Lean away from the shop floor and looks at management styles too	in results – whole area not looked at in any depth,
Lee	• Looks extensively at nine key areas of manufacturing • Does evaluate the nature of team work within the organisation • Looks at the need to build lasting and effective relationships with the suppliers	• Culture and the need to treat Lean as an ideology not examined, • Main issue – Lean should result in results – whole area not looked at in any depth, • Change paid insufficient attention too
Shah and Ward	• Ten factors examined are regarded to constitute the operational complement, • the complementary and synergistic effects of the ten distinct but highly inter-related elements give Lean its unique character • none of the components are equivalent to the system, but together they constitute the system.	• Looks at process and operations, but insufficiently into Lean change, • Consequently culture and the need to treat Lean as an ideology not examined, • Main issue – Lean should result in results – whole area not looked at in any depth,

Table 5.2
Analysis of the Lean audits

5.4 The Role of Lean audits

Periodically an assessment should take place to investigate the overall status of an organisation's Lean standpoint. Equally the questions should represent the standards an organisation is striving towards. Often in any Lean assessment an organisation may need to redefine the standards it aims to achieve, since Lean is dynamic in nature. The assessment also informs an organisation of the progress it has made since the inception of Lean. Similarly, the outcomes of any assessment should assist to focus an organisation towards areas requiring further effort. Research (Mann, 2005) proposes that quarterly assessments are sufficient. The assessments should not be viewed as a customer based activity but undertaken on a regular basis and embrace the ideas of time and pace as important ingredients of Lean.

Likewise, if the assessments are to take place at 90-day intervals it is important to keep them simple and free of bureaucracy. Consider the size of the organisation in order to commence a regular program of assessment. Wherever, possible, it is useful to encourage team leaders to undertake an assessment. Ideally a unit's assessment score should be based on the appraisal undertaken by the leader of the next level in the organisation. Where this becomes impractical, a mixed model of assessors could be considered to retain the credibility and validity. Senior management should be involved in order to maintain a common understanding of assessments. Large sub-units could be assessed by a core of managers from other areas backed by internal managers. The number of categories will depend on the complexity of the operations and the organisation. Similarly, an examination of various dimensions is imperative since a single average would not induce appropriate action. An appropriate proposal is a radar screen profile which is used subsequently. When feasible to compare one unit over time a "*consistency*" (Mann, page 168) index should be developed.

5.5 A comprehensive Lean assessment

The proposed audit aims to establish the current status of an organisation on the Lean journey and proceeds to fit into the contemporary models. Some of the comparable views of Lean implementation are as follows:

- Feld (2001) divides Lean implementation into five phases; the Lean assessment, current state gap, future state design, implementation and finally continuous training,
- Harbour (2001) uses four stages; organisational development, discipline building, tool use and continuous improvement,
- Motley (2004) divides Lean implementation into six stages and they are: define value from the final customer's perspective, identify the value stream, map current and future states, develop a product focused organisation, introduce pull systems, and perfect the earlier steps of continuous repetition,
- Drew et al., (2004) examine five phrases; the preparatory stage, an assessment of the current state, defining a desired future state, implementing a pilot and finally continuous improvement.

5.6 The proposed seven stages of Lean

Lean should be viewed as comprising of a journey consisting of seven stages, which are depicted in Table 5.3. Organisations at the final stage will have experienced every one of the preceding six stages. Most organisations have failed to reach the summit stage and this is reinforced by the lack of successful Lean implementations. Whilst the aspiration should always be the ideological stage it recognises that if the status quo is to be maintained, the philosophy of continuous improvement needs to be fully incorporated. The Cylinder chart (Figure 5.1) outlines the seven stages an organisation is regarded to encounter in its quest towards being classed as an organisation achieving complete Leanness. It indicates the percentages against the various stages of Lean. The length of time spent on each juncture is dependent solely upon an organisation's willingness to tackle issues such as culture, remuneration systems, the lack of training, choice of the appropriate tools and their implementation at a suitable time.

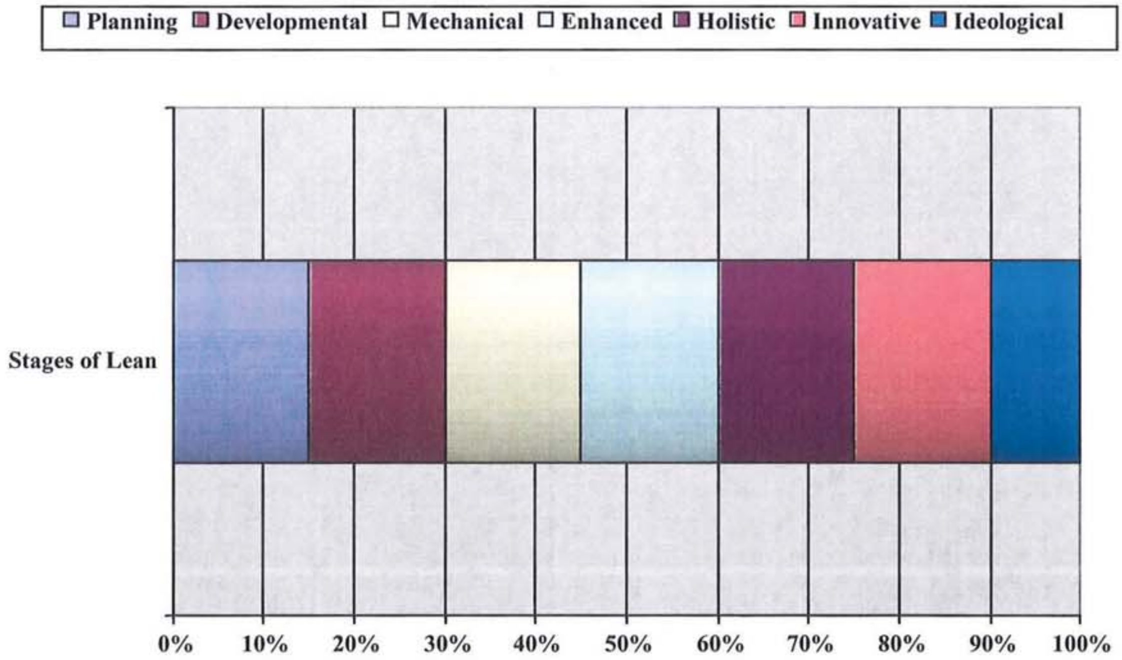


Figure 5.1 Lean Stages

Figure 5.1 illustrates graphically the percentage scores allotted to each juncture on the Lean journey and these are summarised below:

- Planning - 0 - 15%
- Developmental - more than 15%
- Mechanical - more than 30%
- Enhanced - more than 45%
- Holistic - more than 60%
- Innovative - more than 75%, and
- Ideological - more than 90%

Table 5.3 lists the seven stages and provides an indication of the core characteristics that would be exhibited by an organisation at each respective Lean phase.

Stages of a Lean Journey	
Seven Stages	**Indicative organisational characteristics**
Planning	No implementation; benefits evident but no infra-structure and no organisational decisions have been implemented
Developmental	Implementation started; pilot area selected and work commenced; no roll out; few tools with little subsequent commitment; may have been implemented in other areas; importance of culture not recognised
Mechanical	Pilot progressing well; few tools embedded within internal organisation but largely within manufacturing only; tools are implemented in a piecemeal fashion with little consideration of correlations; importance of culture not recognised

Enhanced	Pilot proven successful; roll out programme progressing in other key areas within the internal organisation; predominantly manufacturing based; recognition that culture and the organisational practices need addressing but few tangible signs visible towards accomplishing this
Holistic	Roll out programme on track; internal organisation nearly incorporated; suppliers embraced and signs towards integration of the whole value chain; organisational and cultural developments still in their infancy
Innovative	Lean principles applied across the whole internal organisation; good progress towards integrating across the whole value chain; some cultural and organisational development issues fully implemented but further progress required; ingrained as a strategy
Ideological	Lean tools, culture and organisational practices alongside the ideology implemented across every component of the value chain; recognised as a combination of value streams, Lean viewed as the way of working with a quest for perfection apparent

Table 5.3
Lean stages clarified

In summary an organisation would only be deemed to have incorporated Lean as a philosophy if the ultimate stage has been achieved and is being sustained.

5.7 The Proposed Audit

The audit has twelve distinct sections and encompasses respective indices in each category as depicted below (Table 5.4). Within the audit, an indication is specified regards what would score a one and what would secure a ten against each criteria. Ultimately the total score can deduce the phase of the Lean journey the organisation occupies.

1]	**Overall Safety, Cleanliness and Orderliness**	
Criteria	**Rating of one**	**Rating of 10**
Health and Safety	Completely unsafe, many hazards and poorly enforced procedures	Totally safe; no hazards with full adherence to polices
Cleanliness	Very dirty with no procedures for general maintenance	Spotlessly clean coupled with a structured cleaning program for administration areas too
Orderliness	Absolutely cluttered; very disorganised and much time is wasted trying to find tools	Just necessary items readily available; clear markings for tools
Maximum points = **Points scores = divided by 3** **Category score =**		

2]	**Production and Operational Flow (JIT)**	
Criteria	**Rating of one**	**Rating of 10**
Continuous flow	Very disjointed with large batches and groups of machines	Sophisticated flow and very small batches
Process Definition	Generally only in print form and very often out of date	Expected performance of all processes defined and documented; documented processes match actual processes
Pull	No planning; production	Robust Kanban system, MRP only for

	to forecasts with substantial MRP use	planning and is built to customer demand only
Line switches and Machine Setup	Virtually hours	Line switches within one TAKT time, batch change in less than 10 minutes
Customer Service and Scheduling	Totally separate function and is heavily MRP driven	Total integration; one hour between order entry and the order on the shop floor; scheduling takes place at cell level
Maximum points = **Points scores =** **Category score =**	**divided by 5**	

3]	**Processes and Operations**	
Criteria	**Rating of one**	**Rating of 10**
Ability to accommodate fluctuations in short-term customer demand	Cannot easily adapt or finds it very difficult	Can easily adapt up to 25%
Responsiveness to changes in product mix	Very difficult	Poses no problems
Manufacturing steps organised in work cells or whereby there is zero WIP between them	Less than 25%	75% or above
Manufacturing process	Each operation has its own independent schedule	Exclusively one-piece flow
Manufacturing process engineering	Large size lot sizes which are mostly office based	Machine designed for flow and not capacity; equally there is full factory floor representation
Total Productive Maintenance	Essentially not in existence	A thorough TPM system
% maintenance spent on unplanned or emergency repairs	More than 40%	10% or less
Average OEE of production equipment	Generally less than .60	Overall 0.85 or above
Quick changeover or SMED training of 8 or more hours is provided	Less than 15% of workforce	More than 50% of the workforce
Maximum points = **Points scores =** **Category score =**	**divided by 9**	

4]	**Visual management**	
Criteria	**Rating of one**	**Rating of 10**
Visual Pictorial Presentation	Not present	Totally prominent; team performance stated in the offices too
Warehouse inventory	Random access locations and computer driven	Totally fixed locations with clear minimum and maximum inventories
Shop floor inventory	Totally minimum control; mostly stacked in work locations in random order	FIFO adherence, fixed locations and Kanban squares utilised

Visual indicator update	Hardly ever used	Continuously in use
Visual controls to support production	None in evidence	Data tracked regularly for trends to spot problems; used for root cause solutions
Maximum points = **Points scores =** **Category score =**	**divided by 5**	

5]	**Quality designed into the product**	
Criteria	**Rating of one**	**Rating of 10**
5s is integral in the Design process	None existent	Totally integrated
Equipment designs identify defects and stop production	None existent	Total stoppage when faults occur
Authority to operatives to stop production	None existent	Virtual individual authority is granted
Mistake proofing to avert defects	None existent	Total usage on all essential processes
FIFO inventory	None existent	Total adherence
Closed loop quality problem solution	None existent	All problems have a detailed development plan
Root cause problem solving	Totally rare and when used it is by formal technical project teams	Routine methodological approach to root cause solutions
Standardised working and maintained	No work standards	Fully standardised with monthly reviews and updated as required
Goods-in Quality	No self certified suppliers	All key suppliers are self certified and constantly updated
Visual Controls	None in evidence	Regularly analysed to identify top three interrupters/problems; lead to root cause problem solving
% of Production processes controlled by SPC	Less than 15%	More than 70%
Product engineering	Little contact with customers; new designs take over one year	Joint effort with new designs taking less than six months
Disciplined adherence to Process	Attention mainly on exception in results	Pareto drives improvements; frequent reviews of production and related processes
Maximum points = **Points scores =** **Category score =**	**divided by 13**	

6]	**Continuous Improvement**	
Criteria	**Rating of one**	**Rating of 10**
Process of Change implementation	None existent	Whole organisation responds and requests for support; response within two days

Change implementation	Instigated by engineers and management approved	Most personnel have authority and responsibility to implement change
Impact of change is tracked	Results are not communicated or seldom even collated	Results are clearly communicated and measured objectively
Operators and office personnel have regular meetings	Very occasionally, averages to less than one per month	Everyday for about 10 minutes and 30 minute weekly meetings
Continuous improvement team	Not existent	Large numbers following established rules with quantifiable results
Process improvement	Made by formal project teams or in response to disasters	Line leaders see this within their responsibility
Waste Culture	Not existent	Total commitment
Tracking the results of Lean	Totally ad hoc or at Board meetings only	At Weekly process Meetings
Use of Advancing Technology	Manual line design, paper based Kanban-support; No ERP solutions	Integrated solution; real time scheduling and based on order mix; enterprise level tracking and score carding
Maximum points = **Points scores =** **Category score =**	**divided by 9**	

7]	**Lean Change Strategy**	
Criteria	**Rating of one**	**Rating of 10**
Top management Support	Support viewed as lip service	Total and active support from top management
Recognition of prevailing Culture	Simply imposing other organisation's experiences	Full effort to alter behaviour
Lean Champion is evident	Not clear who has overall Lean responsibility	Clearly communicated strategy regards the Lean Champion
Linking Culture to the organisation's performance	No effort exerted; Felt no relationship between the two	Total recognition of the association; every effort to link the two
Consistent Vision is needed	No clear message	Lean becomes the underlying vision
Roll-out of Lean	Little consistency and no evidence of continuous improvement	Possible to audit trail it from the pilot stage to the entire value chain
Future State Maps exist	No attempt to view the future Lean journey	Systematic Lean journey clearly evident
Sensei and other experts used	Occasional assistance from experts and not internalised	Working eventually towards internalising the expertise
Continuous improvement and compensation link is evident	No efforts made to explore this correlation	Every effort made as it is recognised that these two are correlated
Promotion of Positive culture	Little evidence of sustaining or adapting a more conducive culture	Combining culture and strategy; viewing Lean as a never ending journey

Genuine efforts to cascade a culture promoting greater Stability in a changing environment	No genuine efforts to maximise stability	Every effort is made to maximise stability, i.e., schedule changes, program restructures and procurement quantities
Sub-cultures recognised	No effort to deter or recognise sub-cultures	Recognised but strenuous efforts made to ensure that the aims/objectives stay the same
Maximum points = **Points scores =** **Category score =**	**divided by 12**	

8]	**Lean Sustainability**	
Criteria	**Rating of one**	**Rating of 10**
Application of the Lean Tools	Embraced few – generally 2 or less tools	Simultaneous application of 6 or more timely and relevant tools
Lean Toolbox sustainability	Two or less tools have been in operation for several years with little expansion	Simultaneous application of 6 or more appropriate and relevant tools for three or more years
Areas of Application	Limited to the few manufacturing areas only	Across the whole value chain and spread to suppliers too
Lean Departments	Less than 10% operating under Lean conditions	Over 70 % of the organisations Cost Centres operating under Lean conditions
New Market development	None and evidence of maturing markets	New markets constantly being secured
Sales from new products – less than 5 years	Less than 10%	50% or more
Not seen as a value stream	Concentration on one product value stream only	Recognised and viewed as combinations of value streams
Maximum points = **Points scores =** **Category score =**	**divided by 7**	

9]	**Culture – Employee oriented**	
Criteria	**Rating of one**	**Rating of 10**
Levels of Hierarchy	Highly layered; generally 4 or above between the General Manager and the Shop Floor	Very flat structure
Organised by customer families	Little attention is paid to organising flow to the product families	Total organisation is dictated by customer families
Process focused management	Little ownership of the processes	Total ownership and people recognise how they are assisting customers
Organisational structure	Divided by departments	Fully integrated
Self Directed teams	Essentially none	Evidence of a high degree of team empowerment in making decisions

Employees participated on improvement teams in the last 6 months	Less than 15%	80% or more
Team empowerment	Virtually none	Full allocation of responsibility and authority
HRM training	Not existent or very limited	Quite extensive; can be in excess of 80 hours per employee annually with quantifiable achievements
Styles of leadership	Totally autocratic	Participative
Communication	Bureaucratic	Very open communication
Maximum points = **Points scores =** **Category score =**	**divided by 10**	

10]	**Organisational Culture – organisational practices**	
Criteria	**Rating of one**	**Rating of 10**
Overall self reliance	Little control of outsourced products / services	Total control though organisation retains its internal capability
Finance and administration control	Traditional standard costing and not integrated with the rest of the functions	Lean accounting procedures clearly evident; metrics in existence to help the shop-floor
Purchasing approach	Suppliers seen as adversaries and MRP driven	Full involvement and is kanban driven; "*Supplier Development Teams*"
Early involvement of suppliers	Very rarely	Company policy
Purchasing idealism	Constant conflict with other departments	Fully integrated
Human Resources	Seen as a traditional staff role	Recognised that training and communication will bring the culture in line
Lean Leadership at all levels	Not obvious and ad hoc system of distinguishing Lean leaders	Clearly visible Lean leaders at all levels supporting people
HRM evaluations	Only the senior management	Often a 360° approach with continuous support for both personal and professional growth
Compensation	Directly correlated to the seniority of management positions	Skills based
Lean transformation responsibilities are assigned	Ad hoc communication and Lean responsibilities	Fully communicated and the duties of Lean are fully assigned
Marketing	Marketing seen as a separate function and not part of the organisation	Promotion, marketing and selling of every improvement
Office Layout	Managers offices are not readily available to the shop floor	Offices with transparent glass with easy access

Daily accountability process	Plant and Value meetings focus only on production / shortage issues	Accountability is routine; supervisors grasp concepts; use basic project management skills
Maximum points = **Points scores =** **Category score =**	**divided by 13**	

11]	**Lean treated as a Business**	
Criteria	**Rating of one**	**Rating of 10**
Formal strategic planning undertaken	Ad-hoc planning and Lean treated similarly	Detailed five year plan whereby Lean plays a key role
Future State Maps exist	No attempt to view the future Lean journey	Lean journey clearly evident
Metrics include categories in financial, process, customer satisfaction, quality, employee satisfaction , future and supplier performance	Two or less categories are covered and not comprehensively	All categories are covered comprehensively
Metrics linked to the key success factors and / or strategic goals and objectives allowing us to differentiate ourselves from competitors	Measures are either too many / too few or no alignment to the overall Lean journey	Lean measures are fully aligned to the immediate and long term Lean journey
Metrics are fully understood and impact of individuals on the company performance	No ownership and little knowledge regards the impact an individual's performance would have on the organisation	Employees understand the metrics and recognise how their individual performances impact company performance
Link between value streams and competing streams or support functions is clear	The two seen as totally different and not impacting on each other	Recognition that altering a value stream impacts on a competing stream or the support functions
Lean not viewed tactically	Lean seen to be limited to manufacturing alone	Lean seen as an overall strategy (not as manufacturing alone or as one strategy)
Lean viewed as market supremacy	Lean simply seen as a cost cutting exercise	View of Lean is that it will lead to market supremacy
Lean not limited to operational improvements	Lean and operational improvements seen as the same package	Broader view of Lean; higher profits and its ability to compete
Maximum points = **Points scores =** **Category score =**	**divided by 9**	

12]	**Philosophy**	
Criteria	**Rating of one**	**Rating of 10**
Definite clarity of vision	Organisation has little idea of its Lean journey	Lean journey fully mapped out
Way of thinking	Lean seen as a process but	Lean is viewed as a way forward

	with little commitment	for the organisation
Lean seen as an ideology	Little or no commitment	As an ideology, (not religion) since statements are challenged
Tools viewed as techniques	Lean and tools seen in isolation	Tools seen as techniques devised to solve problems
Training culture	Isolated with little overall strategy	Training geared towards changing behaviour
Process focused management	Not in evidence at all	Process focused leadership geared totally towards the customer
To build a successful and robust Business	Simply a cost conscious culture	Profit remains the ultimate but through a successful and robust business
Reflection becomes the norm; clear expectations from Lean	Reflection is on a very ad hoc basis	The implementation plan is regularly reviewed
TPS not the Toyota Way	TPS is seen in a restricted fashion with emphasis on the tools solely	TPS treated as an ideology but is adapted to local conditions
Maximum points = **Points scores =** **Category score =**	**divided by 9**	

Table 5.4
Proposed Lean Audit

Consequently, the maximum score an organisation can attain over the twelve sections is 1,040 points since there are 104 individual indices. Consequently, the scores were divided amongst the seven phases and the scoring system is summarised in Table 5.5:

Lean Assessment scoring system		
Lean stage	**Required Points**	**% of the maximum score of 1,040 points available**
Ideological	**936**	**> 90%**
Innovative	**780**	**> 75%**
Holistic	**624**	**> 60%**
Enhanced	**468**	**> 45%**
Mechanical	**312**	**> 30%**
Developmental	**156**	**> 15%**
Planning	**0 – 155**	**≤ 0% - 15%**

Table 5.5
Audit Scores

Accordingly, an organisation could secure a marking of, for instance, 550 points; according to the table this places the respective organisation at the "*Enhanced stage*". Consequently, whilst still pursuing this hypothetical example the fictitious organisation has three probable Lean courses of direction:

- It may progress to the next stage by tackling the existing barriers,
- It could stay at this level but never reap the full benefits Lean offers, or
- It fades and either settles at a lower phase or its Lean journey begins to fizzle out.

The ideological stage is tantamount for an organisation viewing Lean as a philosophy and the juncture that any organisation hoping to reap the full benefits Lean has to offer.

5.8 Validation of the Audit Results

In order to assess its viability the meticulous audit was undertaken in twenty organisations who had clearly articulated that they were on the Lean journey. The full audit results of the twenty companies are included in Appendix Three; Table 5.6 compares the Mean and Standard deviation of the best performing five organisations as opposed to the remaining fifteen.

		Mean	Std. Deviation	Number
Rest of companies	Turnover of the group last year	2.87	1.19	15
	Number of employees	1298.53	1356.04	15
	Aggregate gross assets	2.53	0.74	15
	Lean Stage	4.33	0.82	15
	TOTAL SCORE	471.53	119.04	15
	PERCENTAGE AVERAGE	45.35	11.43	15
	Overall safety, cleanliness and orderliness	18.13	4.42	15
	Production and operational flow	27.67	6.83	15
	Processes and operations	48.20	10.33	15
	Visual management	26.27	6.64	15
	Quality designed into the product	65.60	17.96	15
	Continuous improvement	43.33	12.86	15
	Lean change strategy	53.60	15.59	15
	Lean sustainability	33.60	12.21	15
	Culture employee oriented	40.67	9.19	15
	Organisational culture - organisational practises	51.80	14.86	15
	Lean treated as a business	33.40	10.68	15
	Philosophy	29.27	8.71	15
	Number of employees	2.07	0.80	15
Best performing	Turnover of the group last year	2.60	1.34	5
	Number of employees	719.60	928.88	5
	Aggregate gross assets	2.00	1.00	5
	Lean Stage	2.80	0.45	5
	TOTAL SCORE	703.60	80.68	5
	PERCENTAGE AVERAGE	67.66	7.76	5
	Overall safety, cleanliness and orderliness	21.60	2.70	5
	Production and operational flow	32.60	6.31	5
	Processes and operations	58.20	14.62	5
	Visual management	35.40	2.61	5
	Quality designed into the product	84.80	10.43	5
	Continuous improvement	58.00	13.04	5
	Lean change strategy	81.60	10.45	5

	Lean sustainability	52.80	3.49	5
	Culture employee oriented	67.80	5.93	5
	Organisational culture - organisational practises	89.00	9.46	5
	Lean treated as a business	64.80	6.76	5
	Philosophy	57.00	7.62	5
	Number of employees	1.80	0.84	5
Total	Turnover of the group last year	2.80	1.20	20
	Number of employees	1153.8	1265.99	20
	Aggregate gross assets	2.40	0.82	20
	Lean Stage	3.95	1.00	20
	TOTAL SCORE	529.55	149.81	20
	PERCENTAGE AVERAGE	50.93	14.40	20
	Overall safety, cleanliness and orderliness	19.00	4.28	20
	Production and operational flow	28.90	6.90	20
	Processes and operations	50.70	11.97	20
	Visual management	28.55	7.10	20
	Quality designed into the product	70.40	18.26	20
	Continuous improvement	47.00	14.15	20
	Lean change strategy	60.60	18.89	20
	Lean sustainability	38.40	13.60	20
	Culture employee oriented	47.45	14.66	20
	Organisational culture - organisational practises	61.10	21.32	20
	Lean treated as a business	41.25	16.98	20
	Philosophy	36.20	14.83	20

Table 5.6
Comparison of Mean and Standard Deviation

The following three sub-tables (Table 5.7) provide the audit scores recorded from the audits undertaken in the respective organisations and are grouped by the size of the organisation:

Company	Organisation Size	Lean Stage	TOTAL SCORE	%
Trentex Engineering Ltd	**Small**	**Mechanical**	**355**	**34%**
Fletcher Moorland	**Small**	**Mechanical**	**345**	**33%**

Company	Organisation Size	Lean Stage	TOTAL SCORE	%
Drayton Beaumont.	**Medium**	**Mechanical**	**341**	**33%**
Excel (Electronics) Assemblies	**Medium**	**Holistic**	**628**	**60%**

Timkin Aerospace (UK)	**Medium**	**Holistic**	**628**	**60%**
Blanc Aero Industries (uk) Ltd	**Medium**	**Enhanced**	**474**	**46%**

Company	Organisation Size	Lean Stage	TOTAL SCORE	%
Unilever UK (foods)	**Large**	**Holistic**	758	**73%**
Ina Bearing Company Ltd.	**Large**	**Holistic**	**664**	**64%**
Ilford Imaging Ltd,	**Large**	**Mechanical**	**349**	**34%**
Corus Colours Group	**Large**	**Holistic**	**693**	**67%**
Scapa (UK) Ltd	**Large**	**Enhanced**	**477**	**46%**
Ford Motor Company,	**Large**	**Holistic**	**625**	**60%**
Ricardo	**Large**	**Mechanical**	**373**	**36%**
Vauxhall Motors	**Large**	**Innovative**	**811**	**78%**
Royal Doulton (UK) Ltd,	**Large**	**Developmental**	**298**	**29%**
3M (UK) PLC	**Large**	**Enhanced**	**570**	**55%**
Leoni Wiring,	**Large**	**Enhanced**	**544**	**52%**
BMW engines.	**Large**	**Enhanced**	**541**	**52%**
Jaguar Cars Ltd,	**Large**	**Enhanced**	**585**	**56%**
Perkins Engines	**Large**	**Enhanced**	**532**	**51%**

Table 5.7
Lean Audit Scores

The scores are reflected on the graph below – Figure 5.2; the range of scores recorded was 29% (Royal Doulton) to 78% (Vauxhall Motors). The graph further summarises the results of the sub-tables and reflects that the top performing companies were: Vauxhall Motors (78%), Unilever (73%), Corus Colours (67%), Ina Bearing Limited (64%) and Excel electronics (61%).

In order to gauge the potential feedback from an organisation, after the extensive audit it was considered crucial to device another questionnaire, which permitted the respective organisation to comment on the results and the general feedback they had received. Moreover, the research (Ligus 2007, Mann 2005) implies that unless there exists a general concurrence from the organisation regarding the audit results, no initiatives will be instigated to rectify the problem issues. Astoundingly, it was gratifying to note that whilst every organisation may have not readily wished to have received the detrimental comments and scores in the audits undertaken within their organisation; the feedback questionnaires included as appendix three showed that the "*overall agreed score*" quoted in the last column, scores an eight or nine out ten from every one of the twenty organisations. Table 5.8 provides a summary of the feedback received from the twenty organisations audited once the results of the audit (Appendix two) had been undertaken and the results (appendix three) communicated back to each respective organisation audited. Consequently, the proforma used in appendix four was devised to capture feedback from the respondents of the twenty organisations in which the audit was undertaken.

Table 5.8 lists the twenty organisations in the first column; columns two and three provide the audit score and the corresponding Lean stage awarded to each respective organisation. The penultimate column states the range of scores awarded by the organisation on the scores they had received on each of the twelve categories assessed in the audit; the respondents were asked to award a mark of between 1 to10; a "1" if they totally disagreed and disputed the audit score given to their organisation; a "10" if they unequivocally agreed with the audit score given to their organisation. The last column indicates that every organisation felt that there existed an 80% or 90% consensus with the overall audit mark. This is despite the fact that certain organisations when asked to comment on the audit, may have contested certain individual category scores; Excel Electronics and Fletcher Moorland, for instance, on individual categories had awarded a five. This specified that they may have not agreed with the audit score awarded to one or more categories but still agreed with the overall audit. Table

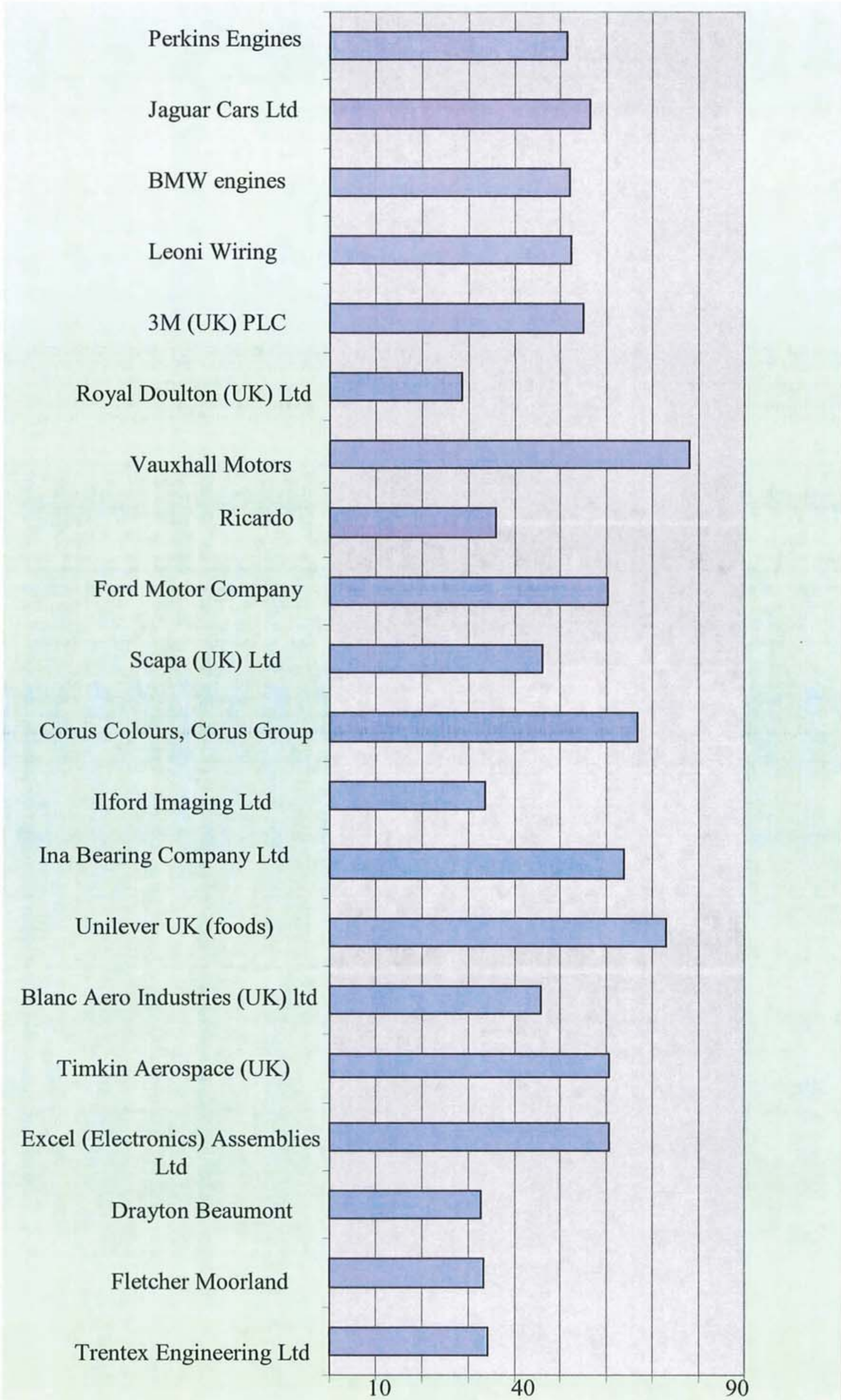


Figure 5.2
Lean Audit scores

5.8 provides a summary of the individual responses received from the respective organisations as depicted in appendix 4.

Feedback from organisations on the Lean Audit Score				
Organisation	**Lean Audit %**	**Lean Stage**	**Range of Scores Given**	**Overall agreed Score**
3M (UK) Plc	55%	Enhanced	8-9	**8**
Blank Aero Industries	46%	Enhanced	8-9	**9**
BMW Petrol Engines	52%	Enhanced	6-10	**8**
Corus Colours Group	67%	Holistic	8-10	**9**
Drayton Beaumont	33%	Mechanical	8-10	**9**
Excel Electronics	61%	Holistic	5-9	**8**
Fletcher Moorland Ltd	33%	Mechanical	5-10	**9**
Ford-Bridgend Engine Plant	60%	Holistic	8-9	**9**
Ilford Imaging Limited	34%	Mechanical	8-9	**9**
Ina Bearing Company Ltd	64%	Holistic	7-9	**9**
Jaguar Cars	56%	Enhanced	6-10	**8**
Leoni Plc	52%	Enhanced	8-10	**9**
Perkins Engines	51%	Enhanced	7-10	**9**
Ricardo	36%	Mechanical	8-10	**9**
Royal Doulton Plc	29%	Developmental	8-10	**9**
Scapa	46%	Enhanced	8-10	**9**
Timkin Aerospace	60%	Holistic	8-10	**9**
Trentex Engineering	34%	Mechanical	8-10	**9**
Unilever	73%	Holistic	6-9	**8**
Vauxhall Motors Ltd	78%	Innovative	8-10	**9**

Table 5.8
Feedback on Audit Scores

5.9 Relevance of the Lean Audit

A total of 104 indices are used in the audit developed. Undoubtedly, every single measurement is unlikely to be equally important to every manufacturing organisation on all occasions. Nonetheless, whilst the rationale behind the audit's development and pilot has been explored, it is evident that large components of the audit are totally flexible and can be applied to any manufacturing organisation. In total ten categories and their respective indices could be applied to any organisation on the Lean journey; namely:

- Overall safety, cleanliness and order,
- Visual management,
- Quality designed into the product,
- Continuous improvement,
- Lean change strategy,
- Lean sustainability,
- Culture – employee oriented,
- Organisational culture – organisational practices,
- Lean treated as a business and
- Lean philosophy.

Likewise, the two remaining categories and relevant indices; namely:

- Production and operation flow,
- Process and operations,

would compel minor adjustments to certain indices in order to make them appropriate to be utilised within the respective organisation. This is reliant on the type of process and industry involved.

Under "*Processes and Operations*" component of the audit (Appendix 2), for instance, one of the individual measurements with an indicative rating of one or ten as depicted in Table 5.9 looks at the OEE of production equipment:

Criteria	Indicative scoring		Comments
	Rating of one	**Rating of ten**	
Average OEE of Production equipment	Generally less than .60	Overall 0.85 or above	

Table 5.9
Audit Measurement

Undeniably, an OEE of 0.85 or above may not apply in every situation as a generic guide. Nonetheless, by using appropriate benchmarking methodologies a credible target could be established to make a judgement regards the organisation in question. Likewise, certain other indices may require adapting as is mentioned in the subsequent sections that the market characteristics of an industrial sector should influence the production strategy chosen. A push system can be effective for component manufacturers given unstable customer demand and short term customer relationships. Lean practices do not provide a compelling competitive edge in all operational practices. Undeniably, for many smaller organisations involved in contract manufacturing, some Lean practices, such as cellular manufacturing, becomes much more challenging. A small organisation with many different categories of customers and a schedule that changes all the time, may struggle to guarantee the consistency required to set up cells.

5.10 Summary

The transition to a Lean operating environment is a difficult undertaking. Ensuring that the transition itself is carried out in a Lean and value added manner is an important first step in developing the discipline and culture necessary to sustain the continuous improvement towards a Lean environment. Whilst the feedback from the twenty organisations regards the aptness of the audit was most encouraging it was necessary to identify that Lean may not be appropriate in every situation. In respect to audits and awards, true Lean companies such as Toyota and Danaher would consider their value from the customer's perspective. The next chapter clarifies the new knowledge and the research conclusions. This is realised by revisiting the original research objectives to resolve whether these were indeed met. Moreover, certain inherent limitations of the research are explored and a proposal for additional future research is presented. The chapter culminates with a section on the overall generic conclusions of the research.

CHAPTER SIX

DISCUSSION and CONCLUSIONS

6.0 New Knowledge and the Research conclusions

6.1 Introduction

This chapter clarifies the new knowledge and the research conclusions. This is achieved by revisiting the original research objectives in order to determine whether they were met. Moreover, certain inherent limitations of the research are explored and a proposal for additional future research is presented. The chapter culminates with a section on the overall generic conclusions of the research.

6.2 The Research objectives

The predominant objectives were as follows; to

i. Establish whether organisations embracing Lean as a philosophy actually performed better. It was necessary to advance the research beyond the financial accounts of the respective organisations. Consequently an adapted version of a scorecard proposed by Maltz et al., (2003) was used to gauge the performance of organisations as a direct consequence of adopting Lean. In order to evaluate this it was necessary to judge their performance utilising key strategic, operational and related indices in an attempt to investigate the future potential of the organisation,

ii. Wholly ascertain the stage an organisation actually embraces Lean as a philosophy. Consequently, there was a need to specifically and precisely determine whether an organisation has adopted "*Lean as a philosophy*" as opposed to another process or strategy. This required the need to clarify accurately what is meant by philosophy within the Lean context. In testing this objective, various aspects were considered; the prominent aim was to fully open this debate and to elucidate aspects required to be evaluated when determining how it would be feasible to conclude that an organisation views Lean as an ideology; namely:

- Lean becomes the way of thinking,
- concept of continuous improvement is fully embraced,
- An appreciation that Lean is an integration of a complete system,
- A recognition that Lean is not synonymous to religion,
- Lean has to produce profits and consequently has to be treated as a business model,
- Lean should not be viewed as having a final destination,
- The Importance of developing people is fully acknowledged,
- An implementation programme of the appropriate Lean tools is in place,
- To simultaneously apply five or more of the technical tools depending on the stage of the implementation,

- The tools should be considered as mechanisms to observe problems and not the actual solutions,
- Any organisation should not confuse local tools in the TPS with universal solutions,
- Lean is extended to the entire value chain,
- There persists a clear clarity of vision,
- make numerous cultural changes embracing empowerment and sponsor the Lean principles through-out the value chain and
- make substantial organisational changes such as the accounting methodologies utilised, links with marketing and logistics, the metrics used and a training culture,

iii. Identify the stage of the Lean journey an organisation has attained. This involved the need to develop a framework in order to markedly identify the stage an organisation occupies on its Lean journey.

6.3 Main conclusions of the research

The conclusions were derived as a result of data captured in 68 organisations that had consented to partake in completing the survey questionnaire together with seven extensive case studies. SPSS version 13 assisted to validate the analysis whereby both parametric and non-parametrical tests were undertaken. Initially the primary objective will be revisited in order to ascertain whether organisations deemed to consider Lean as a philosophy did outperform their counterparts.

6.3.1 Performance of larger organisations

An important corresponding factor emerged suggesting that larger companies were more successful through the adoption of Lean. Due to the scorecard devised, it was feasible to identify the impact of Lean on the performance of the organisations. The "financial" indices represented the very short term whereas the "future" looks at the very long term. The effect of Lean on the customers, internal processes and people was also sought through the various indices. In total 36 indices were used to make an informed judgement on the actual impact of Lean on the organisation. The Performance Factor (the sum of the five category averages as depicted in Table 4.5) was considered an appropriate gauge to measure each organisation's performance. Various underlying reasons were exposed which may have contributed towards this enhanced performance level.

6.3.1.1 Lean application

Irrefutably, a principal consideration was the application of Lean across the entire value chain. The literature had indicated the crucial importance of applying Lean through the value chain. Within the case studies Lean was only applied in some units of manufacturing or supply or across the whole of the manufacturing or supply functions. None of the seven companies had embraced Lean across the whole internal organisation and consequently not across the value chain. The survey responses across the 68 organisations depicted the following position in ranking order; namely that Lean was applied:

i. Across the whole internal organisation (40%),
ii. Few tools only were embraced (30%),
iii. Across some units of manufacturing or supply (30%),
iv. Across the whole value chain (30%),
v. Across manufacturing and supply functions (20%) and
vi. Across the manufacturing or supply functions (20%).

However, a revealing factor was exposed regards the larger organisations; when investigating whether Lean was administered across the value chain; the following overall picture was achieved:

- large organisations : 40%
- medium sized organisations: 25%, and
- small organisations : 20%.

This was reinforced by the question inquiring whether improving the supply chain remains an on-going aspiration (Appendix 1; Section C; question 6); the responses received were:

- 74% of the larger organisations responded positively,
- 53% of the medium sized organisations, and only
- 47% of the small organisations stated it as an aspiration.

6.3.1.2 Cultural implications

Culturally, the larger organisations excelled in some vital areas too; when asked weather "*The organisation promotes a culture which maintains the challenges of existing processes by proactive systems such as Standard Operating Procedures*" (Appendix One; Question E8) a response of 1-10 was sought with "10" suggesting total agreement with the statement; 77% of large, 57% of medium and only 42% of small organisations scored between 7-10. Likewise, when respondents were asked whether "*The organisation offers customer assistance to suppliers and maintains Supplier Development Teams*" (Appendix One; Question E9); 23% of large, only 6% of medium and 0% of the small organisations managed to secure a 9 or 10.

6.3.1.3 Lean Tools

Similarly, in any successful implementation, the application of the suitable Lean tools and at an appropriate stage is obligatory. It was interesting to discover that there was consensus amongst the Case Studies regards the top five tools engaged; pleasantly whilst only one ranking order varied, the top five tools were identical to those indicated in the survey questionnaires:

i. Kaizen / continuous improvement,
ii. 5's and general visual management,
iii. Process mapping,
iv. Attacking value and the seven wastes and
v. TPM.

In an examination of the Lean tools embraced, the top six tools in small, medium and large organisations were taken to achieve an average application. The average length the top six quoted Lean tools had been in operation was: 4.7 years for large, 3.3 years for the small and 3.1 years for the medium sized organisations.

6.3.1.4 Tracking of Lean

A vitally important ingredient is the process by which the Lean results are tracked. Lean needs to be treated as a business initiative and this requires the need to gauge how well the investment is performing; consequently, a thorough evaluation system is required. Consequently, in tracking of the Lean results it was revealed that it was undertaken in large organisations on the basis of 60% weekly and 83% monthly; in medium sized organisations it was 38% weekly and 63% monthly and for smaller organisations it was 50% weekly and 50% monthly. Whilst the enhanced performance of larger organisations was a secondary deduction the aforementioned analysis helps to explain the reasons for this superior performance level.

6.3.2 The best performing Organisations

Having observed that fifteen organisations revealed vastly better performances as recorded on the scorecard devised, it was imperative to try and deduce the underlying reasons for this enhanced performance level.

6.3.2.1 Lean barriers

Initially it was discovered how the best fifteen organisations reflected a very strong and negative association with the following potential Lean barriers (all significant at 0.01 level, two tailed):

	Correlation	**Sig**
• insufficient understanding of the potential benefits	- 0.8	0.000
• insufficient external funding	- 0.7	0.002
• lack of internal funding	- 0.6	0.053

		Correlation	Sig
•	insufficient senior management skills to implement Lean	- 0.8	0.003
•	insufficient supervisory skills to implement Lean	- 0.7	0.003
•	insufficient workforce skills to implement Lean and	- 0.6	0.002
•	the cost of the investment	- 0.6	0.002

This proved that in the highest performing organisations, the Lean barriers are either not permitted to cultivate and / or do not prevent the organisation from advancing on its Lean journey.

6.3.2.2. Prominent indices

Additional detailed investigations on the best performing organisations revealed a strong and positive relationship with the following factors:

		Correlation	**Sig**
•	The Aspirations of improving the supply chain management,	0.7	0.008
•	People Average,	0.6	0.002
•	Service quality,	0.6	0.003
•	On-time delivery (customer defined),	0.6	0.003
•	Depth and quality of strategic planning and	0.7	0.003
•	Customer average.	0.7	0.004

This revealed the importance of the "people" category which embraces the following individual indices:

- Employee perception surveys,
- Health and Safety per employee,
- retention of top employees,
- the quality of professional and technical development, and
- quality of leadership development;

and the "Customer" indices; namely:

- market share by product group,
- customer satisfaction index,
- customer retention rate,
- service quality,
- responsiveness and
- on-time delivery.

6.3.2.3. Sustainability

Equally when Lean sustainability was analysed; namely the proportion of an organisation's employees and departments operating under Lean conditions; the best performing organisations had 72.5% of the departments and 74.5% of employees operating under Lean as opposed to 54.7% of the departments and 55.4% of the employees in the remaining organisations. This was reinforced by a correlation of 0.7 at a 0.008 significance level in reference to the aspiration of "*improving the supply chain management*" in these organisations.

6.3.2.4 Tools in application

A vital question on the survey questionnaire inquired (D2; appendix 1) "*from the list of Lean tools indicate which one(s) apply to your organisation.*" Although, all organisations confirmed varying degrees of application, a thorough investigation of the best performing organisations revealed the following results regards the top three tools in operation:

i. Continuous improvement - 91%
ii. 5s and general visual management - 90%
iii. attacking value and the seven wastes - 88%

Conversely, the same question was posed to the remaining organisations surveyed and the same three tools were mentioned. However, it was the level of application that varied:

i. Continuous improvement - 80%
ii. 5s and general visual management - 79%
iii. attacking value and the seven wastes - 71%.

Consequently, in exploring this situation further, it was decided to compare an average length of application of the top six tools listed both in the best performing fifteen and the remaining organisations. Interesting results were discovered when an analysis was undertaken to deduce the application of the six top tools in place:

- the best performing organisations had an average of 82% application, whereas
- the remaining organisations had an average of 69% application.

6.3.2.5 Cultural differences

Through the extensive literature review, we were reliably informed that a key factor in every Lean failure was culture. Consequently, it was imperative that this was investigated further. Accordingly, for the ten key cultural questions asked in the Survey questionnaire, (section E; Appendix 1) organisations were asked to respond using a scale of 1-10 with "10" suggesting total agreement with the statement. When scores over the ten questions were analysed, the best performing organisations averaged 42% of the respondents scoring 8, 9 and 10 as opposed to 29% in the remaining organisations. This implies a considerably higher number of cultural factors to be in existence in the better performing organisations. In 60% of the cases the better performing organisations confirmed a higher score against each of the respective statements. This meant that the cultural conditions in these organisations were more conducive towards Lean. The questions had been chosen in order to decipher the prevailing culture of each organisation. Consequently, it was found that more of the cultural conditions regarded as essential for a successful Lean implementation existed within the better performing organisations.

6.3.2.6 Performance of the indices

Evidently, the scorecard devised and applied to all the organisations exposed that Lean had proven successful. The gap between the best fifteen organisations and the remaining was quite apparent. This is easily witnessed by the category averages; the remaining organisations' category averages in ranking order were as follows:

i. Process - 13.4%
ii. Customer - 11.1%
iii. Future - 9.7%
iv. Finance - 7.2% and
v. People - 6.2%.

The ranking order for the best performing fifteen organisations was as follows:

i. Customer - 30.7%
ii. Future - 26.6%
iii. Process - 25.9%
iv. People - 19% and
v. Finance - 13.4%.

Similarly, an exploration into the best performing seven individual indices (scorecard; section G; appendix One) reiterates this point aptly; the average for the remaining organisations was 15.1% as opposed to 38.4% for the best performing organisations. It was necessary to probe into the individual indices in more detail. The top seven separate indices reiterate this point pertinently; the seven highest performing indices for the remaining organisations were as follows along with one of the five categories to which each belongs too:

i. Cycle time 16% - process category
ii. Space productivity 15.9% - process category
iii. Raw material inventory 15.8% - process category
iv. WIP Inventory 15.7% - process category
v. Stock turnover 14.3% - process category
vi. Defects of critical components 14.1% - process category

vii.	Labour productivity	13.9% -	process category

Similar research on the best performing organisations revealed the following position:

i.	Customer satisfaction	53.7% -	customer category
ii.	Responsiveness	45% -	customer category
iii.	On-time delivery	40.2% -	customer category
iv.	Stock turnover	32.7% -	process category
v.	Raw material inventory	32.7% -	process category
vi.	Defects of critical products	31.1% -	process category
vii.	Depth and quality of strategic planning	30.9% -	future category

Although, the top seven indices for the remaining group of organisations all belonged to the "process" category; the top seven indices of the best performing organisations belonged to three different categories; namely "customer", "process" and "future". Moreover, the top three indices in reality belonged to the "customer" category which reinforced the importance placed upon the actual customer by the better performing organisations. Accordingly, the relevance of the "future" category was apparent; namely "*Depth and quality of strategic planning.*" Furthermore, the eighth individual highest performance measurement, *"% sales from new products (< 5 years)"* also belonged to the "future" category. Essentially this helped to confirm that the better performing organisations paid particular significance towards ensuring that their position of representing a superior performance was actually maintained.

6.3.2.7 Principal indices

In an investigation undertaken to resolve which indices contributed to the overall performance factor of each organisation revealed similarly engaging results. This factor is verified by the correlations of the individual Scorecard indices against the overall performance factor for every organisation.

	Correlation	**Significance**
• Profit after interest and tax,	0.6	0.000
• Rate of return on capital employed,	0.7	0.000
• Current ratio (current assets - current liabilities),	0.6	0.001
• Customer satisfaction index,	0.6	0.001
• Customer retention rate,	0.6	0.000
• Responsiveness (customer defined),	0.5	0.000
• Defects of critical products/components	0.6	0.002
• Employee Perception surveys,	0.6	0.001
• Retention of top employees,	0.6	0.001
• Quality of leadership development,	0.6	0.001

• Depth of quality and strategic planning	0.6	0.001
• Anticipating future changes	0.5	0.002
• New market Development	0.5	0.001
• New Technological Development	0.5	0.001
• % of Sales from new products	0.6	0.002

An important deduction centred on the non-financial facet; the financial indices were not considered more important than the remaining. Furthermore, the significance of all the five categories is represented. This substantiates that for an organisation to achieve a good performance, it needs to excel in each category. This was validated by the association discovered between the average for each of the five categories, as per the scorecard, and the main performance figure for the entire sixty-eight organisations. In ranking order the correlation between the average of each category and the overall performance figure for the organisations was as follows:

i. People - 0.5
ii. Process - 0.6
iii. Finance - 0.7
iv. Customer - 0.7 and
v. Future - 0.7

Again, this clarified that for an organisation to perform well, it needs to excel in each category and not the finance components alone.

Equally, a glance at the correlation between the averages for each section, as represented in the scorecard, shows the relationship as follows: Finance and future (0.6); the process indices and people (0.71). The Customer indices had a high correlation with process (0.64), people (0.62) and future (0.66); whereas the Future indices besides the finance (0.60) and customer (0.66) indices also had a strong relationship with the people indices (0.72). Consequently the conclusion could be made that the most important indices in ranking order affecting the overall performance are:

i. Future
ii. People and the
iii. Customer indices.

This is enormously revealing since it shows the impact of the non-finance indices.

6.3.3 Lean Audit results

In a major verification exercise, the extensive Lean audit was undertaken in 20 organisations between June 2007 and July 2008. Primarily, the results were based on the Wilk's Lambda and related to the strategies:

- Overall safety, cleanliness and orderliness (λ=0.870),
- Production and operational flow (λ=0.899); and
- Processes and operations (λ=0.862)

prove to be not different for the best performing group of companies (which means they are common characteristics only for the five best), and may be a distinguishing factor in which these five organisations differed from the other companies. Accordingly, further statistical analysis was undertaken to decipher the important correlations from the Lean Audit; the following were attained for the relevant strategies:

- Lean sustainability ($r = 0.673$; $p \leq 0.001$),
- Culture employee oriented ($r = 0.753$; $p \leq 0.0001$),
- Organisational culture - organisational practises ($r = 0.731$; $p \leq 0.0001$),
- Lean treated as a business ($r = 0.752$; $p \leq 0.0001$),
- Philosophy ($r = 0.731$; $p \leq 0.0001$) and
- Lean change strategy ($r = 0.652$; $p \leq 0.002$).

These reflected significantly high correlations with the best performing companies. Essentially, what this result shows is that in the Lean Audits undertaken, the five best performing organisations demonstrated high correlations with components of what ensures that companies are treating Lean as a philosophy.

6.3.4 The first objective

The first objective hoped to establish whether an organisation embracing Lean as a philosophy actually performed better; overall, this situation has proven to prevail. The best performing organisations endorsed that:

- fewer barriers would be allowed to manifest,
- the importance of the "people" category which embraces the following individual indices:
  - Employee perception surveys,
  - Health and Safety per employee,
  - retention of top employees,
  - the quality of professional and technical development, and
  - quality of leadership development

  and the "Customer" indices; namely:
  - market share by product group,

- customer satisfaction index,
- customer retention rate,
- service quality,
- responsiveness and
- on-time delivery

were clearly made evident,

- there was a wider application of Lean; this was substantiated by the application of Lean to the personnel and the number of departments in an organisation,
- Lean sustainability; namely the proportion of an organisation's employees and departments operating under Lean conditions; for the best performing organisations it was 72.5% of the departments and 74.5% of employees operating under Lean. In contrast, it was 54.7% of the departments and 55.4% of the employees in the remaining organisations. This was reinforced by a correlation of 0.7 at a 0.008 significance level in reference to the aspiration of improving the supply chain management in these organisations,
- Tools in application; the best performing organisations had an average of 82% application, whereas the remaining organisations had an average of 69%,
- A considerably higher number of cultural factors were in existence in the better performing organisations. In 60% of the cases the better performing organisations confirmed a higher score against each of the cultural questions posed,
- The financial indices were not considered more important than the remaining and the significance of all the five categories was conveyed,
- the most important indices affecting the overall performance in ranking order were the: Future, People followed by the customer indices,
- The Lean audit results confirmed that Lean sustainability ($r=0.673$; $p \leq 0.001$), Culture employee oriented ($r=0.753$; $p \leq 0.0001$), Organisational culture - organisational practises ($r=0.731$; $p \leq 0.0001$), Lean treated as a business ($r=0.752$; $p \leq 0.0001$), Philosophy ($r=0.731$; $p \leq 0.0001$) and the Lean change strategy ($r=0.652$; $p = \leq 0.002$) demonstrated significantly higher correlations with the best performing companies,
- The tools listed as having a high correlation with the best performing companies were *elimination of waste, kanban systems, supplier base reduction, single piece flow operation, and process mapping*. Equally, *improved teamwork and improving the supply chain management* played a prominent role. Likewise, they recognised the importance of *higher profitability*, *improved employee performance*, *improved market share*, *increased competitiveness* and *constant waste reduction*.

Consequently, those organisations which performed better depicted all of the characteristics deemed necessary should an organisation regard itself as treating Lean as a philosophy. They were able to demonstrate sustainability, an appropriate culture, the need to treat Lean as a business, Lean change strategy, fewer barriers, a wider application of Lean across the organisation and a better overall tool application. The Lean audit showed how these organisations accomplished better results on the philosophy indices themselves.

6.3.5 Remaining objectives

The objectives seeking to establish:

- when an organisation embraces Lean as a philosophy, and to
- Identify the stage of the Lean journey an organisation had attained were also wholly met as a consequence of the Lean audit devised and piloted in twenty organisations.

The projected seven stages are outlined in Table 6.1 with an indicative content of the core characteristics outlined for each phase.

Stages of a Lean Journey	
Seven Stages	**Indicative organisational characteristics**
Planning	No implementation; benefits evident but no infra-structure and no organisational decisions have been implemented;
Developmental	Implementation started; pilot area selected and work commenced; no roll out; few tools with little subsequent commitment; may have been implemented in other areas; importance of culture not recognised;
Mechanical	Pilot progressing well; few tools embedded within the internal organisation but largely within manufacturing only; tools are implemented in a piecemeal fashion with little consideration of correlations; importance of culture not recognised;
Enhanced	Pilot proven successful; roll out programme progressing in other key areas within the internal organisation; predominantly manufacturing based; recognition that culture and organisational practices need addressing but few tangible signs visible towards accomplishing this;
Holistic	Roll out programme on track; internal organisation nearly incorporated; suppliers embraced and signs towards integration of the whole value chain; organisational and culture developments still in their infancy;
Innovative	Lean principles applied across the whole internal organisation; good progress towards integrating across the entire value chain; some cultural and organisational development issues fully implemented but further progress required; ingrained as a strategy;
Ideological	Lean tools, culture and organisational practices alongside the ideology implemented across the value chain; recognised as a combination of value streams, Lean viewed as the way of working with a quest for perfection apparent;

Table 6.1
Lean Stages Clarified

The scores of the Lean audit (Appendix two) were divided amongst the professed seven phases of Lean. A maximum of 1,040 points were possible covering twelve areas and embracing 104 individual indices. The points were divided as shown in Table 6.2:

Lean Assessment scoring system		
Lean stage	**Required Points**	**% of the maximum score of 1,040 points available**
Ideological	**936**	**>90%**
Innovative	**780**	**>75%**
Holistic	**624**	**>60%**
Enhanced	**468**	**>45%**
Mechanical	**312**	**>30%**
Developmental	**156**	**>15%**
Planning	**0 – 155**	**0% - 15%**

Table 6.2
Audit Scores

Correspondingly, an organisation could secure a marking of, for instance, 650 points; according to the table this places the respective organisation at the "*Holistic stage*". Accordingly, whilst still pursuing this hypothetical example the fictitious organisation has three probable Lean courses of direction:

- It may progress to the next stage by tackling the existing barriers,
- It could stay at this level but never reap the full benefits Lean offers, or
- It fades and either settles at a lower Lean phrase or the journey begins to fizzle out.

The ideological stage is tantamount should an organisation wish to view Lean as a philosophy and hope to reap the full benefits that Lean has to offer. Unfortunately, whilst the research established the process, no organisation within the sample had reached the philosophy stage.

If one was to accept the premise that Lean should always be considered as a journey, it was critical to be able to identify the voyage organisations needed to undertake in their quest to be regarded as a truly Lean organisation. Many frameworks assist to identify the state of a Lean implementation within an organisation. Nonetheless, two particular deficiencies were identified:

- The audits did not wholly investigate the true state of Lean as there was evidently a heavy reliance on the operational aspects of Lean; consequently, the sustainability and ideological facets relating to Lean were largely ignored, and
- A clear correlation of the audit results to an organisation's position on the Lean journey was not clearly acknowledged.

Undeniably, a full Lean implementation requires considerable investment; an important contribution of the research also focuses upon the entire requirements or inputs should any organisation be earnest regards its Lean journey. Too many organisations embark upon this journey without a full comprehension of the total expectations (Ransom, 2008; Lee, 2008). Consequently, the audit questionnaire acts as an excellent review and proceeds to enlighten an organisation of the requirements if it is to be triumphant in implementing Lean.

6.3.6 Supplementary conclusions

The literature intimates towards the lack of successful implementations; whilst the focus of this research was not primarily concentrated on this topic, it was revealed that no organisation in the sample viewed Lean as a philosophy. A multitude of factors could have contributed to this situation which the investigation highlighted.

6.3.6.1 Aspirations from Lean

There was total concurrence amongst the sixty-eight organisations regards the top five aspirations from Lean; these were as follows:

i. increased competitiveness,
ii. increased efficiency,
iii. higher productivity,
iv. higher profitability and,
v. Lower manufacturing costs.

However, very importantly, the following:

- improved teamwork and,
- improve supply chain management

were amongst the lowest quoted aspirations from Lean.

6.3.6.2 Cultural implications

Initially the Case studies (Appendices Ten – Sixteen) indicated that either one or a combination of more than a single factor such as:

- the perception of Lean,
- the established confidence within Lean and
- the method by which Lean is communicated within the respective organisations

necessitates varying degrees of attention. Organisations which contributed to the survey analysis were requested to score against each of the ten statements trying to capture the culture of the organisation. The organisations' representative was encouraged to score between "1" to "10"; a "1" signifying total agreement with the statement in reference to the organisation. Overall the survey results reinforced the Case Study analysis; out of the ten questions asked:

- The average for "1" and "2" over the ten questions was 7.1% for two questions,
- The average score for "5" and "6" over the ten questions was 28.9% (over quarter of the respondents)
- The average score for "9" and "10" over the ten questions was 17.5% (nearly one in five of the respondents).

By way of a synopsis, evidently the cultural factors were not embedded in the organisations and this would have had a detrimental effect on the overall organisational efficiency.

6.3.6.3 Barriers

The barriers to broaden the application of Lean assisted to elucidate why organisations have failed to reach the juncture whereby Lean is viewed as a philosophy. The top seven barriers identified in ranking order were as follows:

i. Insufficient supervisory skills,
ii. Employee attitudes / resistance to change,
iii. Insufficient workforce skills to implement Lean,
iv. Insufficient senior management skills to implement Lean,
v. Insufficient management time,
vi. Cultural issues and the
vii. Cost of investment.

6.3.6.4 Lean sustainability

It was important to try and gauge the proportion of the organisation's departments and employees operating under the Lean umbrella. Whilst, as demonstrated earlier that the ratios varied according to the size of the organisation; when an analysis was undertaken on an average of the all the companies in which a survey was carried out, the situation exposed was that only 58.6% of the departments and 59.6% of the organisation's employees were operating under Lean conditions.

6.4 Limitations of the Research

Every concerted effort was made to either eradicate or reduce potential limitations within the research in order to secure absolute reliability of the results. Any methodology adopted has potential inherent problems. Nonetheless, potential issues surrounding validity, reliability and generalizability were never relinquished. A superior extent of validity and reliability was secured than would have been the case with a single methodological approach (Anderson, 2008). Equally the "Puttick grid" which characterises organisations according to the amount of uncertainty faced in the organisation's market and which uses indices such as sales and product mix; also the level of complexity of the organisation's products and examines factors such as product and process complexity was also utilised. Moreover, the sixty-eight surveyed organisations and the seven Case Study organisations represented small, medium and larger manufacturing entities according to the CIMA classifications (2005). Furthermore, the Product-Process matrix was used to gauge the range of organisations comprising the sample. Likewise, it was considered imperative to integrate a Case Study protocol in an effort to ensure reliability.

Nonetheless, the determination regarding the number of survey questionnaires required is complex. A significant degree of accuracy was sought and bearing in mind the kind of statistical analysis that was planned and the variability in the samples, research suggests that the smaller the population, the bigger the ratio of sample size to population size. In the case of smaller populations (under 1,000) a ratio of about 30% is advisable. Populations between 1,000 -10,000 a ratio of about 10% is acceptable and for populations over 15,000 a ratio of 1% may suffice (Smith et al, 2000; Anderson, 2008). However, having secured access to seven organisations as Case Studies appreciably enhanced the confidence in the results. Surveys and Case Study research have quite diverse intentions and cannot be viewed as interchangeable; nonetheless that makes them excellent complementary tools. The survey research accumulated the numerical evidence which was interpreted with the use of statistical generalisations. The statistical comparison of the companies' data was analysed by using the software SPSS version 13.0 for Windows embracing both parametrical and non-parametrical tests. The consensus opinion was that by increasing the number of questionnaires to approximately one hundred, parametric analysis would have been possible; however, a non-parametric analysis was appropriate. Spearman's Rho was considered as it is the non-parametric option to the Pearson's correlation and measures association between rank orders.

In a discussion of generalisability, the issue of the whole research being based solely on manufacturing organisations within Britain needs to be clarified. At the onset, it was decided that whilst the Lean principles are increasingly applied within the service sector, that the research will be focused in the manufacturing sector alone. This decision was made as the tool application, the objectives, and the barriers to adoption and the prevailing cultures would contrast considerably between the sectors. However, it is necessary to stress that whilst the organisations were based in Britain, the ownership varied as is depicted in the Table 6.3:

Ownership of the organisations represented in the Surveys and Case Studies	
Organisations completed the Surveys	**Organisations acted as Case Studies**

Total Number	Foreign Owned	Total Number	Foreign owned
68	23 (34%)	7	2 (29%)

Table 6.3
Organisations that are foreign owned

Equally a cautionary observation is required in reference to the performance measures utilised. Whilst it is accurate to suggest that the traditional performance measures do not work in a Lean environment (Shah et al., 2007); some degree of prudence is required if we are to suggest that the various indices utilised in the model proposed had improved solely as a direct consequence of Lean. If an organisation has been on the Lean journey for three years and its indices intimate that, for instance its,

- Profit after interest and tax,
- Earnings per share,
- customer satisfaction index,
- Cycle time,
- capital efficiency and
- Ratings on an employee satisfaction survey undertaken have improved.

It is extraordinarily difficult to accurately determine whether all or some component only was attributable to Lean (Baggaley, 2006; Tangen 2005; Malone et al., 2005). Nevertheless, in reference to the research, every effort was made to ensure that a substantial degree of conviction would be held with the results. The survey respondents were informed that their responses should take into account the naturally projected growth rates and that the research was concentrating solely on the impact of Lean in their organisation. Equally, additional integrity was secured through the Case Studies whereby within the seven organisations at least eight informants were used in each case study; the split was as follows:

- two managers interviewed in a semi-structured manner using interview schedules,
- two shop floor operatives interviewed in a semi structured manner again utilising interview schedules,
- two different managers were requested to complete a questionnaire and,
- two different shop floor operatives were also asked to complete a questionnaire.

The aforementioned analysis verified that whilst the ranking and percentages may have fluctuated, that the impact of Lean on the respective indices was always positive.

6.5 Future research

It is firmly felt that two specific areas would benefit from some future research being undertaken.

6.5.1 Replicating the study in non-manufacturing

A noticeable natural extension would be to replicate the investigation undertaken but in a non-manufacturing environment. The principal emphasis throughout this enquiry centred on the appropriate tools, processes, cultures and performance management of Lean within the UK manufacturing companies. The application of Lean within the health service, for instance, has witnessed a major intensification since 2004 and the literature still depicts a sketchy implementation record. It would be particularly useful to determine:

- Any similarity of the barriers which are encountered,
- The level of significance of both change and cultural issues,
- whether the Lean journey mirrors the stages depicted within this investigation,
- the key issues in attempting to implement appropriate performance measurement systems,
- whether the time span towards high levels of sustainability are comparable to the manufacturing sector and
- the relevance of the complexity of processes within an organisation in endeavouring to secure a Lean system.

Correspondingly to manufacturing, a huge investment is undertaken by organisations embracing Lean and it is considered that the investigation identified would benefit both organisations on the Lean journey and those considering adopting its philosophy.

6.5.2 Applying Lean during a crisis.

It is considered that insufficient research has been undertaken on the ability of Lean to assist organizations in a major crisis and heading towards severe trading issues and possibly ultimate closure. Since the 1990s the manufacturing sector has been in free fall with one after another company closing, downsizing or re-locating to a low cost economy. Table 6.4 is a summary from the information provided by ESRC (2007):

The Size of the UK's Manufacturing Sector			
Year	**Number of enterprises**	**Total Turnover £m**	**Total employment (000s)**
1999	170,196	461,771	4,269
2001	164,718	461,898	3,964
2003	158,528	447,178	3,535

Table 6.4

UK Manufacturing Sector Size

The Economic and Social Research Council (2007) report shows that over a period of 2001-2004 the investment in UK manufacturing as a proportion of total business investment has fallen from 14.7% to 12.3%. The EEF (2001) asked companies what proportion of their production they expected to be located abroad in five years time. Overall, organizations expected at least some of their production to move abroad and this was a rise from 34% to 49%. A similar question was asked by the "Manufacturer" Magazine (2005) and its conclusions are summarized in Table 6.5:

Movement of manufacturing abroad		
	All of their manufacturing operations	**Part of their manufacturing operations**
Very Likely	**4**	**23**
Quite likely	**8**	**23**
Not very likely	**19**	**19**
Not al all likely	**71**	**35**

Table 6.5
Movement of UK manufacturing

We need to recognise that the UK manufacturing sector is still the sixth largest manufacturing sector in the world employing nearly 3m people and contributing more than £150 Billion a year to the UK economy (MAS Bulletin; May, 2009). It has raised productivity by 50% since 1997, with 75% of business spend going towards research and development and is responsible for about half of Britain's exports (MAS Bulletin; May, 2009). Consequently, it would be useful to establish the capability of Lean in the type of economic climate faced by many manufacturing organisations presently; the prominent issues would need to ascertain whether:

- Lean when applied in a comprehensive and systematic manner can in fact assist organisations through its concentration on the basics of process improvement,
- It would facilitate delivering approximately the same functionality to customers and still make a reasonable margin while selling the products for a lower target price,
- If, operated effectively, a well planned and executed Lean implementation could be largely self-financing since the increased cash flows could fund the implementation.

6.5.2.1 Royal Doulton's experience of outsourcing

Many other British organisations could learn from the experiences of Royal Doulton (in many respects the instigator of this investigation) since it began to outsource from Indonesia. The company substantiated the subsequent empirical data suggesting the need to add approximately 50% to the quoted price to reach a total cost figure. Furthermore, the company failed to fully recognise the following costs:

- increased response time,
- reduced sales,
- a reduction of trust from our supply chain partners,
- image and perception of the organisation; within a year it became evident that our tableware exports to the USA had shrunk by over 30%; the marketing department stated that the only reason forwarded was that the ware was not manufactured within the UK,
- a loss of intellectual propriety, and
- increased vulnerability.

No country has ever built a sustainable competitive advantage based on low wages. Equally, organisations cannot persistently pursue cost cutting strategies. Inevitably, wages along with other costs begin to rise, as they have already began to in China. However, it does mean that the successful Chinese firms will commence manufacturing operations in other regions. We can witness evidence of this already in Europe and America whereby some organisations that moved to low wage locations such as Brazil and China discovered that cheap direct labour costs can easily be offset by a whole host of unforeseen additional costs. Accordingly, Lean should and could be utilized effectively to initially retain and subsequently improve this position.

6.5.2.2 Adapting performance measurement

Accordingly, in proposing the application of the Lean philosophy during severe adversity, the performance measurement techniques would necessitate refinement too. The research highlighted the need to look beyond just the financial measures whilst addressing the short-comings of the balanced score card. Consequently the model proposed by Maltz et al., (2003) was adapted. However, if the intention is to attain a stringent system to gauge whether Lean assisted to revolve the fortunes of a flagging organisation, changes are required to existing performance measurement systems. This too needs to act as a preamble for future research as it is considered that various key gaps need to be addressed; namely:

- how to deploy enterprise performance management rather than measurement systems,
- how do we accurately and reliably measure performance across the whole value chain of an organisation to secure an accurate impact of Lean which would have proven difficult in this investigation should the organisations have reached that stage,

- the need to look at the intangible and tangible assets; existing literature lacks the capability to accurately quantify the correlation between intangible and tangible assets,
- a need to examine ways to develop dynamic rather than static measurement systems which take account of organisational changes, and
- owing to their complex structure the task of an aggregate measurement development for the corporate level in multinational corporations is more complicated and needs to be awarded greater attention.

6.6 Conclusions

6.6.1 Benefits of Lean

A major deduction of the research was that despite the risks associated with Lean, organisations considered that the benefits outweighed the potential pitfalls. Ultimately Lean will simplify the planning and scheduling process at the same time as it compresses the total Lead time through the supply chain. An important conclusion which emerged suggested that larger companies were more successful as a consequence of adopting Lean. Various emerging factors were discovered that might have contributed to this; namely a wider application of Lean across the value chain and a more conducive culture. Moreover, in investigating the average length that the top six quoted Lean tools had been in operation it was established that larger organisations performed 30% better than the smaller organisations and 35% than medium sized organisations. Furthermore, if we are to accept Lean as a business ideology, once again it was discovered that the larger organisations seem to trace the results of their Lean implementations more fervently than was the case with smaller and medium sized organisations.

The investigation focused on the highest performing organisations to determine the underlying factors for this enhanced performance. Within these organisations, the Lean barriers are either not permitted to develop and/or do not prevent the organisation from advancing on its Lean journey. Furthermore, the best performing group of organisations had 17.8% more departments and a further 18.9% of its employees operating under Lean conditions. The application of the appropriate tools and at a suitable time should not be undervalued. In an exploration regards the top six tools, the best performing organisations had a 13% superior application. Likewise, in the ten questions posed to all the organisations to gauge their prevailing culture, in 60% of cases the best performing organisations confirmed a higher score against each of the respective statements. Consequently, the culture in these organisations was more conducive towards Lean.

Ironically, the finance factors did not necessarily have a greater impact on the overall performance of the organisation; the average scorecard performance of each category revealed the following ranking order for the remaining organisations: *Process, Customer, Future, Finance and People*. Likewise, the ranking order for the best performing organisations was as follows: *Customer, Future, Process, People and Finance*. Lean is still driven predominantly at the factory level, witnessed by the ranking of the "*process*" indices amongst the remaining organisations, but is rated third for the best performing organisations.

When we endeavour to rummage further into the individual indices, the top seven separate indices reiterated this point pertinently; the seven highest performing indices for the remaining organisations all belonged to the "*process*" category; namely *Cycle time, space productivity, raw material inventory, WIP Inventory, Stock turnover, defects of critical components and labour productivity*. However, the top seven for the best performing organisations reflected three from the "*customer*" category; namely *customer satisfaction, responsiveness and on-time delivery*. There were three from the "*process*" category; namely *stock turnover, raw material inventory and defects of critical products*. The seventh highest, *depth and quality of strategic planning* belonged to the "*future*" category. Correlations were undertaken to assess the association between the category averages; the conclusion could be made that the most important indices affecting the overall performance of any organisation and in ranking order are as follows:

i. Future
ii. People and
iii. Customer indices.

This is enormously revealing since it shows the impact of the non-finance indices.

The Lean audit undertaken in twenty organisations reinforced the important findings. Most enlightening results were found based on Wilk's Lambda and related to the strategies:

- Overall safety, cleanliness and orderliness (λ=0.870),
- Production and operational flow (λ=0.899); and
- Processes and operations (λ=0.862)

showed to be not different for the best performing group of companies (which means they are common characteristics only for the five best). The most important correlations from the Lean audit supported the previous discriminant analysis for the following strategies: "*Lean sustainability*", "*culture employee oriented*", "*organisational culture - organisational practises*", "*Lean treated as a business*", "*philosophy*", *and* "*Lean change strategy*".

In essence the five best performing organisations demonstrated high correlations with components of what determines whether an organisation is treating Lean as a philosophy; namely:

- sustainability,
- culture,
- needing to treat Lean as a business,
- Lean change strategy and the
- Philosophy indices themselves.

However, it has to be stressed that no organisation is considered to be treating Lean as a philosophy as depicted by the audit results and the analysis on all surveyed organisations. Evidently, organisations which demonstrated the appropriate processes; namely:

- barriers not permitted to develop,
- a wider application of Lean across the departments and employees,
- sustainability,
- Lean extended to the value chain,
- a wider application of the Lean tools,
- a more sustained application of the Lean tools regards length of use,
- a more conducive culture and change strategy,
- a concerted effort to perform well in a broader sense and not concentrate on the financial benefits alone,

did in fact perform much better and this strongly indicates that when treated as a philosophy, Lean will reap greater benefits. The true benefit of implementing Lean is the overall strengthening of the system. If applied properly the Lean methods will make any shortcomings in the system appear quickly, and the shortcomings will have profound impacts. Lean results in improvements in operational performance and is derived by taking a holistic approach to applying the tools and techniques to the whole value chain; once one line has been Leaned, then the improvements could be replicated elsewhere.

6.6.2 The perseverance towards Lean

Evidently the association with cost became apparent during the investigation. There was agreement between the surveys and the case study results *regards the two top reasons for Lean which were to improve performance and competitor pressures*; equally, the least likely reason too was consistent; namely as a result of attending a special event/conference. The tools and techniques that we normally associate with "Lean" are a framework that makes the application of the thinking more natural for the organisation. Every organisation's Lean journey started under different circumstances, so there exists no unique recipe. However, there was agreement between the operatives and management within the seven case studies who felt at the onset that Lean will not result in more pay or better career prospects; nonetheless, they felt that as a result of Lean their job would become more secure and ironically that they may encounter more pressure as a result of the organisation's decision to adopt Lean. Consequently there was commitment towards the Lean journey. Lean cannot be viewed in the narrow sense of a set of tools, techniques and practices, but rather a holistic approach that transcends the boundaries of the shop-floor. Nonetheless, the transition to Lean requires considerable effort and change. The research showed that implementing Lean can be extremely intricate. This was exposed by the top listed barriers to broaden the application of Lean within the surveyed organisations; in ranking order the top barriers were:

i. insufficient supervisory skills,
ii. employee attitudes / resistance to change,
iii. deficient workforce skills,
iv. limited management skills,
v. scarce management time,
vi. cultural issues and the
vii. cost of investment.

In essence, it embraces the need to fundamentally rethink the business strategy, design responsive and capable processes whilst restructuring the organisation and the supple chains to support them.

Often omitted from Lean implementations are the organisational development aspects that provide the mechanism to hold things together. This includes a change management process aligned to the culture, a performance reward structure; pay systems, a performance measurement system and workforce organisation. Most companies began their Lean journey at a tactical level whereby the results are often restricted and short-term. This can often be attributable to a cost-cutting outlook which consequently results in a long-term loss of market share. Undoubtedly, the cost cutting method towards achievement inherently has a high probability of failure. Growth is the solution and there is a need to modify the Lean strategy. An investigation into the expectations from the organisations' respective Lean journeys reflected this; the top six ranking expectations were as follows: *higher productivity, higher profitability, increased efficiency, lower manufacturing costs, the elimination of waste, and increased competitiveness*. Ironically, the bottom three aspirations from Lean were: *improved market share, improve the supply chain management and improved teamwork*. Organisations need to view their business as a "value system" from the customers' perspective whereby they move their respective Lean strategic preferences towards growth-oriented targets rather than cost-cutting ones. Consequently, instead of the obsession of considering Lean as a means to achieve additional margins to boost share prices it should be focused towards sales and becoming more responsive to demand. In this case, it will continue to be able to maintain lower costs, reduce prices and increase the organisation's market share.

6.6.3 The Lean philosophy

The importance of culture cannot be denied. Lean can only be implemented to an extent before an organisation needs to actively engage its total supply chain including customers and partners. Equally, whilst Lean had proven itself, few organisations were willing to take the necessary steps to adopt Lean thinking across the whole value chain. The research indicated that only 30% of the organisations were even striving towards embracing Lean across the value chain. The investigation revealed that every organisation is unique and is likely to have distinctive problems and constraints. It is imperative that Lean is engrained in the organisation so that it can find its own answers. For any organisation to achieve Lean, it needs to go beyond streamlining today's processes and fundamentally redesigning tomorrow's products, production processes and supply chains. Lean supply chains work because activities are closely synchronized with each other and are closely aligned with customer demand. During the investigation it was rare to find evidence of well structured procedures focusing people to perform the correct tasks. Undoubtedly, there were indications of charts tracking progress over recent months evidenced in all the seven case studies. However, this does not drive activities on the shop floor and if an outsider cannot easily witness what needs to be done on a daily basis, then neither can the employees. The overall investigation illustrated that a major difficulty for many companies attempting to apply Lean thinking is not a lack of knowledge of the respective Lean tools and techniques but a lack of direction, planning and adequate project sequencing. Ultimately, Lean needs to be witnessed as a business philosophy, the more you believe in its doctrine, the easier it is to transform the business and to reap the benefits; this was aptly reflected by the best performing group of fifteen organisations.

6.6.3.1 Appropriateness of Lean

In conclusion, Lean does aid competitiveness by improving overall performance. There is no final product and no end game; it is a journey that needs to start strong and never ends. Lean needs to be viewed as a developing discipline and dynamic since it is improving as days pass by. Lean should be treated as a long term commitment with the ultimate goal requiring it to be viewed as a philosophy. The investigation reflected upon the seven stages of Lean and that no one organisation had achieved this juncture. However, those organisations that had made progress towards this state, were demonstrating better performance levels. The successful practitioners use it to change the entire culture. Undeniably, market characteristics of an industrial sector should influence the type of production strategy chosen. A push system utilising batch production can be effective for automotive component manufacturers given unstable customer demand and short term customer relationships. Lean practices do not provide a compelling competitive edge in all operational practices. A combination of low production volumes, extensive product and process innovation, the continual negotiation of new business contracts and the prevalence of customer switching can result in frequent and severe disruptions to production. Batch production with its de-coupled flow can provide a solution to manage these disruptions. The batch system permits operational flexibility to deal with disruptions caused by product and process innovation, customer switching and new business efforts. This consequently permits organisations the flexibility to try out new businesses and customers. Plants in discrete industries are more likely to implement JIT than those in process industries where kanbans are difficult to imagine. Equally, TPM practices are more likely to be implemented in process industries than in discrete industries. Paradoxically, the findings make sense when one considers the high degree of magnitude placed on capacity utilisation in process industries. Nonetheless, the findings did suggest that Lean practices are prevalent in all industries and do not need to be restricted to industries associated with discrete part manufacturing.

Often vehicle organisations will award new suppliers some low volume, top-up work for existing products. Accordingly, the customer is awarded time to test out the new supplier's quality and delivery performance. Likewise, it gives the supplier a chance to check out its product costs and manufacturing requirements. In essence, both counterparts are able to try out the proposed relationship. When organisations produce low volumes of diverse and changing product lines; this makes it very difficult to achieve a balanced flow of product based upon standard times. In this case, a small organisation with many different categories of customers and a schedule that changes all the time, may struggle to guarantee the consistency required to set up cells. Lean can find it difficult to deal with turbulent and consistent change; Lean is seen to be more successful in areas where the tasks are stable, repetitive and uncomplicated. Nonetheless, as was demonstrated in this investigation Lean is increasingly applied in sectors outside the high-volume repetitive manufacturing environment. Equally, from a strategic perspective it is possible to integrate other approaches without challenging the core objectives of Lean. Good examples would be overall equipment effectiveness (OEE) and overall supply chain effectiveness (OSCE). Equally, Six Sigma attacks sources of variation by applying a rigorous set of quality tools that are highly compatible with Lean approaches.

Consequently, there has to be installed a recognition that to stay Lean, it is vital that strategic and operational changes go outside manufacturing. Equally, the decision towards Lean should not be made frivolously since to be successful, it needs to replace the previous ways of thinking and acknowledge that it needs to embrace a paradigm shift in corporate level decision-making that affects the entire value chain. The most efficient organisations are those that can simplify and smooth the flow from raw material input to the final product. In 2009, the cost pressures are still evident as US and Japanese manufacturers are faced with low-wage competitors. However, the wage gap is so wide that there is no way cost reduction alone can bridge this gap. To be competitive, organisations need to have an edge on quality, lead time, flexibility, and product innovation. In this sense, Lean can be viewed as the pursuit of concurrent improvement in all dimensions of manufacturing performance.

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